



Planning for the Impacts of Climate Change on Colorado's Water Supply

Overview

Colorado's rising population, rapidly evolving economy, and frequent droughts, along with a projected increase in both temperatures and climate variability, are increasingly pressuring the State's water supplies. Meeting the short-term and long-term needs of Colorado's citizens, businesses, agricultural producers, and environment under these conditions will require collaborative and innovative approaches. To better support water resources decision making, the Colorado Water Conservation Board (CWCB) has studied and incorporated climate change impacts on hydrology into State water resource planning.

Background

In November of 2015, Colorado released its first comprehensive [Water Plan](#) as a road map for collaborative policy and decision making. The *Plan* incorporates climate change into statewide water resource planning and management to ensure "a productive economy, vibrant and sustainable cities, productive agriculture, a strong environment, and a robust recreation industry." The *Plan's* success will be measured by achieving quantifiable objectives, goals, and actions by which Colorado will address projected future water needs and track program progress. Relevant goals focus on planning for the future; preparing for and responding to natural disasters; preparing for climate change; and encouraging water reuse.

Over the past few years, the CWCB conducted several studies to examine how climate change will affect the State's water resources. The Colorado River Water Availability Study (CRWAS) aims to quantify how much water is available for future development, including the potential effects of climate projections. A collaboration between the State and water providers, the Joint Front Range Climate Change Vulnerability Study (FRVS) combined the results of the latest climate science with the best available hydrologic simulation capabilities to gauge future streamflow trends.

The Colorado River Water Availability Study (CRWAS)

The Colorado River Water Availability Study (2009-

Program Partners: Colorado Water Conservation Board (CWCB), Colorado's Front Range

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2012, ongoing) is a multi-phase effort which aims to quantify how much water is available for development under future climate conditions. This effort analyzes water supply and water use for the Colorado River and its tributaries.

Phase I provided Colorado River stakeholders with updated models and information on historic and future water availability based on existing levels of water use (i.e., absolute water rights and operating agreements from 1950 through 2005). In addition to historic hydrology analyses, alternate hydrologic scenarios were assessed using recently published results of "downscaled" global climate models (GCM) for the river basin to derive resulting temperature and streamflow changes. Stakeholders have used Phase I results to consider a range of potential future hydrologic conditions, better understand the uncertainty in water management decisions and projections of future climate conditions, and inform water resource policies and programs.

Phase II (ongoing) will address projected future water use levels for State beneficial uses, as well as other potential "non-water right" uses. The information provided by CRWAS serves as a foundation for water resource planning; as resource managers can base planning decisions on their own level of confidence in the historic hydrology, paleo hydrology, or climate-adjusted hydrology.

CRWAS has provided reliable technical analyses that have helped Colorado develop comprehensive water

supply planning tools. Providing a tremendous amount of data about a variety of possible future hydrologic conditions, CRWAS allows users the freedom to interpret the data in the context of their programs, priorities, and water management systems. [Colorado's Decision Support Systems](#) (CDSS), with its integrated databases and simulation models, is likely the most comprehensive, transparent, and geographically extensive system for water supply analyses in the U.S.

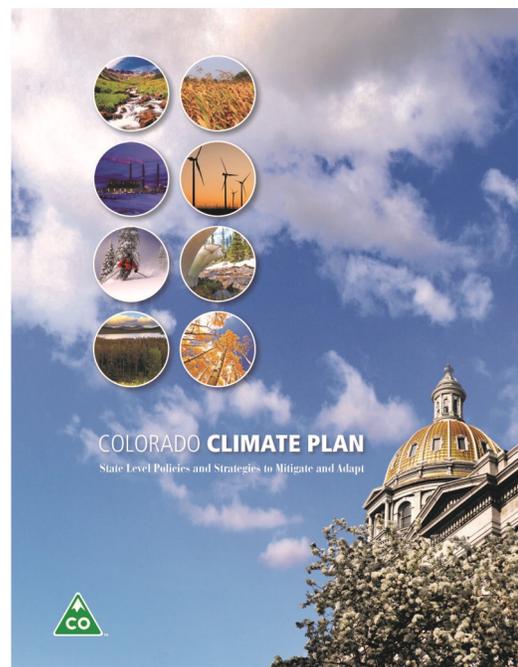
The Joint Front Range Climate Change Vulnerability Study (FRVS)

The main goal of the [Joint Front Range Climate Change Vulnerability Study](#) (FRVS) was to determine streamflow sensitivities to increases in temperature and changes in precipitation. It focused on developing and applying procedures for combining the latest climate science with the best available hydrologic simulation capabilities to gauge streamflow trends expected under future climate conditions.

FRVS simulated climate change impacts on hydrology in the Upper Colorado River Basin, Upper South Platte River Basin, and Upper Arkansas River Basin. To assess potential changes in the timing and volume of hydrologic runoff for years 2040 and 2070 (compared with 1950 to 1999), two [hydrology models](#) were developed and calibrated for the three river basins at 18 [gauge sites](#). The [temperature and precipitation projections](#) used to generate corresponding streamflow came from regionally downscaled temperature and precipitation GCM output. Projected and historic streamflow were then compared to estimate the sensitivity of water supplies to climate change. An educational component was included in FRVS, which was essential to developing the methodology, interpreting the results, and identifying research needs for addressing uncertainty and variability. A final report presenting the Study's results and evaluation of the potential impacts of climate change on Colorado's water availability is currently available [online](#). Another key output was a set of climate-adjusted streamflow sequences representing the impact of future climate projections on un-depleted streamflow volume for the 18 gauge site.

Regional water providers can use FRVS' climate-adjusted streamflow sequences, in conjunction with other water system models, to estimate the impacts of climate change for future water supply planning

purposes. Water providers can also use the information to identify robust management strategies that better address variability and uncertainty in annual water supplies. Furthermore, the methods used to select GCMs, the development of adjusted historical climate sequences, and hydrology simulation developed by FRVS can be applied to assess climate impacts on water supplies for other locations with access to downscaled GCM datasets. Overall, FRVS provides a better understanding of the issues around hydrologic response to climate change that informs local and statewide planning efforts, as well as future research needs.



Collaborating to Support Statewide Water Resource Planning

Both studies reflect effective coordination with other State programs to minimize technical overlap and support implementation of the *Water Plan*. CRWAS involves numerous State-sponsored programs and CWCB projects, including the CWCB Climate Change Technical Advisory Group (CCTAG) and even the [FRVS](#). The CWCB also coordinates CRWAS efforts with ongoing water policy and management programs, especially the [Interbasin Compact Committee](#) and the [basin roundtables](#). FRVS' collaborative approach allowed participants to identify and support a common assessment methodology, develop a coordinated set of evaluation tools, and efficiently utilize resources.