

## **Drought and Climate Change**

### **10.1 INTRODUCTION**

This chapter explores the possible effects that changing global climate conditions and periodic droughts may have on present and future El Dorado County water supplies, and actions the agencies can taken to mitigate these impacts.

### **10.2 CLIMATE CHANGE AND ITS EFFECT ON COUNTY WATER RESOURCES**

Climate change is affecting most of the world's resources. The effect that climate change or global warming has on temperature, sea levels, snow pack, agriculture, forests, and public health is a function largely of greenhouse gas emissions rates. As emissions rise, global temperatures rise. The effects are becoming more evident in rising sea levels, earlier snowmelt, and increasing atmospheric concentration of Ozone and CO<sub>2</sub>, all of which indicate worldwide climate change.

Governor Arnold Schwarzenegger signed Executive Order S-03-05 on June 1, 2005, which acknowledged the adverse effects that global warming will have on many of the States resources, including reducing Sierra snowpack, a major source of California's water supply. In recognition of this threat, the Order states that green house emissions, including carbon dioxide, methane, nitrous oxide and hydrofluorocarbons be lowered by 2010 to 2000 levels, by 2020 reduced to 1990 levels, and by 2050 be reduced to 80 percent below 1990 levels<sup>45</sup>.

As stated in the Order, the California Environmental Protection Agency (CalEPA) has commissioned a study by the California Energy Commission's Public Interest Energy Research (PIER) and its California Climate Change Center (CCC). The 2006 biennial report entitled "*Our Changing Climate, Assessing the Risks to California*" is the product of a multi-institutional collaboration between the California Air Resources Board, California Department of Water Resources, California Energy Commission, CalEPA, and the Union of Concerned Scientists. This report summarizes the effects of three possible climate change scenarios; lower, medium high, and high emissions scenarios. The CCC report was used to describe and predict the possible climate change effects on El Dorado County's water resources.

The detrimental effect on water resources from rising temperatures in California would be immediately felt by the water purveyors in El Dorado County. For instance the County relies on heavy winter snowfall in the Sierras for much of their water supplies to replenish flows in the American and Cosumnes watersheds when the snow melts in the spring, providing fresh clean drinking water, as well as cold, freshwater fish habitat. Rising temperatures due to global warming, under any of the aforementioned scenarios, could be devastating to the County's economy, hydropower production, agriculture, and freshwater supply.

### **10.2.1 WATER SUPPLY**

A reliable water supply cycle is critical to California's current water system. Rising temperatures threaten to reduce Sierra snowpack by 25 percent by the year 2050<sup>44</sup>. The risk of flooding will increase as less water is stored as snowpack because more precipitation will fall as rain. This will necessitate the need for more storage reservoirs to serve as flood control and water storage.

In response to the need for more storage, Governor Schwarzenegger proposed a \$4.5 million Strategic Growth Plan in January of 2007 to invest in storage and conveyance infrastructure in California, in response to current trends and climate research. The proposal provides up to three million acre-feet of additional surface storage, which would supply 500,000 acre-feet of annual water supply. Also part of the proposal is 500,000 acre-feet per year available from groundwater storage, and water conservation projects that would save 200,000 acre-feet per year<sup>46</sup>.

### **10.2.2 HYDROPOWER**

Several hydropower plants operating within the County depend on river and stream flows originating in the Sierra Nevada mountain range. For instance, SMUD operates Loon Lake, Robbs Peak, Jones Fork, Union Valley, Jaybird, and Camino powerhouses as part of the UARP on the South Fork American River and the Rubicon River. Similarly, EID operates El Dorado Powerhouse as part of Project 184 on the South Fork of the American River. The sale of Project 184 power has important economic benefits to for EID. Renewable hydroelectric power supplies approximately 15 percent of California's electricity.

The possible impact to electricity resources in California caused in part by rising global temperatures is two-fold. The demand for energy demand in California will significantly increase if temperatures

rise. At the same time, the higher temperatures would decrease snowpack runoff in rivers and streams, decreasing the potential for hydroelectric power generation by as much as 30 percent

### **10.2.3 AGRICULTURE**

Agriculture is an important part of El Dorado County economics, open space, and recreation. Apple Hill, a rural area in Camino known for its apple orchards and Christmas tree farms, is a popular fall tourism spot. There are also many vineyards and boutique wineries in the Sierra Foothill region that depend on available water and predictable day-night temperatures during the spring and summer growing season. Potential water shortages caused by climate change would impact agriculture in El Dorado County, as this sector is often required by purveyor policy to take shortages before domestic users.

According to predictions from the Climate Change Center, wine grapes are expected to be particularly hard-hit by rising temperatures, which could cause grapes to ripen up to two months earlier, affecting grape quality. Fruit trees are also likely to suffer from rising temperatures. Chill hours required for proper fruit development are diminishing statewide, and temperature increases in the 5.5 to 8° F range could cause chill hour requirements for some crops in the Central Valley to reach a critical threshold<sup>44</sup>.

Agriculture is dynamic in the county and cropping patterns have changed decade to decade due to market factors, insect pressure, and introduces species. These patterns will continue in the future. A shift to crops such as walnuts that can survive prolonged periods with no water and can even be dry farmed, or lower water use crops that can tolerate hotter, dryer conditions, such as olives, will likely occur if climate conditions change as predicted. Whatever climate dynamics unfold over the next century, agriculture will adapt as it has in the past (Kirk Taylor – EID). This is a water master planning level document that identifies potential demands based on agricultural land capability. As a master planning document it will be updated over time to reflect new information and agricultural trends.

## **10.3 WATER SUPPLY PROJECT EFFECTS ON CLIMATE CHANGE**

### **10.3.1 INTRODUCTION AND BACKGROUND**

Much has been written about the effects of climate change on the environment, particularly on the potential effect of climate change on water resources and their management. The previous section

provides detailed information on the potential effects of climate change on the hydrology of the American and Cosumnes Rivers and the management of the river resources. Despite that plethora of information on the potential effects of climate change on water resources, little has been written to date on the effects of water and land use projects on climate change. The purpose of this section, therefore, is to introduce and address some of the potential effects of supplying water for future land use on climate change. Some of the effects will exacerbate the potential problems which might be caused by climate change; some may actually reduce the effects of climate change.

Water projects that would result in potential land use changes could result in indirect impacts on climate change. The discussion presented in Appendix K is intended to serve as an introduction and initial assessment of an issue, a set of issues, for which appropriate standards of practice will evolve as others expand and develop appropriate research and specific recommendations. Just as NEPA and CEQA practices have evolved over time, so will the assessment of the potential effects of water- and land-use on climate change evolve.

### **10.3.2 CONCLUSIONS AND RECOMMENDATIONS REGARDING IMPACTS ON CLIMATE CHANGE**

From the discussion in Appendix K, it would appear that:

*Water projects of themselves may have some direct impacts on climate change:* they could be both adverse and beneficial;

*Water projects could have indirect impacts on climate change:* by enabling changes in uses of the land that in themselves have the potential to impact the production of greenhouse gases could impact climate change;

*Many types of land-uses can affect climate change:* the list of human activities that could affect climate change is not limited to transportation alone;

*Land use activities don't necessarily all have adverse effects on climate change:* as noted, a project which might itself have adverse consequences could replace a project or activity that has even greater consequences; and

*Increasing sequestration of carbon is one of the keys to reducing greenhouse gases:* by increasing the amount of carbon that is actually stored in living materials, in wood products, in

the soil or deeply underground, or in water bodies could decrease the amount of CO<sub>2</sub> released to the atmosphere.

Much more can and should be done to determine the effects of water- and land-use activities on the production of greenhouse gases. Research and development are needed in each of the areas described above.

## **10.4 DROUGHT CONSIDERATIONS (WESTERN SLOPE)**

### **10.4.1 DROUGHT CYCLES**

Dr. David Jones, professor emeritus, Department of Geology and Geophysics, University of California at Berkeley, along with the Citizens for Water group in El Dorado County, has investigated hydrologic cycles affecting the American River during the past century and compared this historic record with information from past centuries derived from tree ring studies. This comparison shows that droughts in past centuries were more severe and of longer duration than any drought experienced during the last century. The historic data show a period of declining rainfall followed by 30 years of normal rainfall, with the remaining part of the century characterized by highly variable conditions. Tree ring data substantiate a similar cyclical pattern extending back to 1600, but with longer periods of drought. These data show that long-term drought is part of the normal climate pattern and suggest the need to plan for drought emergencies by providing additional storage for drought protection. A copy of Dr. Jones' paper is included in Appendix H.

### **10.4.2 DROUGHT RELIEF FOR OTHER COUNTY AREAS**

Drought planning efforts on the western slope, discussed in this chapter, are considering supplemental supply from water purveyors for private wells both inside and outside their service boundaries. Specific language is expected to appear in the western slope water purveyor individual drought plans with respect to the level of responsibility each are willing to take. EDCWA's response to dry well assistance requests will also be defined in its overarching drought plan for the County. These plans are anticipated to be considered for adoption by each Board around the first of the year (2008).

In the Tahoe Basin, as on the western slope, purveyors have been generous in the past when asked for assistance in emergencies. While Tahoe purveyors have specific policies regarding dry well relief for individual property owners, they have historically provided assistance during water shortages of

all kinds. STPUD also has mutual aid agreements and physical interties with three private water companies in the Tahoe Basin.

### **10.4.3 THE SHARED VISION MODEL (SVM) ANALYSIS**

The El Dorado County Western Slope Drought Analysis presents the key outcomes of the first phase of drought analysis effort including: a consensus-based, collaborative stakeholder process, the development of a Shared Vision Model (SVM), and input from a team of veteran experts. The second phase of the drought analysis will establish drought preparedness plans for each of the purveyors participating in this study. Phase 2 is expected to be completed by mid 2007. Agencies involved with this drought planning analysis are the El Dorado County Water Agency (EDCWA), El Dorado Irrigation District (EID), Georgetown Divide Public Utility District (GDPUD), Grizzly Flats Community Services District (GFCSD) and the City of Placerville. These stakeholders participated in the analysis by serving as Drought Advisory Committee members.

The Shared Vision Model assumptions are as follows:

- Purveyor historical record: GDPUD (1966-1980), GFCSD (1911-1987), EID (1922-2004)
- Design drought conditions refer to 1976, 1977, 1977 (repeated) hydrology

### **Climate Change Factors**

Projections of future climate change are represented by changes in seasonal river flow patterns. This assumes lessening amounts of water stored in snow pack, reductions in average annual precipitation amounts, and an increase in the extent and frequency of drought. In order to incorporate the potential for climate change, various climate scenario factors were applied to each purveyor's actual hydrological record as well as the design drought scenario, base 1976, 1977, 1977 (repeated) hydrology. These factors represent the relationship between actual hydrology and four types of shifts in projected hydrologic runoff conditions. These shifts are based on regionally derived scenarios developed by Dr. Jay Lund and his research analysis team at UC Davis. These are the same data sets used in the forecasting tools for the Department of Water Resources, Bulletin 160: California Water Plan and the California Energy Commission Climate Change Report (Vicuna, 2005). Dr. Lund's information for American River watershed inflows to Folsom Lake under four different scenarios was used to index the runoff hydrology and reflect the possible impact due to climate change. The

four scenarios consist of (1) HCM 2050 Scenario, a warmer and wetter climate in year 2050, (2) PCM 2050 Scenario, a cooler and drier climate by year 2050, (3) HCM 2100 Scenario, a warmer and wetter climate by year 2100, and (4) PCM 2100 Scenario, a cooler and drier climate year 2100. PCM 2100 Scenario represents the potential “worst case” climate change scenario for drought. Additional information on how these climate change scenarios were created is provided in the Appendix E of the April 2006 *El Dorado County Western Slope Drought Analysis - Phase I Report*. The second phase of this effort is expected to be complete by the end of the year. When this analysis is completed, information relevant to this Plan will be included as an amendment or addendum.

## Conclusions

Independent of climate change, the SVM demonstrates that demand cutbacks (as adopted in each purveyors water shortage contingency plans) and conservation efforts alone will not decrease drought shortfall magnitudes. A few examples of the effects of enacted drought mitigation measures under projected 2030 demands are summarized below.

- •EID can almost completely mitigate projected 2030 shortfalls under design drought conditions and historical hydrological flow patterns with cutbacks and PL101-514 and the White Rock Diversion Project (92 percent reliability in a design drought) or PL101-514, groundwater banking and Alder Creek Reservoir (94 percent reliability in the design drought).
- GDPUD can expect shortfalls about 5 percent of the time, with a drought being called and policies enacted almost 50 percent of time with cutbacks and Rubicon River 1B UARP and PL101-514 implemented in design drought conditions.
- GFCSD can almost completely mitigate design drought conditions (97.8 percent reliability) with the use of a 350 AF off-stream storage reservoir that is half full at the beginning of the drought. Under historical record-based conditions and the use of an off-stream reservoir the system reliability is 99.7 percent.

A summary report provided in Appendix H provides more detail on system reliability impacts resulting from the climate change scenarios described in this section.

#### 10.4.4 WATER EVALUATION AND PLANNING (WEAP)

The actions contemplated in the drought plan are fairly general. Other planning initiatives contemplate more refined actions either on the infrastructure operations side or on the demand management side. To this end, El Dorado Irrigation District (EID), the Stockholm Environment Institute-US Center (SEI-US) and the National Center for Atmospheric Research (NCAR) have been working collaboratively to more fully integrate climate change considerations into the ongoing multi-agency drought planning effort through development of the Water Evaluation and Planning (WEAP) Decision Support System.

The SVM drought planning process relied upon the use of a water resource systems models to simulate facility operations under observed historic stream flows and a spreadsheet model that manipulates the output of the systems model to assess the effectiveness of proposed responses to periods of drought and climate change. By starting from observed historic streamflows, these tools cannot easily adjust to understanding how flows and operations would change as a result of significant climate change in the American River watershed. While the Shared Vision Model applies various climate scenario factors to each purveyor's actual hydrologic record and design drought scenario and evaluates reliability, WEAP, seamlessly couples water supplies generated through watershed scale hydrologic processes with a water management model driven by water demands and environmental requirements, both governed by the natural watershed and physical network of reservoirs, canals, and diversions.

A WEAP model of a portion of the EID water system (WEAP-EID) has already been developed, calibrated, validated, and applied. The next step currently underway will expand the model to the entire CABY region providing water managers a flexible tool for integrating climate thinking into general operations decision making.

WEAP and the climate change study recommended by this plan will be the first steps in insuring that water supplies will not be over extended. As the effects of climate change are more clearly understood, purveyors will likely adjust their water supply availability policies to avoid over allocation of current and new supplies. County over-site of purveyor water supplies pursuant to Ordinance No. 4385 will provide another layer of protection against over extension of new water supplies. If the effects of climate change are underestimated, and in the absence of new supply sources, many options are available to adaptively manage reduced water supply availability. Outdoor

demand reductions not currently contemplated by the EDC purveyors, can be accomplished through severely inclined rate structures, residential and commercial grants for turf replacement and other incentives used in drier areas of the state and country. Adaptive management may be used in certain operational aspects of individual water agency projects as well.