Union of Concerned Scientists

FACT SHEET

The Big Water Supply Shift

Groundwater Key to Water Security in California's Changing Climate

HIGHLIGHTS

For more than a century, California has relied on its snowmelt-fed reservoirs, rivers, and streams for the majority of its water, but drought and climate change are depleting those traditional supplies. Snow is already melting as many as 30 days earlier than in the mid-twentieth century, meaning less water is available during the hotter months when water demand is highest.

California is increasingly turning to groundwater to meet its water needs. Today, groundwater supplies up to 50 percent of California's water, but California's prolonged drought has led to the over-pumping of groundwater, overdrafting the Central Valley's aquifers. Sustainable groundwater management will allow the state to adapt to climate change while increasing water reliability in the future.

California's recent struggles with drought have brought state water supplies to unprecedented and dangerously low levels. As a result, Californians now see water management as a paramount issue of concern. Drought ranked as the greatest obstacle facing the state over all other issues in a 2015 survey of Californians. A record-high 70 percent of those polled said water supply is a "big problem" in their part of the state (Baldassare et al. 2015). Because this epic drought is a harbinger of what is to come, California must plan now for a different water future (Cook, Ault, and Smerdon 2015).

For more than a century, California has relied on its snowmelt-fed reservoirs, rivers, and streams for the majority of its water. Drought and climate change are depleting those traditional supplies, with California snowpack reaching a 500-year low (Belmecheri et al. 2015). The state surface-water storage system is not designed for a future in which precipitation is expected to come as rain rather than snow; it will consequently not be able to deliver adequate supplies. We must therefore change how we collect and manage our dwindling water resources. California is increasingly turning to groundwater to meet its water needs, so the focus must shift to making groundwater supplies more reliable and sustainable to ensure enough water for generations to come.

California Department of Water Resources

Decreased snowpack has brought less water into reservoirs (such as Lake Oroville, above, in Northern California), while increased temperatures have led to greater evaporation of surface water. Declining surface water supplies have led the state to increase its reliance on groundwater, so strong groundwater management is critical to ensuring a reliable water supply for the future.

Current Impacts and Future Risks

California residents, like people across the country, are now experiencing the consequences of global warming resulting from the buildup of heat-trapping emissions in the atmosphere. The statewide average temperature during the winter of 2014–2015 was the warmest ever recorded, at 50.5°F (NCEI 2015). That is more than 5°F warmer than the average for the twentieth century. Warming has been most evident in the Sierra Nevada, where much of the state's water supply originates, with average minimum temperatures registering above freezing for the first time and the lowest-ever snowpack in 2015 (California DWR 2015). Global climate models agree that we should expect more extreme weather in the coming years: both floods *and* drought (Georgakakos et al. 2014). Unless we make deep and swift cuts in heat-trapping emissions, future changes to our climate could be dramatic.

REDUCED SNOWPACK AND UNCERTAIN STREAM FLOWS

Higher temperatures and changes in precipitation are already having a significant impact on water resources in California. The average early spring snowpack in the Sierra Nevada decreased by about 10 percent during the last century, representing a loss of 1.5 million acre-feet of water (one acre-foot of water is enough to supply one efficient family for a year) (California DWR 2009). Winter snow accumulation in the mountains is a natural water storage system on which California relies during its drier summer months, most critically for agriculture. Snowpack decline is projected to continue as more winter precipitation falls as rain throughout much of the state.

In addition, the timing of the snowmelt is shifting, becoming out of sync with communities' needs. Snow is already melting as many as 30 days earlier than in the mid-twentieth century, reducing summer flows in many snow-fed rivers. This means less water is available during the hotter months, when water demand tends to be highest (Fritze, Stewart, and Pebesma 2011). Thus, even with similar amounts of stream flow over the year, water demand can outstrip water supply in a warming world.

MORE SEVERE DROUGHT

In addition to causing already-observable changes in the timing and quantity of surface water supply in California, global warming is also driving up water demand. For example, hotter temperatures lead to greater evaporation from reservoirs, farms, and lawns. The combination of increased water demand along with the changes to water supply is leading to more severe impacts from drought. NASA researchers report an 80 percent chance that the Southwest will experience a megadrought, one that lasts over 20 years, between 2050 and 2099 unless world governments act aggressively to mitigate climate change (Cook, Ault, and Smerdon 2015).

MORE SEVERE FLOODING

The National Climate Assessment projects that very heavy precipitation events will increase everywhere due to climate change (Walsh et al. 2014). Higher temperatures are expected to lead to more rain rather than more snow, which paradoxically may exacerbate water shortages, particularly if heavy rains follow drought. During a drought, the land becomes so parched that it is difficult for rainwater to infiltrate the soil when it finally does arrive; rather, it tends to run off suddenly and violently, creating flood and landslide conditions (Carey 2015).

In addition, our water systems are not built to store a rapid onslaught of water. In California, we have a series of dams located in the Sierra foothills, built to hold snowmelt as it is slowly released from mountain snowpack over the spring months. The reservoirs created by these dams are not as useful when there is little snow. They are also not useful when there is too much rain during the winter because they must release most of their water to ensure that floodwaters do not overtop their dams. In addition, pavement, downspouts, gutters, and sewer systems in cities force heavy rain to run off the urban landscape quickly. This not only contributes to flooding, but

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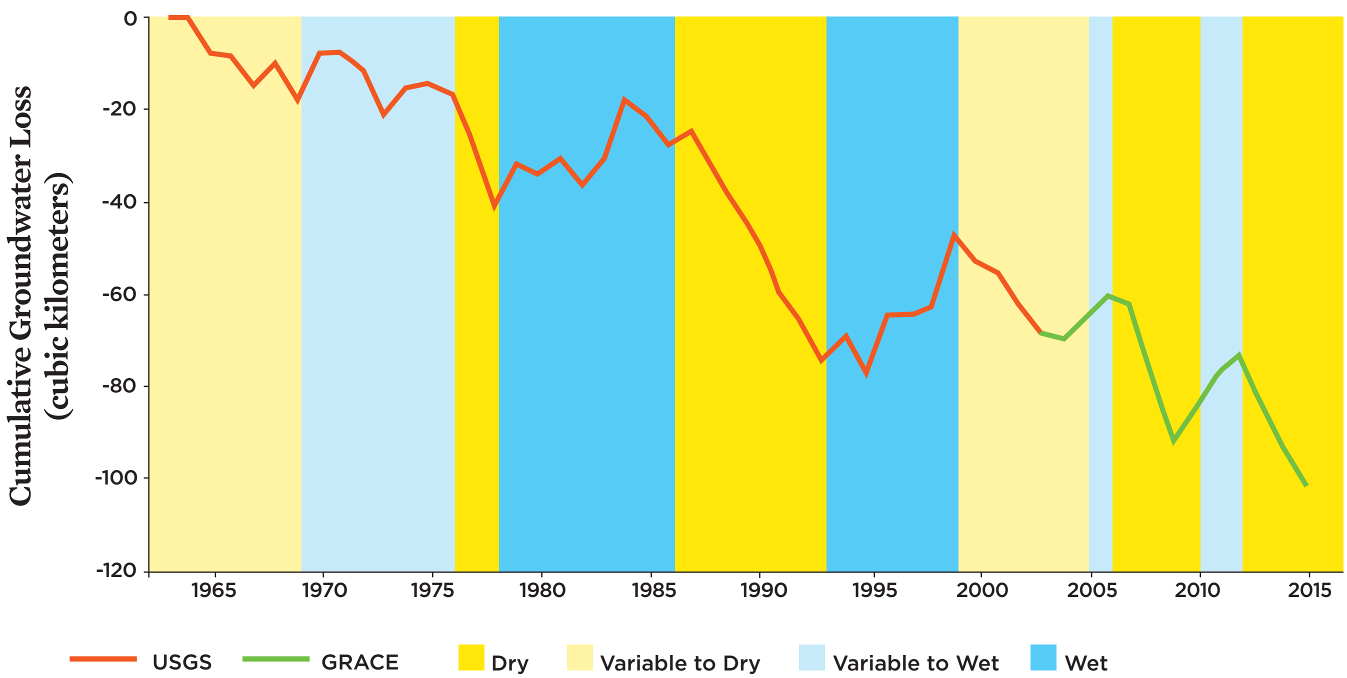
California's four-year drought has left land so parched that it is difficult for rainwater to infiltrate the soil when it finally does arrive. This can lead to sudden and violent surface runoff, creating floods (such as this one in Carmel). Redesigning storm-water capture and groundwater recharge systems can help reduce flooding and store water to use during dry periods.

Cumulative Groundwater Depletion in California's Central Valley



Cumulative groundwater losses in California's Central Valley aquifer since 1962. The red line shows data from groundwater model simulations calibrated by the U.S. Geological Service (USGS) from 1962 to 2003. The green line shows Gravity Recovery and Climate Experiment (GRACE) satellite-based estimates of groundwater storage losses. Background colors represent different water years.

SOURCE: ADAPTED FROM FAMIGLIETTI ET AL. 2014.

also means the surplus of rain has no chance to percolate into the ground to recharge aquifers below.

Groundwater: Current Problem, Future Solution

WE ARE OVERDRAWING OUR GROUNDWATER SAVINGS ACCOUNT

Groundwater supplies between 30 and 50 percent of California's water supply, depending on precipitation, and represents a storage reservoir that is over three times greater than available surface water storage. Over the last several decades, remote satellite data show that groundwater use has substantially increased during dry periods.

As with a bank account, when we continue to withdraw more than we replace, we create an overdraft in our groundwater savings. For instance, between 2011 and 2014, total water storage in California aquifers has declined sharply (Famiglietti et al. 2014), and in late 2014 reached the lowest point ever recorded. With more extreme weather projected for California, it will be critical to achieve a better balance by refilling our groundwater account during wet periods for use during dry periods. As explained in the state's water action plan, "Climate change is exacerbating ongoing problems with groundwater resources in California, including overdraft, seawater intrusion, land subsidence, and water quality degradation. Taking more than is returned lowers groundwater levels which makes pumping more expensive and energy intensive. . . . Well-managed groundwater has the potential to buffer against the impacts of climate change on our water resources" (CNRA, CDFA, and CEPA 2014).

WE CAN STORE FLOODWATERS IN THE GROUND, REPLENISHING OUR GROUNDWATER ACCOUNT

Sustainable groundwater management can help protect California from both severe droughts and severe floods. When it rains, we can slow, sink, and capture runoff in the ground to recharge depleted groundwater aquifers by redesigning storm-water capture and management systems in urban areas and developing aquifer-recharge infrastructure in rural areas above accessible groundwater. This can help reduce flooding and also prepare us for dry periods, when we can use the stored water to make up for surface-water shortfalls. In addition, higher groundwater levels can decrease the energy intensity of groundwater pumping, thus helping to reduce global warming emissions (Christian-Smith and Wisland 2015).

The Growing Importance of Sustainable Groundwater Management

Until recently, surface-water storage and conveyance have been the major focus of water management. Yet, as surface water becomes less reliable, Californians are turning to groundwater supplies. This shift to groundwater does not mean simply turning on a new tap; rather, we must create new physical and institutional infrastructure.

Over the last century, groundwater extraction in many parts of California has been largely unregulated. California's ongoing drought helped spur the passage in 2014 of the Sustainable Groundwater Management Act (SGMA), the first-ever statewide requirement for groundwater management. SGMA requires the formation of local groundwater sustainability agencies (GSAs) by 2017 and the development of groundwater sustainability plans by 2020. If an area fails to develop a GSA in time, or fails to complete a plan, or its plan is deemed inadequate by the state, the State Water Resources Control Board is authorized to take over groundwater management. This means that the State Water Resources Control Board may begin managing local groundwater resources as early as 2017.

This new institutional model for managing groundwater offers an opportunity to increase transparency and public participation. Unlike existing water management structures, which tend to be fairly insular, SGMA requires more transparency and "the active involvement of diverse social, cultural, and economic elements of the population within the groundwater basin" (California Water Code Sec. 10727.8(a)). In addition, the state together with local agencies must develop the physical infrastructure to capture, move, and store groundwater. Most important, there needs to be much better measurement and monitoring of groundwater supplies so we can understand how best to manage this vital resource.

SUSTAINABLE GROUNDWATER SOLUTIONS

SGMA represents a new chapter for water management in California. It will require unprecedented levels of groundwater information collection and analysis, new institutions and broader collaboration between existing agencies, and the active engagement of diverse interests. Although SGMA leaves much of the implementation to local entities, it also requires the state to issue regulations that set the bar for what "sustainability" means in practice. The Union of Concerned Scientists, along with many others, has recommended that the regulations include a common framework for setting thresholds that quantitatively describe what is considered unsustainable, as well as protective triggers that require management actions to avoid crossing thresholds (Christian-Smith and Abhold 2015). This framework will provide greater regulatory certainty and pave the way for successful implementation of SGMA. Sustainable groundwater management offers a new pathway, allowing the state both to mitigate and to adapt to climate change while increasing water reliability in the future.

[Sustainable groundwater management can help protect California from both severe droughts and severe floods.]

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