

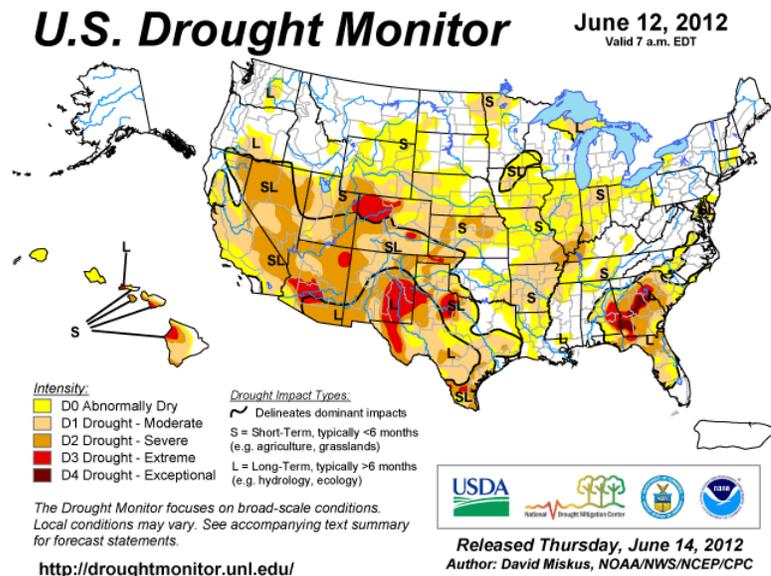
## CLIMATE CHANGE and WATER IN THE SOUTHWEST AND NEW MEXICO

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Climate change models predict that as temperatures rise and precipitation patterns shift, water supply challenges will grow. In this article, we review the current literature on what climate change is predicted to hold for our region.

### Climate Change and Science.

The U.S. southwest is an arid land which has long been subject to considerable climate variability; that is, wide variations in precipitation, temperature and periods of drought. Tree ring studies show that New Mexico and surrounding areas are presently in a very wet period compared to the last 2000 years and that even the 1950's drought was less dry than the long term average.



1 - Courtesy of <http://droughtmonitor.unl.edu/monitor.html>

Climate scientists believe that, in addition to natural variability, there is a new factor involved in the changes which they are observing. Temperatures in the southwest have risen 2 degrees Fahrenheit in the last 100 years and could be as much as 15 degrees warmer in the summer in another 100 years. This temperature rise corresponds with increases in greenhouse gases in the atmosphere.

Greenhouse gases such as carbon dioxide and methane occur naturally in the environment. Over the last century, however, levels of these gases in the atmosphere have risen dramatically as activities such as the burning of fossil fuels, industrial and agricultural processes, and urbanization have accelerated. The natural sinks which capture carbon being introduced into the atmosphere are being eliminated or disrupted through processes like deforestation and oceanic sediments disturbance. The levels of greenhouse gases are higher than in the last 650,000 years. As atmospheric carbon increases, heat is trapped and temperatures rise.

Dr. Jonathan Overpeck (University of Arizona) reports that warmer temperatures throughout the year are causing earlier snowmelt, changes in runoff, decreased soil moisture, and more evaporation. These changes result in declining water supply in rivers and reservoirs. Climate models indicate the trend of rising temperatures will continue. Winter precipitation is, on average, decreasing in the U.S. southwest.

In part, this is due to the jet stream and the storms it carries shifting northward. Dr. Overpeck indicates this shift is consistent with science's understanding of human-caused climate change. He cautions, however, that the models are less certain about summer monsoon predictions. He observes that the problems of reduced precipitation and decreased water supply are compounded by a longer, more intensive demand for water during the summer. Dr. Overpeck notes that the models' predictions are borne out by observational records from the last several years.

When there is insufficient water for an extended period in streams, reservoirs, aquifers, lakes, soils and from precipitation to meet current needs, a "drought" or more specifically "hydrologic drought" occurs. Dr. Overpeck warns that the current drought in the southwest and across the nation is mild when compared with drought record from the past 2000 years. Although the roles of climate variability and human activities in climate change and drought is hotly debated, he asserts that they appear to be connected. Regardless, Dr. Overpeck urges that drought-prone areas, like the southwest, take steps to be more prepared and more resilient to the predicted challenges.

In preparing the Environmental Impact Statement for the Navajo-Gallup project, the U.S. Bureau of Reclamation relied upon the work of researcher N. Christensen, M.S.E. and Dr. D. P. Lettenmaier (University of Washington) to analyze effects of climate change on temperature, precipitation, runoff and evaporation in the San Juan Basin. Christiansen and Lettenmaier analyzed data from eleven general circulation models, two future emission scenarios and three time periods, and reported that:

"[g]enerally, for the time period 2070 to 2099 compared to historic conditions, mean temperature is predicted to increase in the range of 2.7 to 4.4 degrees Celsius, and precipitation is predicted to decrease from 1 to 2 percent. Other predicted changes include:

- An earlier, warmer spring
- A drier, warmer summer
- A shift in precipitation from summer to winter
- Peak runoff to the San Juan River occurring about 1 month earlier
- An increase in spring runoff monthly flows
- A decrease in summer runoff and summer base flows
- An increase in evaporation
- Increases in irrigation demand (may occur as a result of increased summer temperatures and decreased precipitation)

The impact to total runoff to the San Juan River is expected to be from -38 percent to +8 percent."

Rising temperatures and changing precipitation patterns have tremendous impacts on natural and human systems. In the last 20 years, up to 18% of southwestern forests have died due to drought, insect and disease epidemics and wildfires. Southwestern forests are sensitive to precipitation changes and very sensitive to warmer temperatures. These conditions, along with over-crowding caused by fire suppression, weaken the trees making them more susceptible to bark beetle, disease, and infestations, resulting in death. In New Mexico, millions of piñon and ponderosa pine have died, particularly in northern areas.

Dying forests, heavy fuel loads from decades of fire suppression, abnormally dry conditions, and high



2 - Courtesy of United States Forest Service

temperatures fuel intense, sometimes huge, wildfires, such as the Wallow (AZ) and Las Conchas (NM) fires of 2011. Since the 1990's, changing conditions have led to a ten week expansion of the western fire season. These fires kill and injure wildlife and destroy their habitats. They release carbon into the air and ash into the rivers, adding to greenhouse gases and polluting water ways. The wildfires also increase the risk of flooding as plant material that once slowed and absorbed runoff

from melting snow and storm events is burned away and soils become hydrophobic.

New Mexico has experienced these effects first hand. Over the last 14 years, the Pueblo of Santa Clara has experienced the pain of wildfire and its aftermath of flooding. Following the 2011 Las Conchas fire, it was estimated that damage from wildfire covered 30% of the reservation, 50% of the Pueblo's watershed and 80% of its forest. This damage opened the way to water quality degradation and potentially dangerous flash floods. The Santa Clara watershed was stripped of vegetation and the soils baked rendering them hydrophobic, or resistant to absorbing water. In the August 2011 flash flood, Santa Clara Creek became blocked by mud from erosion, water control facilities were filled with silt and debris and the earthen dam of one of the reservoirs was threatened. Further downstream on the Rio Grande, the Buckman Direct Diversion that supplies the City of Santa Fe and Albuquerque-Bernalillo County Water Utility Authority facilities shut down to avoid intake of mud- and ash-laden waters from the Santa Clara Canyon. In another flash flood, the Dixon Apple Orchards was demolished.

Changes in temperature and precipitation degrade water quality which affects aquatic species, particularly fish. As freshwater temperatures rise, water quality degrades and becomes inhospitable. Runoff increases the total dissolved solids and other harmful additives while salts and other pollutants become more concentrated. Changes in seasonal fluctuations of stream flows can disrupt breeding cycles, feeding and growth of fish and other aquatic species. If the dry period between spring floods and the monsoons increases, many fish may not survive. Southwest species such as the Gila chub, Rio Grande trout and silvery minnow, already under siege from diversions, are further threatened as temperature and drought conditions intensify in New Mexico and Arizona.

According to the United States' Census, in the southwest, human populations have burgeoned: between 1950 and 2010 (rounded) Arizona's population rose from about 750,000 to 6,400,000; New Mexico from about 680,000 to 2,000,000 and Nevada from about 160,000 to 2,700,000. As populations and agriculture have expanded they have come to account for 98% of use of available freshwater resources.

Water needs have been met through aggressive reservoir construction, transbasin diversions and groundwater mining.

As temperatures, precipitation, and runoff patterns and quantities change, less water will be available for storage. The CLIMAS website reports that in the spring 2012, southwestern reservoir levels tend to be low. In the eastern half of Arizona, reservoirs are well below their historical averages. In New Mexico, the Navajo Reservoir is at 79% capacity; Elephant Butte Reservoir is at 17% capacity and all the reservoirs along the Pecos River are below levels set by the extremely dry winter of 2007-08. Low reservoir levels have had adverse effects on agriculture, recreation and municipal supplies. Elephant Butte Irrigation District (NM) is projecting a total of six inches delivery in the summer of 2012; commercial rafting companies on the Poudre River (CO) are facing a year similar to 2002 when their business dropped 40% due to low flows and wildfires; and, the City of Las Vegas (NV) is drilling a third raw water intake for use when the Lake Mead levels drop below the two existing intakes.



3 - Courtesy United States Bureau of Reclamation

Transbasin diversions have been viewed as a way to bring water from rural areas to population centers. In the upper Colorado Basin, there are over 35 major transbasin diversions moving approximately 700,000 acre feet of water annual to populated areas including the Central Arizona Project, and New Mexico's San Juan-Chama Project. These projects have deprived rivers of the water necessary to support riparian ecosystems and endangered species, and have enabled human settlement far beyond the water that is native to a region. More recently, proposed private projects for transbasin transfers to New Mexico's Middle Rio Grande include the Augustin Plains Ranch Water Resource Development Project west of Socorro, New Mexico and the Berrendo Project around Ft. Sumner, New Mexico. The New Mexico State Engineer has denied the permits for both of these projects.

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#### **Climate Change, Water Supply and the Law**

In New Mexico, as in rest of the southwest, the law is used to address water demand and shortages whenever available resources are insufficient. The law tends to preserve the *status quo*. Changes through litigation are incremental and slow. As changes in temperature and precipitation become more apparent, systems of laws will be challenged to respond to meet the societal and environmental challenges of change.

### *Water Law and the States*

Western state water law addresses water allocation and distribution. Each state has developed a system of identifying, managing and regulating water use, but they all are based in the law of prior appropriation. New Mexico's Constitution provides that all existing rights are recognized; unappropriated water belongs to the public and is subject to appropriation for beneficial use; priority of appropriation gives the better right; and beneficial use shall be the basis, the measure and the limit of the right to the use of water. Its statutes provide the rules for appropriating, inventorying, forfeiting and managing water and water districts. The Office of the State Engineer is the state's water administrator and has developed regulations for the identification and management water uses.

With increased demands for and decreasing supplies of water, states like New Mexico need to develop strategies for managing shortages both short term and long term, and for living within and preserving available resources for the future. The state and regional water plans address the present and future water needs within New Mexico. Conservation programs are promoted in cities such as Albuquerque, which reached its conservation goal of 150 gallons per person per day in 2011 through rate structures, rebates for more efficient appliances and credits for lawn removal. Conservation allows cities to allocate less water for serving their customers, but removes flexibility for shortages; that is, if people are using less water, they have less to give up when a shortage occurs. And if a city conserves water, what will be done with that water? If the water savings are used to recharge an aquifer or reduce groundwater pumping, then the city is preparing for a drier and warmer future. But if conserved water is used to accommodate growth and consumer demand, the city is adding to the inevitable water crisis as water becomes more scarce.

Some strategies for meeting shortages in agricultural areas have developed. One of these is sharing surface water shortages. State statutes relating to the federal irrigation districts call for the pro rata distribution of the project supply so that, for example, in 2012 New Mexico's Elephant Butte Irrigation District anticipates delivering 6 inches to each assessed acre. To make up the difference between the 6 inches of surface water allocated and the 4.5 acre feet per acre adjudicated by the court in *State of New Mexico v. EBID*, many farmers turn to pumping groundwater. During a dry summer in 1996, the Pueblos of Jemez and Zia and several ditch associations entered into a shortage sharing agreement on the Jemez River. This agreement was entered by the court in the water adjudication case, *State of New Mexico v. Abousleman*, renewed in 2002. Water users on this river experience shortages even in years of average moisture so this agreement continues to guide the distribution of surface water in the lower part of the Jemez River system.

Other strategies used in New Mexico include water banking and water transfers. Water banking allows farmers on ditches or acequias who are not using surface water to "bank" it. This practice allows a farmer to avoid forfeiture or abandonment for non-use and neighbors to put the water to beneficial use in the present. Water transfers involve moving the right to use water through the leasing or selling of water rights by willing parties. A transfer must be done in accordance with the rules and regulations of the State Engineer; may involve experts, hearings and trials; and, can be very expensive in time and dollars. If a transfer involves water delivered by an acequia or community ditch, it may have to be approved by the acequia or ditch before the parties approach the State Engineer.

Priority administration is the ultimate tool for water rights management within a state in times of drought. In New Mexico and much of the west, the senior use, that is, the one established first and maintained through time, has the right to a full allocation from the current water supply before any

junior user. The authority for priority administration lies within the New Mexico Constitution and the authority to carry it out lays with the State Engineer. Administration requires that the manager know sufficiently the priorities and amounts of the rights to be administered. The standard ways of identifying these elements is through either adjudication or licensing. This water administration system is hampered because while these processes are ongoing, much of the formal adjudication or licensing has not been completed.

In 2004, the Office of the State Engineer promulgated the Active Water Resource Management (AWRM) regulations, which in part, defined the types of documents that could be used to identify priorities for administration when rights were not been adjudicated or licensed. These regulations were challenged in court and in 2010 the New Mexico Court of Appeals rejected using documents other than court decrees and licenses for administration. The Supreme Court has the case under review. The New Mexico State Engineer has implemented priority administration on the Cimarron River and on Costilla Creek in northeastern New Mexico; both adjudicated watersheds are located in primarily rural areas.

There are serious social and economic consequences to this approach to water management. The most senior users in New Mexico are Native Americans, whose rights are huge and mostly unquantified, and farmers. Junior users tend to be domestic, municipal and commercial and located in population centers. Since New Mexico does not prioritize uses, under prior appropriation, these junior users could be completely cut off from water if seniors are satisfied and the water supply is depleted. Strategies for supporting juniors in times of drought while supporting senior users must be developed and implemented even where priorities and quantities have not been formally recognized through adjudication.

#### *Water Law and the Federal Government*

Historically, the federal government deferred to state governments in the area of water allocation and distribution. The general exceptions to that rule involve tribes and sister states. In the allocation of water to tribes, the Department of Justice represents the United States in its trustee relationship with tribes in state and federal court water right adjudications. Tribes and the United States rely on federal case law such as the *Winters Doctrine* (Congress set aside sufficient water to meet the purpose of a reservation when it set aside the land) and the PIA standard from *Arizona v. California* (tribal reservation set aside for agricultural purposes is entitled to sufficient water to serve all practicable irrigable acreage) to describe tribal rights. Congress also enacts legislation to approve and fund water right settlements like those of the Crow Tribe (MT), Taos Pueblo (NM), White Mountain Apache Tribe (AZ), and the Aamodt Pueblos of Nambé, Pojoaque, San Ildefonso, and Tesuque (NM). In the allocation of water between sister states, Congress enacts legislation to formally recognize allocation agreements between them, such as the Colorado River Compact of 1922 (CO, NM, UT, WY, NV, AZ and CA) and the Rio Grande Compact (CO, NM and TX).

In 1902, Congress created the Bureau of Reclamation to construct and manage large water supply projects primarily for the benefit of agriculture. Today, the Bureau is the largest provider of water in the United States. Its mission is to “manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.” The Bureau works with environmental laws, partners with other federal agencies, states, tribes, the public and others, and, incorporates climate change research and effects in executing its mission.

Several laws work together to authorize and guide agencies like Reclamation and the Fish and Wildlife Service in enhancing, protecting and managing the water supply and related species habitats. The

National Environmental Policy Act of 1969 (NEPA) requires federal agencies to integrate environmental inquiry and considerations in the planning and decision-making in any major project. It requires full disclosure and consideration of alternatives, impacts and possible mitigation measures. It requires participation by states, tribes, local governments, and public and private organizations. As a part of the process, the agency must prepare an Environmental Impact Statement (EIS). As a part of the EIS, the agency must take into consideration any species listed under the Endangered Species Act (ESA).

Reclamation conducts a NEPA investigation as a part of each project it undertakes. One ongoing project involves the construction of the Navajo-Gallup Water Supply system (NM). This project will deliver water to the Navajo Nation, the Jicarilla Apache Nation and the City of Gallup. The final EIS for this project was published in September, 2009. A part of the EIS addresses mitigation measures designed to protect the two fish species, the Colorado pikeminnow and razorback sucker, listed under the ESA. The February 26, 2009 Biological Opinion includes a provision requiring the Bureau to monitor the fish and their designated critical habitat for climate change effects on timing and amount of runoff. If such effects will adversely affect the fish or their habitat, Reclamation is required to reinstate consultation with the Fish and Wildlife Service to consider appropriate action. Thus, providing sufficient water for species in the face of climate change is an important concern in developing a water supply system for humans.

The Omnibus Public Land Management Act of 2009 contains the SECURE Water Act. In the Water Act, Congress recognized adequate and safe supplies of water as fundamental to the health, economy, security and ecology of the nation. It identified climate change as a significant factor affecting these supplies. Congress directed the federal government to support state, regional, local and tribal governments in acquiring data, conducting research, and executing plans and projects to ensure future water supplies.

The Department of Interior has launched several water initiatives to provide accessible science-based information on the effects of climate variation and to fund local and collaborative projects. These programs are designed to facilitate risk assessment and the development of mitigation strategies at all levels of government as well as in the public and private sectors. Reclamation has a new website which increases access to stream flow data from 195 river and stream sites in the west. The USGS announced a new modeling studies program that projects effects of climate change on water availability in 14 basins, including four in California and Colorado. Reclamation is funding data collection, research activities and projects to assess climate change risks in major water river basins, including basins of the Colorado, Rio Grande, and Truckee Rivers. The Fish and Wildlife Service has a strategic plan for responding to accelerating climate change in which it will work with the larger conservation community to ensure sustainability of species and habitats. Access to this kind of information and the funding to develop resources is critical to people at every level working to meet the challenges of climate change and to achieve sustainable water supplies.

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### **Conclusion**

According to the Palmer Hydrological Drought Index of Long-term Conditions as of April 2012: ([http://www.ncdc.noaa.gov/img/climate/research/2012/apr/phd201204\\_pg.gif](http://www.ncdc.noaa.gov/img/climate/research/2012/apr/phd201204_pg.gif))

- Arizona: Much of the southern part of the state is in moderate to severe drought.
- California: Southeastern California is in severe drought while the southwest area and Central Valley area is in moderate drought.
- Colorado: Southern and western parts of the state are in severe drought while the San Luis Valley is in extreme drought. On June 13, 2012, Representative Cory Gardner wrote to the U.S. Secretary of Agriculture Thom Vilsack to issue a drought declaration for certain Colorado counties. The declaration will help farmers who seek federal aid.
- Nevada: Northwestern part of the state is in severe drought while the northeast is in moderate drought.
- New Mexico: Most of the central and southeastern parts of the state are in extreme drought. The northeastern and southwestern parts are in severe drought. On May 15, 2012, New Mexico's Governor, Susana Martinez formally declared the entire state in drought, much of it suffering in severe drought at one time or another. Under the declaration, she directed the State Engineer to bring together the New Mexico Drought Taskforce to consider ways in which the state can prepare for, respond to and assist communities with serious drought conditions. The declaration will also open opportunities for communities to seek federal funding.
- Utah: Most of the state is in moderate drought while an area in the northeast was in severe drought.

Monsoons and a good snow pack next year could change all that.

The drought that we are experiencing in 2012 is indicative what we might expect of a hotter and drier climate. Reservoir levels are very low; as of May 9, 2012 the total reservoir storage in the Colorado Basin was at 62.2% of capacity. Urban dwellers will face mandatory water rationing, at least for landscaping and car washing. Irrigation districts' surface water deliveries to their customers will be cut back and those farmers who can, will turn to groundwater to keep their crops alive. While the effects on recreation and tourism is harder to measure, activities such as boating and camping may benefit from a longer season, while winter sports such as skiing are likely to suffer shorter seasons due to a lack of snow. Activities such as rafting and fishing may suffer from lower water levels and tourists are less likely to visit an area which has experienced a forest fire or the threat of one. Effects on ecosystems are also hard to measure but studies indicate that plant and animal populations migrate away or die out from historic grounds when warmer temperatures, less precipitation, low soil moisture, wildfire and drought exceed tolerable ranges. There is increasing access to science and opportunities for funding to examine and make plans for climate change, especially if communities at all levels and people of all kinds join together to approach the challenges, to devise mitigation and adaptation strategies, and to prepare themselves and their communities to live in a different world.

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