BAY AREA WATER SUPPLY AND CONSERVATION AGENCY
BOARD OF DIRECTORS MEETING

March 13, 2015

Correspondence and media coverage of interest between January 2015 and March 12, 2015

Correspondence

Date: February 2015
From: Dan Wade, SFPUC WSIP Director
Re: 2014 Year In Review

Media Coverage

Conservation:

Date: March 12, 2015
Source: SF Gate
Article: State poised to step up crackdown on water wasting

Date: March 9, 2015
Source: San Jose Mercury News Editorial
Article: California urban water users must get serious about conservation

Date: March 4, 2015
Source: San Jose Mercury News
Article: California water conservation weakening as drought worsens. Tougher rules on the way?

Drought:

Date: March 11, 2015
Source: Capital Public Radio
Article: Despite Drought, Not Time For Drastic Measures

Date: March 11, 2015
Source: San Jose Mercury News
Article: Bay Area rain will be short-lived; it could reach 80 this weekend

Date: March 9, 2015
Source: The Marin Independent
Article: El Nino not the savior for drought concerns around Bay Area, state

Date: March 8, 2015
Source: Associated Press
Article: El Nino finally here; but this 1 is weak, weird and late

Date: March 3, 2015
Source: ACWA News
Article: DWR Says Statewide Snowpack at 19% is Lowest Since 1991

Date: January 2015
Source: Proceedings of the National Academy of Sciences
Article: Anthropogenic warming has increased drought risk in California

Water Rates:

Date: March 10, 2015
Source: San Jose Mercury News
Article: Big water rate hike plan reduced by Santa Clara Valley Water District

Date: March 7, 2015
Source: San Jose Mercury News
Article: California drought: Big water rate hikes considered by Bay Area agencies

Water Supply:

Date: March 11, 2015
Source: Bay Area News Group
Article: Surplus water buy for Dublin and San Ramon provides relief but stirs controversy

Date: March 9, 2015
Source: Sacramento Bee
Article: New Partnership seeks to restore Sierra forests

Date: March 7, 2015
Source: Fresno Bee
Article: Droughts can expose quirks, create confusion in California water management

Date: March 5, 2015
Source: Santa Cruz Sentinel
Article: California business coalition pushes for secure water supply

Date: March 4, 2015
Source: National Geographic
Article: Lack of Snow Leaves California's "Water Tower" Running Low

Date: March 3, 2015
Source: Modesto Bee
Article: Fish vs. people frustration rages at Oakdale Irrigation District meeting

Date: February 11, 2015
Source: Appeal Democrat
Article: Action aplenty for Yuba County Water Agency

Miscellaneous:

Date: March 10, 2015
Source: LA Times
Article: Risk of 8.0 earthquake in California rises, USGS says

Pipeline segments later installed inside the Bay Tunnel

HETCH HETCHY WATER SYSTEM IMPROVEMENT PROGRAM

2014 YEAR IN REVIEW

Welcome from Dan Wade, WSIP Director

The Water System Improvement Program (WSIP) made substantial progress by reaching over 85 percent completion by the end of 2014. We were especially excited to bring the first tunnel built under the San Francisco Bay into service. The WSIP continues to hold a remarkable safety record as construction crews have completed over seven million safe working hours to date. Our work has not gone unnoticed: WSIP programs have received national media recognition and a number of industry awards for our efficient and innovative approach to completing the critical infrastructure improvements needed to achieve our Level of Service (LOS) goals: meet water quality requirements, ensure seismic and delivery reliability, and meet water supply goals.

This newsletter is an opportunity to reflect on important milestones and to celebrate the dedication and hard work of the hundreds of individuals, including our many stakeholders, who have contributed to the overall success of the WSIP to date. We look forward to continuing this important work in 2015 and providing reliable water service for our 2.6 million customers who rely on the Hetch Hetchy Regional Water System every day.

Happy New Year!

Daniel L. Wade

New Treated Water Reservoir Brought into Service in the Peninsula

In December, SFPUC Operations staff brought our new 11 million gallon treated water reservoir at the Harry Tracy Water Treatment Plant into service. This new reservoir, along with other facilities, will allow us to provide 140 million gallons of water per day (MGD) for 60 days following a major earthquake. The reservoir consists of two reinforced concrete walls linked to a slab by splayed-out seismic cables, with a concrete channel between them that will help increase the capacity and seismic reliability of the treatment plant. The entire reinforced structure is wrapped with seismic-resistant cables and the roof sits atop 88 concrete columns.

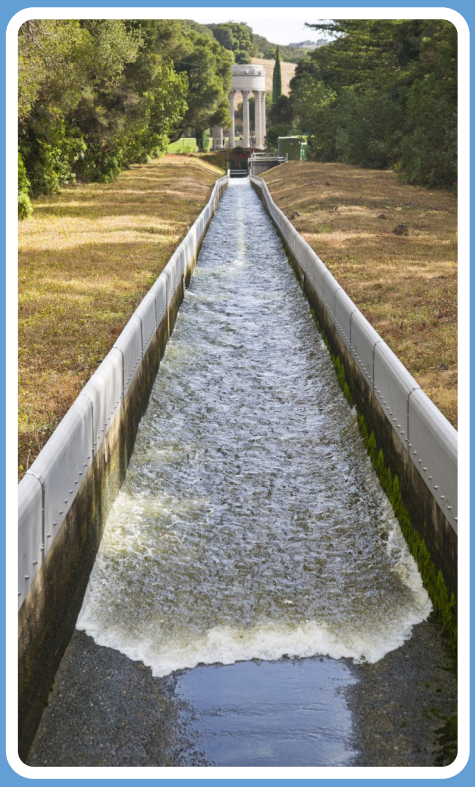
Construction on upgrades to the plant began in March 2011 and are on schedule to be completed in early 2015.

New treated water reservoir in San Bruno

Aerial of the upgraded Harry Tracy Water Treatment Plant

Celebrating the FIRST WATER from the FIRST TUNNEL under SF Bay

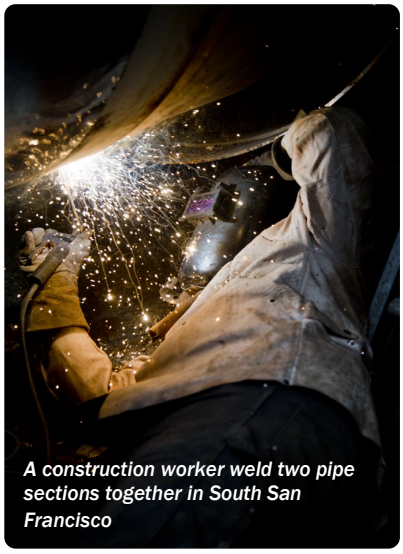
In October, the SFPUC and our Bay Area partners celebrated the completion of the Bay Tunnel, which is the first tunnel built under San Francisco Bay. This project is one of the largest in the WSIP, and was brought into service the same week as the 25th Anniversary of the 1989 Loma Prieta Earthquake that caused extensive damage to the Bay Area.



First water from the Bay Tunnel flowing into Crystal Springs Reservoir

This event also marked the 80th anniversary of when San Francisco celebrated the first water from Hetch Hetchy Reservoir to flow into Crystal Springs Reservoir. Speakers as well as local and regional media gathered to recognize both this tremendous achievement and notable anniversary, just as the first water from the Bay Tunnel passed through an open channel below the Pulgas Water Temple and into Crystal Springs Reservoir.

SFPUC Commissioner Anson Moran, BAWSCA CEO Nicole Sandkulla, San Mateo County Board of Supervisors President Dave Pine, SFPUC General Manager Harlan L. Kelly and SFPUC Commissioner Vince Courtney all helped us celebrate this big milestone



A construction worker weld two pipe sections together in South San Francisco

Construction Teams Recognized for Completing 7 Million Safe Work Hours

The construction teams working on WSIP projects recently achieved a huge and important milestone. Between April 2009 and October 2014, WSIP project teams performed 7 million hours of work on major construction projects without lost time or a single major injury, SFPUC representatives acknowledged this with the presentation of a certificate to the nine active construction management and contractor teams this last December.

Safety incident rates for the WSIP projects are well below the industry average. SFPUC management attributes this success to the robust safety program that has been embraced by the construction management teams as well as the project contractors and our partners in labor. This milestone is evidence of the project teams' outstanding commitment to the *Think Safety, Work Safely* approach, ensuring the program's construction sites are a safe place to work.

Regional Groundwater Storage and Recovery Project Reached Historic Milestone

Cal Water, Daly City , San Bruno and SFPUC celebrate signing of operating agreement

It was a quiet milestone. With a stroke of a pen, representatives from the SFPUC, and three of our Peninsula wholesale customers–Cal Water, Daly City, and San Bruno–made history. On Dec. 16, they signed an operating agreement to create a new dry year groundwater supply in the South Westside Groundwater Basin. The agreement allows these agencies to cooperatively operate the basin, ensuring its long term management and sustainability.

The Regional Groundwater Storage and Recovery Project is an important Bay Area groundwater supply project that will provide a water savings account to protect against future drought and earthquake emergencies.

Do you follow us on Twitter? Check us out via **@WSIPInTheNews** to learn about your regional water supply!

Fossil Finds at Calaveras Dam

One aspect of the Calaveras Dam Replacement Project that garnered a lot of attention from local and national media outlets this past year was the incredible fossils that have been unearthed during construction. While moving more than half of the 10 million cubic yards of rock and dirt to make space for the new dam, construction crews uncovered more than 600 fossil specimens that date back to when the area was an ocean floor more than 20 million years ago.

These marine animals include sea scallops, clams, mussels, Megalodon shark teeth (a giant ancestor of the modern great white), and even marine mammals. Paleontologists have excavated 10 whale skulls and found a Desmostylus tooth, a mammal that resembles a hippopotamus, but is believed to be unrelated. The fossil record from this period is limited, and these abundant and diverse fossil finds provide new insight into the ancient environment of 20 million years ago. The SFPUC has worked to preserve these fossils and make them available for scientific research.

A Paleontologist works to uncover fossils near Calaveras Dam

PPSU contractor finished installing more than 900 feet of pipe in Millbrae

Construction Starts on Last WSIP Pipeline Project

In August, the Peninsula Pipeline Seismic Upgrade (PPSU) Project kicked off construction in Millbrae, San Bruno, Colma and South San Francisco. To date, the project replaced 900 feet of pipeline in Millbrae and this pipeline section was brought into service in December.

The PPSU project is the WSIP's last pipeline project to start construction and will cost approximately $42 million. The project includes seismically upgrading three Hetch Hetchy regional water delivery pipelines located in Northern San Mateo County and will ensure the pipelines can continue to deliver water to customers after a major earthquake. The PPSU project will be complete in December 2015.

Media Highlights


San Francisco Chronicle
Breakthrough under S.F. Bay
5-mile tunnel to shore up region's water supply a 1st

- **Breakthrough under S.F. Bay: 5-mile tunnel to shore up region's water supply a 1st** — SF Chronicle
- **Hetch Hetchy Delivers Seismically Sound Water Tunnel** — ABC 7
- **San Francisco Looks to Groundwater to Augment Potable Supplies** — Civil Engineering Magazine
- **Ensuring a Sustainable Future** — Tunnel Business Magazine
- **New Pipelines Aid "Earthquake Country" of Fremont, CA** — American City & County
- **Slip n Slide: Innovative Pipeline has joints designed to soak up seismic solutions** — ENR Magazine
- **San Francisco's Sutro Reservoir Gets Seismic Safety Upgrades** — NBC Bay Area

2014 Awards Recap

- **Regional American Council of Engineering Companies (ACEC) Engineering Excellence Honor Awards** *(Tesla Treatment Facility)*
- **American Public Works Association (APWA) Project of the Year $25-$75M** *(Crystal Springs Pipeline No. 2)*
- **American Public Works Association (APWA) Project of the Year >$75M** *(Sunol Valley Water Treatment Plant Expansion)*
- **American Public Works Association (APWA) Staff of the Year – Engineering & Technology** *(Stephanie Wong)*
- **National American Council of Engineering Companies (ACEC) Engineering Excellence Honor Awards** *(Tesla Treatment Facility)*
- **National American Public Works Association (APWA) Project of the Year >$75M** *(Sunol Valley Water Treatment Plant Expansion)*
- **Construction Management Association of America (CMAA) Northern California Chapter 2014 Project Achievement Award** *(Crystal Springs Pipeline No. 2)*
- **American Society of Civil Engineers (ASCE) San Francisco Chapter Water Project of the Year** *(Sunol Valley Water Treatment Plant Expansion)*

Hetch Hetchy Regional Water System

Services of the San Francisco Public Utilities Commission

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State poised to step up crackdown on water wasting
SF Gate | March 12, 2015 | By Kurtis Alexander

Drought-stricken California is preparing to raise the ante on water conservation.

Starting next month, households around the state may be limited to two days a week of outdoor watering. Restaurants might be barred from serving water unless a customer requests a glass. And hotels could have to get approval from guests before washing their towels.

The constraints, which would carry fines of up to $500 per violation, are part of a broader crackdown on water use that state officials are proposing as California faces a likely fourth year of drought.

While the new conservation measures are seen as common-sense practices — steps that many people are already taking voluntarily — state officials say getting everyone on board will go a long way to stretching the state's diminished water supplies.

The proposal builds upon temporary restrictions enacted last summer, which target outdoor watering, and are set to expire April 25.

The State Water Resources Control Board is scheduled to vote Tuesday on whether to enact the new, broader rules for another 270-day emergency period. But state officials say they will eventually go a step further and consider making the mandates permanent.

"What we're experiencing now, while draconian and maybe the worst we've ever had ... may not be as abnormal as we see it today," said Frances Spivy-Weber, a member of the water board's governing council.

'Climate-change California'

Noting that drier weather may be here to stay, she said, "I think it's time to be thinking about what we should be doing in a climate-change California."

Many California homes and businesses appear ready to conserve for the long haul.

At hotels in the Bay Area and beyond, door hangers or decorative stationery increasingly advise guests that they can save water by hanging their towels after they use them — a signal to housekeepers that no laundering is needed.

"I think it's great that they put that out there," said Andrea Osojnik, 27, of Los Angeles, who was staying at the San Francisco Marriott Marquis for business and accepted the hotel's invitation to limit her laundry service. "For them to change the sheets every night seems like a waste."

At restaurants, the question of "still or sparkling?" has become common for gauging whether customers really need a glass of water.

"We'd like to sound progressive, but the truth is we just like to check with our guests and see what they want," said Miles Palliser, the owner of the Corner Store in San Francisco, where water is already served only upon request.

"I can't see why any restaurant would be opposed to this," Palliser added. "It's going to save not only the environment but the water bill."

As for outdoor watering, the proposed rules would extend the restrictions adopted in July. Those included bans on spraying down sidewalks and driveways, overwatering lawns, washing cars without a shutoff nozzle on a hose, and using drinking water in ornamental fountains.

Additionally, watering would be barred within 48 hours of a rainstorm, and local water departments that don't already limit what days their customers can water would be required to restrict watering to two days a week.

State officials say they don't know exactly how many water departments currently have no limits on watering. But under the proposed rules, agencies would have to report their efforts, as well as a host of other information to help the state better monitor conservation.

The new regulations, if approved by the state water board, would have to be signed off by the Office of Administrative Law as a matter of procedure, and likely take effect in late April.

Enforcement of the rules — including penalties — would be the responsibility of the local agencies. State water board officials say they want to intervene at the community level as little as possible but, at the same time, make sure conservation is a priority.

California is home to hundreds of water districts that independently source their supplies, whether from mountain reservoirs or coastal creeks, and some need to do a lot more than others to keep the taps flowing.

Fines up to $500

The watering restrictions passed by the state in July, like the new set being considered, allow local water departments to fine residents and business owners up to $500 for violations.

Most departments have not resorted to penalties, however, including agencies in San Francisco, San Jose and the East Bay, all of which reported that warnings did plenty to keep customers in line.

"The ability to issue fines can be an effective deterrent," said Max Gomberg, a senior environmental scientist for the water board who helped draft the regulations this year and last.

Year-over-year water use in California fell about 10 percent during the final seven months of last year, the period tracked by the state. The reduction remained short of the 20 percent cut that Gov. Jerry Brown asked of urban users when he declared a drought emergency in early 2014.

In January this year, the last month evaluated, statewide conservation was just 8.8 percent.

“Moving from where we are today to where we need to be is probably going to take more,” said Spivy-Weber.

The rainy season this year, which will soon come to a close, is on track to be the fourth in a row with below-average precipitation. State officials have estimated that California needs 150 percent of normal rainfall this winter to begin putting a dent in the drought. That is very unlikely at this point.

The state’s largest reservoirs remain lower than usual, and the snowpack that recharges those reservoirs is less than a fifth of normal.

Scientists have pinned the four dry years on a persistent mass of high-pressure air that has hung over the state and blocked storms from reaching shore. But why the system has emerged remains under investigation, with some citing climate change as a source and others saying the warming climate is merely exacerbating the state’s already dry conditions.

Researchers, though, agree that California has experienced prolonged droughts before and will see long periods of drought again.

Tightening the taps

The State Water Resources Control Board last year barred people from spraying down sidewalks, driveways and patios, watering lawns or gardens to the point of causing runoff, washing cars without a shutoff nozzle and using drinking water in ornamental fountains. New rules that may be adopted by the board Tuesday in a bid save water during the ongoing drought include:

Restaurants and bars prohibited from serving water without a customer request.

Hotels and motels required to offer guests the option of not having towels and linens laundered daily.

Water agencies required to inform customers when leaks are detected on customer property.

Water agencies required to restrict customers’ outdoor watering to as little as two days a week.

Homes and businesses prohibited from watering when it’s raining or within two days of rain.

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California urban water users must get serious about conservation
Mercury News Editorial | March 9, 2015

California is in the midst of its fourth consecutive drought year, and based on a new study by Stanford scientists, it appears to be a long-time weather pattern. The December downpours were just a nice distraction.

The state has to get serious about conserving water. Suggestions are not enough.

Emergency regulations proposed Friday by the State Water Resources Board staff would be a start, but permanent regulations are needed, and communities, at least region by region, need to be on the same page as to how to accomplish goals. Regulation by the state can help enormously by shoring up local programs like the one the Santa Clara Valley Water District is discussing this month.

Gov. Jerry Brown has called for a 20 percent reduction in water use this year, but we are nowhere close. Statewide, homes and businesses cut their water use by 8.8 percent in January compared with January 2013. The Bay Area did worse, reducing by just 3.3 percent.

Brown likes to let local governments decide on regulations. We can see differences in regions -- say, Monterey v. Fresno -- but saying anything goes city to city is confusing in a statewide crisis.

For example, the local water district will have a smaller supply to sell this year and needs to get people to conserve. But only cities and counties can enforce rules, and if each municipality has its own set, it complicates the district's work, including education campaigns.

This is one of the factors in the district's proposal for a 30 percent rate increase that will be on April's agenda. We have yet to review whether that much is warranted -- the district is still recovering from a reputation of profligacy -- but a serious drought will increase district costs.

In Santa Clara County, Morgan Hill has become a model in conservation by limiting landscape watering to one day a week, among other things. Since watering lawns accounts for about half of California's household water use. this would go a long way toward meeting conservation goals if it were broadly adopted.

The State Water Resources Control Board's proposal allows local water agencies to come up with their own conservation plans, but if they're not meeting the 20 percent goal, it says they should limit yard and landscape watering to two days a week. The board calls for fines of up to $500, but inforcement is up to municipalities.

Lower water use has to become the norm. Agriculture can adjust by shifting from, say, almond orchards back to less water-intense crops, but even if it does, cities will need to step up. Residents shouldn't be waiting to get started.

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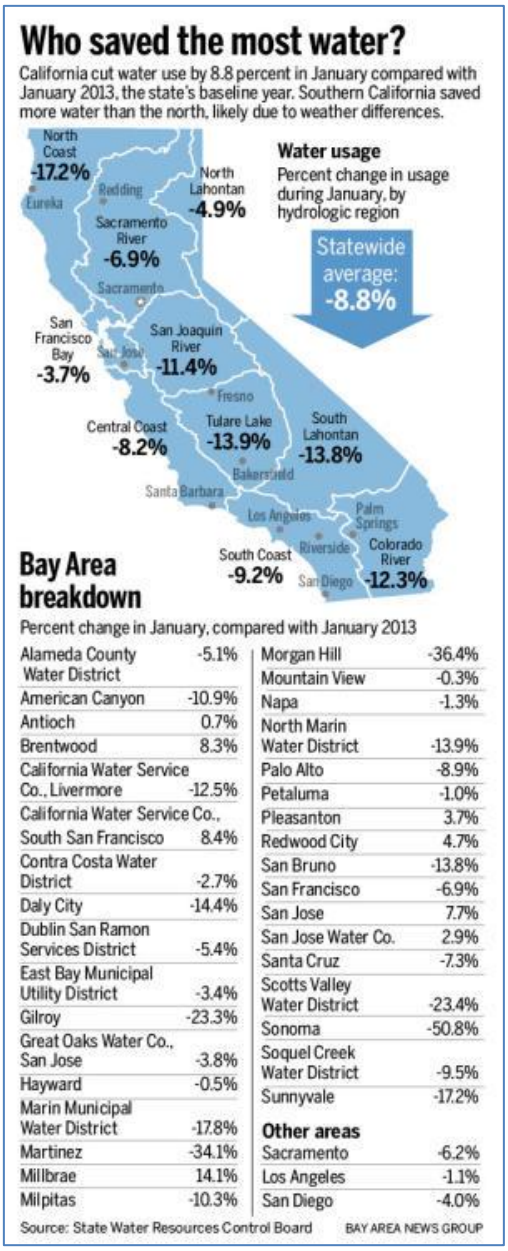

California water conservation weakening as drought worsens. Tougher rules on the way?

San Jose Mercury News | March 4, 2015 | Paul Rogers

California is heading into the fourth summer of a historic drought, but when it comes to conserving water, its urban residents are going backward.

State officials are mulling tougher water restrictions, but critics say the new rules being considered don't go nearly far enough and that the state risks severe water shortages if it doesn't do more soon.

According to new data released Tuesday, Californians cut water use 8.8 percent statewide at homes and businesses in January compared with January 2013, the baseline year used by state water officials.

That's a far cry from the 20 percent conservation target that Gov. Jerry Brown asked state residents to hit last year. And it's a significant drop-off from the 22 percent drop that Californians recorded in December compared with December 2013.

In a reversal from previous trends, residents in the Los Angeles-San Diego area cut water use 9.2 percent in January, significantly more than Bay Area residents, who reduced their use by only 3.7 percent.

The reason for the backsliding, experts say, is that December had two big storms, which led millions of residents to turn off lawn sprinklers and stop watering outdoor plants.

But January was the hottest and driest January recorded in many California communities since modern records were first kept back to 1850. And with the balmy, sunny conditions, lawn watering accelerated.

"Folks look at their lawns, and they just can't bear them being brown," said Felicia Marcus, chairwoman of the State Water Resources Control Board, which collects data from roughly 400 cities, counties and water agencies.

On March 17, the board will consider new rules to increase water savings.

Marcus said the rules are likely to include requirements that all restaurants in California refrain from serving water unless customers ask, all hotels post signs telling guests they can elect not to have sheets and towels washed every day and a rule that limits lawn watering after it rains.

Critics say the state's efforts have been too timid.

"The responses have to be far more comprehensive and aggressive," said Peter Gleick, president of the Pacific Institute, an Oakland water research organization. "The issue is not telling people not to water their lawns after it rains; the issue is telling people to get rid of their lawns. The issue is not about restaurants and glasses of water; it's about getting rid of millions of inefficient appliances."

Marcus said that the board, whose members are selected by Gov. Jerry Brown, prefers to allow local governments -- with their varying climates, water rights and water supplies -- as much control as possible, rather than passing one-size-fits-all rules from Sacramento. That mirrors a philosophy Brown has often voiced on other issues such as education.

Sullivan pushes a tennis ball next to his owner, Armando Lopez, near Echo Summit, Calif., March 3, 2015. Sullivan is a Glen of Imaal Terrier, a type of Irish terrier. (Rich Pedroncelli / AP)

"Our objective has been to get local agencies to step up," she said. "If it doesn't rain though, we will have to consider more. No tool will be left off the table."

Marcus said other rules the board could consider starting in May include bans on watering parks or golf courses with potable water if recycled water is available, a requirement that all cities check their water systems for leaks and limiting lawn watering to two days a week.

Gleick said the Brown administration should be distributing money from the water bond voters passed in November to fund programs that pay people to replace old washers, dishwashers and other appliances with more efficient models. The funds, he said, should also be used to pay people to remove lawns, which use 50 percent of all the water in many California communities.

"The policy we adopted last year of hoping for rain has turned out to be a failure," Gleick said. "We better look for more effective new ones -- and soon."

Although winter rains in Northern California have been encouraging, leaving rainfall totals near historic averages so far in the Bay Area and Sacramento, rainfall totals have been much lower in the Central Valley and Los Angeles.

Worse, record hot temperatures and warm winter storms have left the state with a historically small Sierra Nevada snowpack. On Tuesday, the state Department of Water Resources reported that the snowpack is 19 percent of the historic average for the beginning of March.

For most of 2014, Bay Area residents conserved more than Southern Californians. Despite the reversal in January, in per capita residential use, Bay Area residents used just 56 gallons per person per day in January, while L.A.-San Diego area residents used 75 gallons per person per day.

State water officials have said California needed about 150 percent of average rainfall this winter to break the drought. And with only one month left in California's winter rain season and forecasts for more hot, dry weather through March, a fourth year of drought is now a virtual certainty.

"It is hard to overstate the severity of the drought we are in," said Max Gomberg, an environmental scientist at the state water board. "We have a dismal snowpack, our reservoirs are low, our groundwater basins are depleted. Some rural communities are out of water. Farmland is being fallowed, and people are out of work."

Last year, the state water board made it illegal for anyone in California to waste water, banning washing cars without a hose nozzle, using ornamental fountains that don't recycle water or watering lawns so much the water runs off into the street or neighboring properties.

Although the board allowed fines of up to $500, it left enforcement up to local cities, counties and water districts. But very few have hired staff members to write tickets for violators. In addition, no major water agency has imposed mandatory rationing or strict limits on water use with fines.

That's largely because many of the agencies either had water in their reservoirs or sufficient groundwater supplies. And when residents cut their use, the agencies lose millions of dollars in water sales, often forcing them to take the politically unpopular action of raising rates to pay fixed costs such as electricity, salaries and pensions.

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Despite Drought, Not Time For Drastic Measures
Capital Public Radio | March 11, 2015 | Katie Orr

Folsom Lake

Here in California it can be frustrating to see the East Coast and Midwest buried in snow while the west remains bone dry. But the news can be hard to avoid. Snow piling up so high, cities are struggling to get rid of it, while the west remains stormless. Seems like a waste. Surely there's a way some of that extra snow can be moved to where it's needed.

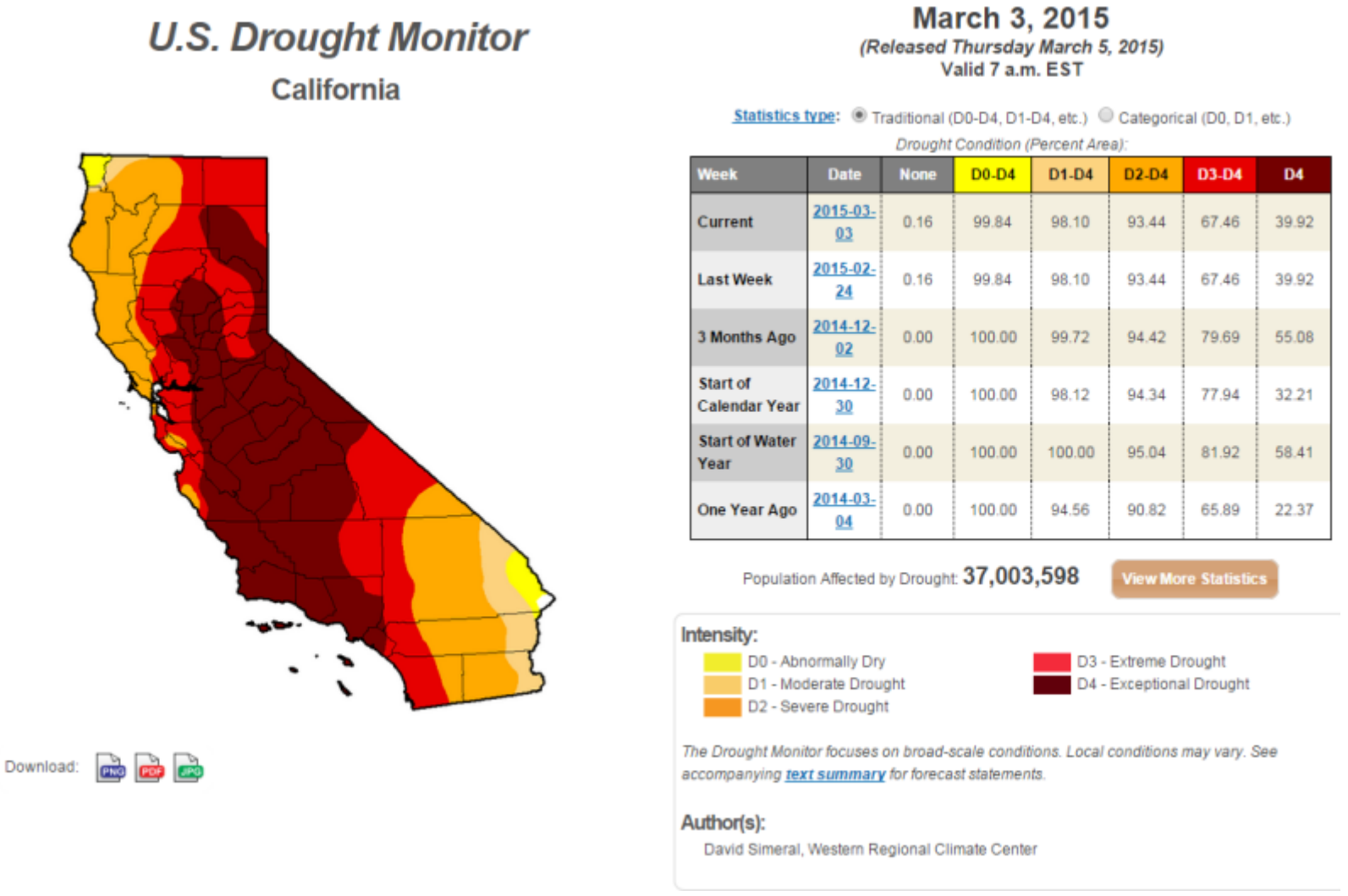
Jay Lund is the Director of the Center for Watershed Sciences at UC Davis.

"A lot of people have thought about this problem and there have been all kinds of really interesting and somewhat crazy ideas," he says. "There are ideas of towing icebergs. There are ideas of filling up big bags of water and towing them behind barges. There are ideas of rail cars. There are ideas of taking that fog on the coast and condensing it or collecting it on big screens."

But are these ideas so crazy? After all, we're in an epic drought that's stretching into a fourth year. Isn't it about time we do everything we can? Well, Lund says no. He says it would be extremely expensive to ship water and it is not yet valuable enough to justify the effort. Take rail cars. Lund says you'd need about 12 to move one acre foot of water across the country. And an acre foot currently costs about $1,000 in the drier parts of the state.

"In order for it to be a good business proposition over in California, you have to be able to load that snow onto a rail car, move that rail car all the way across the country and unload it in California and put that water on the field for less than about $80 per rail car," Lund says.

Last year, Lund says, California was short about 6 million acre feet of surface water in the Central Valley. That would mean more than 70 million rail cars.



At Folsom Lake people ride their bikes and walk along the receding lakefront. The calendar may say it's winter, but the sun is shining and the trees are already in bloom. Still the early spring-like weather isn't enough to convince people in California that it's time for something like a coast-to-coast water pipeline.

Sally Adam doesn't think the water would stay in Northern California long.

"If we bought it from Boston we would just ship it down to Los Angeles and that would just cost us more money," she says.

Tracey McKinney says such a project isn't practical.

"I think building an infrastructure like that is maybe short sighted because weather changes," she says. "You could invest in that and then they could get no more snow and then you've got something that is not usable anymore."

Londa Halase would rather see the money be spent on projects within California.

"It would cost a lot of money so I think it would be more economical to do some kind of other reservoirs in the area instead," she says.

The state does plan to invest in more water storage, which is part of the $7.5 billion water bond voters approved last year. But Governor Jerry Brown says it's too soon to consider more drastic measures, like desalination plants.

"Desalination plants are very expensive, so water would have to get a lot more expensive before people start building desalination plants," he says.

So for now all we can do is keep conserving water, better manage the water we have and pray for rain or snow.

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Bay Area rain will be short-lived; it could reach 80 this weekend
San Jose Mercury News | March 11, 2015 | By Mark Gomez

SAN JOSE -- Wednesday's sprinkles may have saved some folks a trip to the car wash but the overall rainfall totals did nothing to alleviate the drought.

The National Weather Service expects rainfall totals in the Bay Area to max out at .10 inches. Skies are expected to clear by Wednesday afternoon and will be followed by a high-pressure ridge that could produce 80-degree temperatures Saturday.

"Just enough rain to wash off the pollen on your car and make the roads a little bit slick for this morning's commute," said Steve Anderson, a forecaster with the weather service. "No drought relief whatsoever."

As of 7 a.m., rainfall totals in the Bay Area were miniscule, including .07 inches in San Jose, .04 inches in Oakland and .03 in San Francisco. And that was the heavy stuff, said Anderson, adding the system was moving south out of Santa Clara Valley. There is still a chance of scattered showers throughout the morning.

After that, the Bay Area is in store for sunny skies and above-average temperatures for the next seven days.

"There is no hope for any rain after today for the next week," Anderson said.

Saturday could produce some 80-degree temperatures in some parts of the Bay Area, including San Jose.

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El Niño not the savior for drought concerns around Bay Area, state
The Marin Independent Journal | March 9, 2015 | by Mark Prado

El Nino to the rescue of a rain-starved Bay Area, ready to raise reservoirs in a single storm?

Not quite.

"The only thing it will raise is people's hopes, and then it will dash them," said Steve Anderson, meteorologist with the National Weather Service.

El Nino -- the weather phenomena that can have water managers dancing in the streets when it packs a precipitation punch -- has arrived, but with a thud. But for drought-stricken California, it's too little, too late, meteorologists say.

"The only time Marin and the Bay Area see rains from an El Nino is when it's strong," Anderson said. "This is weak."

The National Weather Service last week proclaimed the phenomenon is now in place. El Nino events -- when warmer-than-normal sea surface temperatures in the Pacific Ocean at the equator affect the jet stream -- can lead to wetter winters in California.

But this one is not only weak, but a late version of El Nino, so don't expect too many places to feel its effects, National Weather Service's Climate Prediction Center says.

That not exactly the best news for Marin, which has seen a roller coaster type rainy season with torrential rains followed by periods of dryness. The county is in the latter right now: .02 of an inch of rain has fallen in the last month at Lake Lagunitas on Mount Tamalpais, where the Marin Municipal Water District measures rainfall. And the county's rainfall total at 36.86 inches has slipped below what is roughly a 40-inch average for this time of year.

Still, the county is in decent shape with water supplies. The water district's seven reservoirs are close to 98 percent of capacity, about 10 percent more than normally seen this time of year.

That cannot be said for much of the rest of the state.

California's third snow survey this winter was done last week and found the Sierra Nevada snowpack is far below normal and leaning toward being the lowest on record in more than two decades. The snowpack supplies about a third of the water needed by state residents, agriculture and industry.

Ever since March 2014, the weather service has been saying an El Nino was just around the corner and with it there were hopes it would inspire heavy rains. But it didn't quite show up until now.

Meteorologists said the key patch of the Pacific was warming but they didn't see the second technical part of its definition -- certain changes in the atmosphere. Mike Halpert, deputy director of the weather service's Climate Prediction Center, said he didn't know why this El Nino didn't form earlier as forecast, saying "something just didn't click this year."

"What we've learned from this event is that our definition is very confusing and we need to work on it," he added.

This is the first El Nino since spring of 2010.

El Nino's flip side -- a cooling of the central Pacific called La Nina -- has been more common from 2005 to 2014, said Allan Clarke, a physical oceanography professor at Florida State University. There have been twice as many months with a La Nina than with El Nino, weather records show.

Last year, some experts were hoping that El Nino would help bring more winter rain and snow to California -- even flooding and mudslides that Marin saw during 1997-98's strong El Nino.

Not a chance.

"This is not the answer for California," Halpert said.

# # #

El Nino finally here; but this 1 is weak, weird and late

Associated Press | March 8, 2015| Seth Borenstein, Ap Science Writer

WASHINGTON (AP) — A long anticipated El Nino has finally arrived. But for drought-struck California, it's too little, too late, meteorologists say.

The National Weather Service on Thursday proclaimed the phenomenon is now in place. It's a warming of a certain patch of the central Pacific that changes weather patterns worldwide, associated with flooding in some places, droughts elsewhere, a generally warmer globe, and fewer Atlantic hurricanes. El Ninos are usually so important that economists even track them because of how they affect commodities.

But this is a weak, weird and late version of El Nino, so don't expect too many places to feel its effects, said Mike Halpert, deputy director of the weather service's Climate Prediction Center. He said there may be a slight decrease in the number of Atlantic hurricanes this summer if the condition persists, but he also points out that 1992's devastating Hurricane Andrew occurred during an El Nino summer, so coastal residents shouldn't let their guard down.

Ever since March 2014, the weather service has been saying an El Nino was just around the corner. But it didn't quite show up until now. Meteorologists said the key patch of the Pacific was warming but they didn't see the second technical part of its definition — certain changes in the atmosphere. Halpert said he didn't know why this El Nino didn't form as forecast, saying "something just didn't click this year."

"What we've learned from this event is that our definition is very confusing and we need to work on it," Halpert said.

Last year, some experts were hoping that El Nino would help the southwestern droughts because moderate-to-strong events bring more winter rain and snow to California — even flooding and mudslides during 1998's strong El Nino. But this El Nino arrives at the end of California's rainy season and is quite weak, Halpert said.

"This is not the answer for California," Halpert said.

The U.S. Southeast may see some above average rainfall, which is typical for an El Nino, Halpert said.

This is the first El Nino since spring of 2010.

Allan Clarke, a physical oceanography professor at Florida State University, said as far he's concerned, El Nino has been around awhile and the weather service didn't acknowledge it. But he agrees that this doesn't look like a strong one.

That fits with the pattern the last 10 years, when El Nino's flip side, a cooling of the central Pacific called La Nina, has been more common. From 2005 to 2014, there have been twice as many months with a La Nina than with El Nino, weather records show. More than half of the time, the world has been in neither.

# # #

DWR Says Statewide Snowpack at 19% is Lowest Since 1991
ACWA News | March 3, 2015 | by Emily Allshouse

The Department of Water Resources' third manual snow survey of the season showed the state's snowpack at disappointingly low levels on Tuesday.

The statewide snowpack was at just 19% of average for the date -- the second-lowest statewide snowpack recorded in early March since 1991's reading of 18%. In January the statewide snowpack was at 25%.

Following manual measurements that turned up less than one inch of snow at the Phillips Station snow course, DWR reported the northern Sierra snowpack is at 16% while the central and sourthern Sierra readings were 20% of average and 22% of average, respectively, for the date.

According to DWR, this year's manual measurements of 180 lower-elevation snow courses showed just 13% of average, the lowest ever for this time of year.

With the bulk of the rainy season now past, DWR said it is now "almost certain" that California will remain in drought throughout 2015.

Barring above-normal precipitation in the coming weeks reminiscent of 1991's "March Mircacle," the state can expect to end the traditional wet season with an alarmingly low amount of water stored in the mountain snowpack, DWR said in a release.

DWR also reported on rainfall measurements at the state's 8-station index as well as reservoir conditions. Rainfall measurements for the 8-station index now stand at 87% of normal – only a slight decrease from January report of 88% of normal but a much sharper decrease from December's measurements of 146% of normal.

DWR reported that many reservoirs at faring better than they were in March 2014, due in part to recent rains. Specifically, Oroville is at 49% capacity; Shasta at 58%, and San Luis Reservoir at 64%. These figures represent increases in storage over March 2014 levels of 9% for Oroville, 18% for Shasta and 31% for San Luis Reservoir. DWR specifically credited the improvement in storage at San Luis Reservoir to the agency's improved drought management strategies.

# # #

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Anthropogenic warming has increased drought risk in California

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Edited by Jane Lubchenco, Oregon State University, Corvallis, OR, and approved January 30, 2015 (received for review November 22, 2014)

California is currently in the midst of a record-setting drought. The drought began in 2012 and now includes the lowest calendar-year and 12-mo precipitation, the highest annual temperature, and the most extreme drought indicators on record. The extremely warm and dry conditions have led to acute water shortages, groundwater overdraft, critically low streamflow, and enhanced wildfire risk. Analyzing historical climate observations from California, we find that precipitation deficits in California were more than twice as likely to yield drought years if they occurred when conditions were warm. We find that although there has not been a substantial change in the probability of either negative or moderately negative precipitation anomalies in recent decades, the occurrence of drought years has been greater in the past two decades than in the preceding century. In addition, the probability that precipitation deficits co-occur with warm conditions and the probability that precipitation deficits produce drought have both increased. Climate model experiments with and without anthropogenic forcings reveal that human activities have increased the probability that dry precipitation years are also warm. Further, a large ensemble of climate model realizations reveals that additional global warming over the next few decades is very likely to create ∼100% probability that any annual-scale dry period is also extremely warm. We therefore conclude that anthropogenic warming is increasing the probability of co-occurring warm–dry conditions like those that have created the acute human and ecosystem impacts associated with the "exceptional" 2012–2014 drought in California.

drought | climate extremes | climate change detection | event attribution | CMIP5

The state of California is the largest contributor to the economic and agricultural activity of the United States, accounting for a greater share of population (12%) (1), gross domestic product (12%) (2), and cash farm receipts (11%) (3) than any other state. California also includes a diverse array of marine and terrestrial ecosystems that span a wide range of climatic tolerances and together encompass a global biodiversity "hotspot" (4). These human and natural systems face a complex web of competing demands for freshwater (5). The state's agricultural sector accounts for 77% of California water use (5), and hydroelectric power provides more than 9% of the state's electricity (6). Because the majority of California's precipitation occurs far from its urban centers and primary agricultural zones, California maintains a vast and complex water management, storage, and distribution/conveyance infrastructure that has been the focus of nearly constant legislative, legal, and political battles (5). As a result, many riverine ecosystems depend on mandated "environmental flows" released by upstream dams, which become a point of contention during critically dry periods (5).

California is currently in the midst of a multiyear drought (7). The event encompasses the lowest calendar-year and 12-mo precipitation on record (8), and almost every month between December 2011 and September 2014 exhibited multiple indicators of drought (Fig. S1). The proximal cause of the precipitation deficits was the recurring poleward deflection of the cool-season storm track by a region of persistently high atmospheric pressure, which steered Pacific storms away from California over consecutive seasons (8–11). Although the extremely persistent high pressure is at least a century-scale occurrence (8), anthropogenic global warming has very likely increased the probability of such conditions (8, 9).

Despite insights into the causes and historical context of precipitation deficits (8–11), the influence of historical temperature changes on the probability of individual droughts has—until recently—received less attention (12–14). Although precipitation deficits are a prerequisite for the moisture deficits that constitute "drought" (by any definition) (15), elevated temperatures can greatly amplify evaporative demand, thereby increasing overall drought intensity and impact (16, 17). Temperature is especially important in California, where water storage and distribution systems are critically dependent on winter/spring snowpack, and excess demand is typically met by groundwater withdrawal (18–20). The impacts of runoff and soil moisture deficits associated with warm temperatures can be acute, including enhanced wildfire risk (21), land subsidence from excessive groundwater withdrawals (22), decreased hydropower production (23), and damage to habitat of vulnerable riparian species (24).

Recent work suggests that the aggregate combination of extremely high temperatures and very low precipitation during the 2012–2014 event is the most severe in over a millennium (12). Given the known influence of temperature on drought, the fact that the 2012–2014 record drought severity has co-occurred with record statewide warmth (7) raises the question of whether long-term warming has altered the probability that precipitation deficits yield extreme drought in California.

Significance

California ranks first in the United States in population, economic activity, and agricultural value. The state is currently experiencing a record-setting drought, which has led to acute water shortages, groundwater overdraft, critically low streamflow, and enhanced wildfire risk. Our analyses show that California has historically been more likely to experience drought if precipitation deficits co-occur with warm conditions and that such confluences have increased in recent decades, leading to increases in the fraction of low-precipitation years that yield drought. In addition, we find that human emissions have increased the probability that low-precipitation years are also warm, suggesting that anthropogenic warming is increasing the probability of the co-occurring warm–dry conditions that have created the current California drought.

Author contributions: N.S.D., D.L.S., and D.T. designed research, performed research, contributed new reagents/analytic tools, analyzed data, and wrote the paper.

The authors declare no conflict of interest.

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Results

We analyze the "Palmer" drought metrics available from the US National Climatic Data Center (NCDC) (25). The NCDC Palmer metrics are based on the Palmer Drought Severity Index (PDSI), which uses monthly precipitation and temperature to calculate moisture balance using a simple "supply-and-demand" model (26) (*Materials and Methods*). We focus on the Palmer Modified Drought Index (PMDI), which moderates transitions between wet and dry periods (compared with the PDSI) (27). However, we note that the long-term time series of the PMDI is similar to that of other Palmer drought indicators, particularly at the annual scale (Figs. S1 and S2).

Because multiple drought indicators reached historic lows in July 2014 (Figs. S1–S3), we initially focus on statewide PMDI, temperature, and precipitation averaged over the August–July 12-mo period. We find that years with a negative PMDI anomaly exceeding –1.0 SDs (hereafter "1-SD drought") have occurred approximately twice as often in the past two decades as in the preceding century (six events in 1995–2014 = 30% of years; 14 events in 1896–1994 = 14% of years) (Fig. 1*A* and Fig. S4). This increase in the occurrence of 1-SD drought years has taken place without a substantial change in the probability of negative precipitation anomalies (53% in 1896–2014 and 55% in 1995–2014) (Figs. 1*B* and 2 *A* and *B*). Rather, the observed doubling of the occurrence of 1-SD drought years has coincided with a doubling of the frequency with which a negative precipitation year produces a 1-SD drought, with 55% of negative precipitation years in 1995–2014 co-occurring with a –1.0 SD PMDI anomaly, compared with 27% in 1896–1994 (Fig. 1 *A* and *B*).

Most 1-SD drought years have occurred when conditions were both dry (precipitation anomaly < 0) and warm (temperature anomaly > 0), including 15 of 20 1-SD drought years during 1896–2014 (Fig. 2*A* and Fig. S4) and 6 of 6 during 1995–2014 (Fig. 2*B* and Fig. S4). Similarly, negative precipitation anomalies are much more likely to produce 1-SD drought if they co-occur with a positive temperature anomaly. For example, of the 63 negative precipitation years during 1896–2014, 15 of the 32 warm–dry years (47%) produced 1-SD drought, compared with only 5 of the 31 cool–dry years (16%) (Fig. 2*A*). (During 1896–1994, 41% of warm–dry years produced 1-SD droughts, compared with 17% of cool–dry years.) The probability that a negative precipitation anomaly co-occurs with a positive temperature anomaly has increased recently, with warm–dry years occurring more than twice as often in the past two decades (91%) as in the preceding century (42%) (Fig. 1*B*).

All 20 August–July 12-mo periods that exhibited a –1.0 SD PMDI anomaly also exhibited a –0.5 SD precipitation anomaly (Fig. 1*B* and 2*E*), suggesting that moderately low precipitation is prerequisite for a 1-SD drought year. However, the occurrence of –0.5 SD precipitation anomalies has not increased in recent years (40% in 1896–2014 and 40% in 1995–2014) (Fig. 2 *A* and *B*). Rather, these moderate precipitation deficits have been far more likely to produce 1-SD drought when they occur in a warm year. For example, during 1896–2014, 1-SD drought occurred in 15 of the 28 years (54%) that exhibited both a –0.5 SD precipitation anomaly and a positive temperature anomaly, but in only 5 of the 20 years (25%) that exhibited a –0.5 SD precipitation anomaly and a negative temperature anomaly (Fig. 2*A*). During 1995–2014, 6 of the 8 moderately dry years produced 1-SD drought (Fig. 1*A*), with all 6 occurring in years in which the precipitation anomaly exceeded –0.5 SD and the temperature anomaly exceeded 0.5 SD (Fig. 1*C*).

Taken together, the observed record from California suggests that (*i*) precipitation deficits are more likely to yield 1-SD PMDI droughts if they occur when conditions are warm and (*ii*) the occurrence of 1-SD PMDI droughts, the probability of precipitation deficits producing 1-SD PMDI droughts, and the probability of precipitation deficits co-occurring with warm conditions have all been greater in the past two decades than in the preceding century.

These increases in drought risk have occurred despite a lack of substantial change in the occurrence of low or moderately low precipitation years (Figs. 1*B* and 2 *A* and *B*). In contrast, statewide warming (Fig. 1*C*) has led to a substantial increase in warm conditions, with 80% of years in 1995–2014 exhibiting a positive temperature anomaly (Fig. 2*B*), compared with 45% of years in 1896–2014 (Fig. 2*A*). As a result, whereas 58% of moderately dry years were warm during 1896–2014 (Fig. 2*A*) and 50% were warm during 1896–1994, 100% of the 8 moderately dry years in 1995–2014 co-occurred with a positive temperature anomaly (Fig. 2*B*). The observed statewide warming (Fig. 1*C*) has therefore substantially increased the probability that when moderate precipitation deficits occur, they occur during warm years.

The recent statewide warming clearly occurs in climate model simulations that include both natural and human forcings ("Historical" experiment), but not in simulations that include only natural forcings ("Natural" experiment) (Fig. 3*B*). In particular, the Historical and Natural temperatures are found to be different at the 0.001 significance level during the most recent 20-, 30-, and 40-y periods of the historical simulations (using the block bootstrap resampling applied in ref. 28). In contrast, although the Historical experiment exhibits a slightly higher mean annual precipitation (0.023 significance level), there is no statistically

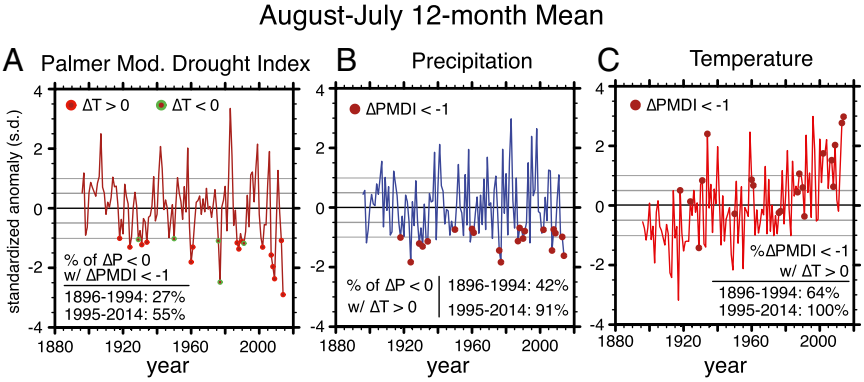

Fig. 1. Historical time series of drought (*A*), precipitation (*B*), and temperature (*C*) in California. Values are calculated for the August–July 12-mo mean in each year of the observed record, beginning in August 1895. In each year, the standardized anomaly is expressed as the magnitude of the anomaly from the long-term annual mean, divided by the SD of the detrended historical annual anomaly time series. The PMDI is used as the primary drought indicator, although the other Palmer indicators exhibit similar historical time series (Figs. S1 and S2). Circles show the years in which the PMDI exhibited a negative anomaly exceeding –1.0 SDs, which are referred to as 1-SD drought years in the text.

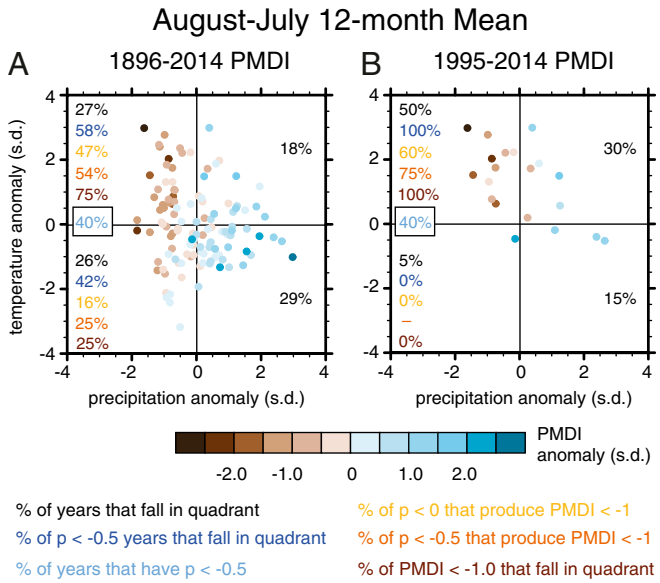

Fig. 2. Historical occurrence of drought, precipitation, and temperature in California. Standardized anomalies are shown for each August–July 12-mo period in the historical record (calculated as in Fig. 1). Anomalies are shown for the full historical record (*A*) and for the most recent two decades (*B*). Percentage values show the percentage of years meeting different precipitation and drought criteria that fall in each quadrant of the temperature–precipitation space. The respective criteria are identified by different colors of text.

significant difference in probability of a –0.5 SD precipitation anomaly (Fig. 3 *A* and *C*). However, the Historical experiment exhibits greater probability of a –0.5 SD precipitation anomaly co-occurring with a positive temperature anomaly (0.001 significance level) (Fig. 3*D*), suggesting that human forcing has caused the observed increase in probability that moderately dry precipitation years are also warm.

The fact that the occurrence of warm and moderately dry years approaches that of moderately dry years in the last decades of the Historical experiment (Fig. 3 *B* and *C*) and that 91% of negative precipitation years in 1995–2014 co-occurred with warm anomalies (Fig. 1*B*) suggests possible emergence of a regime in which nearly all dry years co-occur with warm conditions. We assess this possibility using an ensemble of 30 realizations of a single global climate model [the National Center for Atmospheric Research (NCAR) Community Earth System Model (CESM1) Large Ensemble experiment ("LENS")] (29) (*Materials and Methods*). Before ~1980, the simulated probability of a warm–dry year is approximately half that of a dry year (Fig. 4*B*), similar to observations (Figs. 1*B* and 2). However, the simulated probability of a warm–dry year becomes equal to that of a dry year by ~2030 of RCP8.5. Likewise, the probabilities of co-occurring 0.5, 1.0 and 1.5 SD warm–dry anomalies become approximately equal to those of 0.5, 1.0, and 1.5 SD dry anomalies (respectively) by ~2030 (Fig. 4*B*).

The probability of co-occurring extremely warm and extremely dry conditions (1.5 SD anomaly) remains greatly elevated throughout the 21st century (Fig. 4*B*). In addition, the number of multiyear periods in which a –0.5 SD precipitation anomaly co-occurs with a 0.5 SD temperature anomaly more than doubles between the Historical and RCP8.5 experiments (Fig. 4*A*). We find similar results using a 12-mo moving average (Fig. 4*C*). As with the August–July 12-mo mean (Fig. 4*B*), the probability of a dry year is approximately twice the probability of a warm–dry year for all 12-mo periods before ~1980 (Fig. 4*C*). However, the occurrence of warm years (including +1.5 SD temperature anomalies) increases after ~1980, reaching 1.0 by ~2030. This increase implies a transition to a permanent condition of ~100% risk that any negative—or extremely negative—12-mo precipitation anomaly is also extremely warm.

The overall occurrence of dry years declines after ~2040 (Fig. 4*C*). However, the occurrence of extreme 12-mo precipitation deficits (–1.5 SD) is greater in 2006–2080 than in 1920–2005 (<0.03 significance level). This detectable increase in extremely low-precipitation years adds to the effect of rising temperatures and contributes to the increasing occurrence of extremely warm–dry 12-mo periods during the 21st century.

All four 3-mo seasons likewise show higher probability of co-occurring 1.5 SD warm–dry anomalies after ~1980, with the probability of an extremely warm–dry season equaling that of an extremely dry season by ~2030 for spring, summer, and autumn, and by ~2060 for winter (Fig. 4*D*). In addition, the probability of a –1.5 SD precipitation anomaly increases in spring ($P < 0.001$) and autumn ($P = 0.01$) in 2006–2080 relative to 1920–2005, with spring occurrence increasing by ~75% and autumn occurrence increasing by ~44%—which represents a substantial and statistically significant increase in the risk of extremely low-precipitation events at both margins of California's wet season. In contrast, there is no statistically significant difference in the probability of a –1.5 SD precipitation anomaly for winter.

Discussion

A recent report by Seager et al. (30) found no significant long-term trend in cool-season precipitation in California during the 20th and early 21st centuries, which is consistent with our

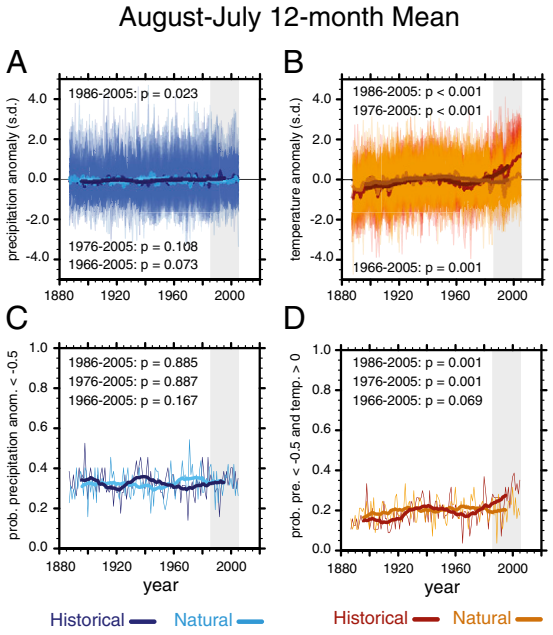

Fig. 3. Influence of anthropogenic forcing on the probability of warm–dry years in California. Temperature and precipitation values are calculated for the August–July 12-mo mean in each year of the CMIP5 Historical and Natural forcing experiments (*Materials and Methods*). The *Top* panels (*A* and *B*) show the time series of ensemble-mean standardized temperature and precipitation anomalies. The *Bottom* panels (*C* and *D*) show the unconditional probability (across the ensemble) that the annual precipitation anomaly is less than –0.5 SDs, and the conditional probability that both the annual precipitation anomaly is less than –0.5 SDs and the temperature anomaly is greater than 0. The bold curves show the 20-y running mean of each annual time series. The CMIP5 Historical and Natural forcing experiments were run until the year 2005. *P* values are shown for the difference between the Historical and Natural experiments for the most recent 20-y (1986–2005; gray band), 30-y (1976–2005), and 40-y (1966–2005) periods of the CMIP5 protocol. *P* values are calculated using the block bootstrap resampling approach of ref. 28 (*Materials and Methods*).

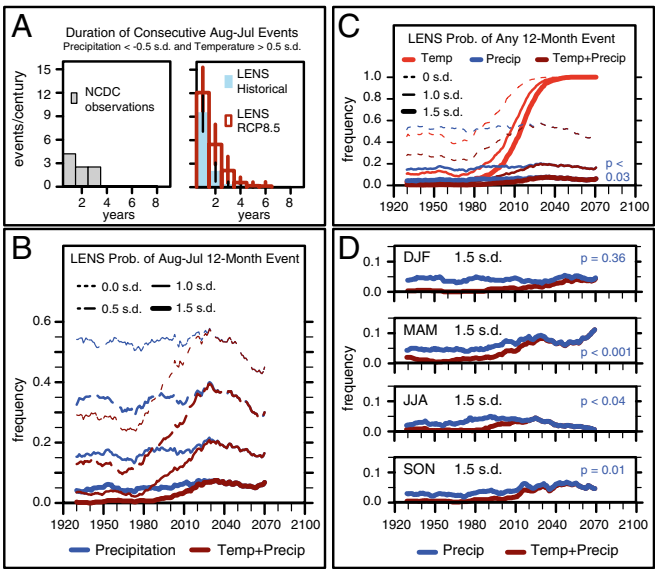

Fig. 4. Projected changes in the probability of co-occurring warm–dry conditions in the 21st century. (*A*) Histogram of the frequency of occurrence of consecutive August–July 12-mo periods in which the 12-mo precipitation anomaly is less than –0.5 SDs and the 12-mo temperature anomaly is at least 0.5 SDs, in historical observations and the LENS large ensemble experiment. (*B*) The probability that a negative 12-mo precipitation anomaly and a positive 12-mo temperature anomaly equal to or exceeding a given magnitude occur in the same August–July 12-mo period, for varying severity of anomalies. (*C*) The probability that a negative precipitation anomaly and a positive temperature anomaly equal to or exceeding a given magnitude occur in the same 12-mo period, for all possible 12-mo periods (using a 12-mo running mean; see *Materials and Methods*), for varying severity of anomalies. (*D*) The unconditional probability of a –1.5 SD seasonal precipitation anomaly (blue curve) and the conditional probability that a –1.5 SD seasonal precipitation anomaly occurs in conjunction with a 1.5 SD seasonal temperature anomaly (red curve), for each of the four 3-mo seasons. Time series show the 20-y running mean of each annual time series. *P* values are shown for the difference in occurrence of –1.5 SD precipitation anomalies between the Historical period (1920–2005) and the RCP8.5 period (2006–2080).

findings. Further, under a scenario of strongly elevated greenhouse forcing, Neelin et al. (31) found a modest increase in California mean December–January–February (DJF) precipitation associated with a local eastward extension of the mean subtropical jet stream west of California. However, considerable evidence (8–11, 31–33) simultaneously suggests that the response of northeastern Pacific atmospheric circulation to anthropogenic warming is likely to be complex and spatiotemporally inhomogeneous, and that changes in the atmospheric mean state may not be reflective of changes in the risk of extreme events (including atmospheric configurations conducive to precipitation extremes). Although there is clearly value in understanding possible changes in precipitation, our results highlight the fact that efforts to understand drought without examining the role of temperature miss a critical contributor to drought risk. Indeed, our results show that even in the absence of trends in mean precipitation—or trends in the occurrence of extremely low-precipitation events—the risk of severe drought in California has already increased due to extremely warm conditions induced by anthropogenic global warming.

We note that the interplay between the existence of a well-defined summer dry period and the historical prevalence of a substantial high-elevation snowpack may create particular susceptibility to temperature-driven increases in drought duration and/or intensity in California. In regions where precipitation exhibits a distinct seasonal cycle, recovery from preexisting drought conditions is unlikely during the characteristic yearly dry spell (34). Because California's dry season occurs during the warm summer months, soil moisture loss through evapotranspiration (ET) is typically high—meaning that soil moisture deficits that exist at the beginning of the dry season are exacerbated by the warm conditions that develop during the dry season, as occurred during the summers of 2013 and 2014 (7).

Further, California's seasonal snowpack (which resides almost entirely in the Sierra Nevada Mountains) provides a critical source of runoff during the low-precipitation spring and summer months. Trends toward earlier runoff in the Sierra Nevada have already been detected in observations (e.g., ref. 35), and continued global warming is likely to result in earlier snowmelt and increased rain-to-snow ratios (35, 36). As a result, the peaks in California's snowmelt and surface runoff are likely to be more pronounced and to occur earlier in the calendar year (35, 36), increasing the duration of the warm-season low-runoff period (36) and potentially reducing montane surface soil moisture (37). Although these hydrological changes could potentially increase soil water availability in previously snow-covered regions during the cool low-ET season (34), this effect would likely be outweighed by the influence of warming temperatures (and decreased runoff) during the warm high-ET season (36, 38), as well as by the increasing occurrence of consecutive years with low precipitation and high temperature (Fig. 4*A*).

The increasing risk of consecutive warm–dry years (Fig. 4*A*) raises the possibility of extended drought periods such as those found in the paleoclimate record (14, 39, 40). Recent work suggests that record warmth could have made the current event the most severe annual-scale drought of the past millennium (12). However, numerous paleoclimate records also suggest that the region has experienced multidecadal periods in which most years were in a drought state (14, 39, 41, 42), albeit less acute than the current California event (12, 39, 41). Although multidecadal ocean variability was a primary cause of the megadroughts of the last millenium (41), the emergence of a condition in which there is ∼100% probability of an extremely warm year (Fig. 4) substantially increases the risk of prolonged drought conditions in the region (14, 39, 40).

A number of caveats should be considered. For example, ours is an implicit approach that analyzes the temperature and precipitation conditions that have historically occurred with low PMDI years, but does not explicitly explore the physical processes that produce drought. The impact of increasing temperatures on the processes governing runoff, baseflow, groundwater, soil moisture, and land-atmosphere evaporative feedbacks over both the historical period and in response to further global warming remains a critical uncertainty (43). Likewise, our analyses of anthropogenic forcing rely on global climate models that do not resolve the topographic complexity that strongly influences California's precipitation and temperature. Further investigation using high-resolution modeling approaches that better resolve the boundary conditions and fine-scale physical processes (44–46) and/or using analyses that focus on the underlying large-scale climate dynamics of individual extreme events (8) could help to overcome the limitations of simulated precipitation and temperature in the current generation of global climate models.

Conclusions

Our results suggest that anthropogenic warming has increased the probability of the co-occurring temperature and precipitation conditions that have historically led to drought in California. In addition, continued global warming is likely to cause a transition to a regime in which essentially every seasonal, annual, and multiannual precipitation deficit co-occurs with historically warm conditions. The current warm–dry event in California—as well as historical observations of previous seasonal, annual, and multiannual warm–dry events—suggests such a regime would substantially increase the risk of severe impacts on human and natural systems. For example, the projected increase in extremely

low precipitation and extremely high temperature during spring and autumn has substantial implications for snowpack water storage, wildfire risk, and terrestrial ecosystems (47). Likewise, the projected increase in annual and multiannual warm–dry periods implies increasing risk of the acute water shortages, critical groundwater overdraft, and species extinction potential that have been experienced during the 2012–2014 drought (5, 20).

California's human population (38.33 million as of 2013) has increased by nearly 72% since the much-remembered 1976–1977 drought (1). Gains in urban and agricultural water use efficiency have offset this rapid increase in the number of water users to the extent that overall water demand is nearly the same in 2013 as it was in 1977 (5). As a result, California's per capita water use has declined in recent decades, meaning that additional short-term water conservation in response to acute shortages during drought conditions has become increasingly challenging. Although a variety of opportunities exist to manage drought risk through long-term changes in water policy, management, and infrastructure (5), our results strongly suggest that global warming is already increasing the probability of conditions that have historically created high-impact drought in California.

Materials and Methods

We use historical time series of observed California statewide temperature, precipitation, and drought data from the National Oceanic and Atmospheric Administration's NCDC (7). The data are from the NCDC "nClimDiv" divisional temperature–precipitation–drought database, available at monthly time resolution from January 1895 to the present (7, 25). The NCDC nClimDiv database includes temperature, precipitation, and multiple Palmer drought indicators, aggregated at statewide and substate climate division levels for the United States. The available Palmer drought indicators include PDSI, the Palmer Hydrological Drought Index (PHDI), and PMDI.

PMDI and PHDI are variants of PDSI (25–27, 48, 49). PDSI is an index that measures the severity of wet and dry anomalies (26). The NCDC nClimDiv PDSI calculation is reported at the monthly scale, based on monthly temperature and precipitation (49). Together, the monthly temperature and precipitation values are used to compute the net moisture balance, based on a simple supply-and-demand model that uses potential evapotranspiration (PET) calculated using the Thornthwaite method. Calculated PET values can be very different when using other methods (e.g., Penman–Monteith), with the Thornthwaite method's dependence on surface temperature creating the potential for overestimation of PET (e.g., ref. 43). However, it has been found that the choice of methods in the calculation of PET does not critically influence the outcome of historical PDSI estimates in the vicinity of California (15, 43, 50). In contrast, the sensitivity of the PET calculation to large increases in temperature could make the PDSI inappropriate for calculating the response of drought to high levels of greenhouse forcing (15). As a result, we analyze the NCDC Palmer indicators in conjunction with observed temperature and precipitation data for the historical period, but we do not calculate the Palmer indicators for the future (for future projections of the PDSI, refer to refs. 15 and 40).

Because the PDSI is based on recent temperature and precipitation conditions (and does not include human demand for water), it is considered an indicator of "meterological" drought (25). The PDSI calculates "wet," "dry," and "transition" indices, using the wet or dry index when the probability is 100% and the transition index when the probability is less than 100% (26). Because the PMDI always calculates a probability-weighted average of the wet and dry indices (27), the PDSI and PMDI will give equal values in periods that are clearly wet or dry, but the PMDI will yield smoother transitions between wet and dry periods (25). In this work, we use the PMDI as our primary drought indicator, although we note that the long-term time series of the PMDI is similar to that of the PDSI and PHDI, particularly at the annual scale considered here (Figs. S1 and S2).

We analyze global climate model simulations from phase 5 of the Coupled Model Intercomparison Project (CMIP5) (51). We compare two of the CMIP5 multimodel historical experiments (which were run through 2005): (*i*) the Historical experiment, in which the climate models are prescribed both anthropogenic and nonanthropogenic historical climate forcings, and (*ii*) the Natural experiment, in which the climate models are prescribed only the nonanthropogenic historical climate forcings. We analyze those realizations for which both temperature and precipitation were available from both experiments at the time of data acquisition. We calculate the temperature and precipitation values over the state of California at each model's native resolution using all grid points that overlap with the geographical borders of California, as defined by a high-resolution shapefile (vector digital data obtained from the US Geological Survey via the National Weather Service at www.nws.noaa.gov/geodata/catalog/national/html/us_state.htm).

We also analyze NCAR's large ensemble ("LENS") climate model experiment (29). The LENS experiment includes 30 realizations of the NCAR CESM1. This large single-model experiment enables quantification of the uncertainty arising from internal climate system variability. Although the calculation of this "irreducible" uncertainty likely varies between climate models, it exists independent of uncertainty arising from model structure, model parameter values, and climate forcing pathway. At the time of acquisition, LENS results were available for 1920–2005 in the Historical experiment and 2006–2080 in the RCP8.5 (Representative Concentration Pathway) experiment. The four RCPs are mostly indistinguishable over the first half of the 21st century (52). RCP8.5 has the highest forcing in the second half of the 21st century and reaches ~4 °C of global warming by the year 2100 (52).

Given that the ongoing California drought encompasses the most extreme 12-mo precipitation deficit on record (8) and that both temperature and many drought indicators reached their most extreme historical values for California in July 2014 (7) (Fig. 1 and Figs. S1 and S2), we use the 12-mo August–July period as one period of analysis. However, because severe conditions can manifest at both multiannual and subannual timescales, we also analyze the probability of occurrence of co-occurring warm and dry conditions for multiannual periods, for all possible 12-mo periods, and for the winter (DJF), spring (March–April–May), summer (June–July–August), and autumn (September–October–November) seasons.

We use the monthly-mean time series from NCDC to calculate observed time series of statewide 12-mo values of temperature, precipitation, and PMDI. Likewise, we use the monthly-mean time series from CMIP5 and LENS to calculate simulated time series of statewide 12-mo and seasonal values of temperature and precipitation. From the time series of annual-mean values for each observed or simulated realization, we calculate (*i*) the baseline mean value over the length of the record, (*ii*) the annual anomaly from the baseline mean value, (*iii*) the SD of the detrended baseline annual anomaly time series, and (*iv*) the ratio of each individual annual anomaly value to the SD of the detrended baseline annual anomaly time series. (For the 21st-century simulations, we use the Historical simulation as the baseline.) Our time series of standardized values are thereby derived from the time series of 12-mo annual (or 3-mo seasonal) mean anomaly values that occur in each year.

For the multiannual analysis, we calculate consecutive occurrences of August–July 12-mo values. For the analysis of all possible 12-mo periods, we generate the annual time series of each 12-mo period (January–December, February–January, etc.) using a 12-mo running mean. For the seasonal analysis, we generate the time series by calculating the mean of the respective 3-mo season in each year.

We quantify the statistical significance of differences in the populations of different time periods using the block bootstrap resampling approach of ref. 28. For the CMIP5 Historical and Natural ensembles, we compare the populations of the August–July values in the two experiments for the 1986–2005, 1976–2005, and 1966–2005 periods. For the LENS seasonal analysis, we compare the respective populations of DJF, March–April–May, June–July–August, and September–October–November values in the 1920–2005 and 2006–2080 periods. For the LENS 12-mo analysis, we compare the populations of 12-mo values in the 1920–2005 and 2006–2080 periods, testing block lengths up to 16 to account for temporal autocorrelation out to 16 mo for the 12-mo running mean data. (Autocorrelations beyond 16 mo are found to be negligible.)

Throughout the text, we consider drought to be those years in which negative 12-mo PMDI anomalies exceed –1.0 SDs of the historical interannual PMDI variability. We stress that this value is indicative of the variability of the annual (12-mo) PMDI, rather than of the monthly values (compare Fig. 1 and Figs. S1 and S2). We consider "moderate" temperature and precipitation anomalies to be those that exceed 0.5 SDs ("0.5 SD") and "extreme" temperature and precipitation anomalies to be those that exceed 1.5 SDs ("1.5 SD").

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Big water rate hike plan reduced by Santa Clara Valley Water District
San Jose Mercury | March 10, 2015 | By Paul Rogers and Katie Nelson

SAN JOSE -- Facing a public outcry and some skepticism from their board of directors, the top staff of the Silicon Valley's largest drinking water provider on Tuesday suggested reducing a proposed drought-related water rate hike this year from 31 percent to 19 percent.

The Santa Clara Valley Water District officials introduced the idea Tuesday night at a public meeting of the agency's seven-member elected board. Staff making the presentation told board members that some reductions could be made through staffing vacancies, while high-priority projects such as seismic retrofits and dam improvements would have to remain in the budget.

"I would like to see it go lower if it can," Gary Kremen, the district's board chairman and a critic of the initial proposal, said before the meeting. "I'd like to see some lower-priority construction projects deferred -- and some killed."

San Jose resident Ruth Callahan, the only resident to publicly comment at the board meeting Tuesday night, said the board was not doing nearly enough to help prevent what she said was a major monetary sacrifice for Santa Clara County residents.

"Where do you cut, where do you sacrifice?" she said. "I'm the face of the rate payer, OK? I've been rate-increased to the max.

"At some point it has got to stop. What you've asked us to do -- conserve -- it only comes back to hurt us again and again and again."

Beau Goldie, the water district's CEO, said last week that the large rate increase was needed because of the drought. The district will lose $20 million this year if the public cuts water use by 20 percent, as the district has requested, he said.

The district also will incur at least $42 million in other drought costs, he added. Among them: $22 million to buy water from sellers outside the county; $5 million for rebates to pay residents to remove lawns and replace old toilets and appliances; and $7 million to bring in water from a groundwater bank in Kern County.

Tuesday's staff proposal called for softening the rate hike by adjusting the timing of transferring funds to do seismic repairs on Anderson Dam as well as leaving open jobs at the district vacant.

Board director Barbara Keegan said she agreed with Callahan and said she was not pleased with what was proposed Tuesday.

"We're not going to make our case to the public," she said of the reasoning behind the potential rate increases. "I don't feel comfortable with the recommendations we're seeing right now. Let's

exercise some muscles here and not have our knee jerk reaction be 'We need to raise rates.' If there are other options, we need to consider those."

The district is the wholesale water supplier for Santa Clara County, providing drinking water and flood protection to 1.8 million people. It is proposing raising the "pump tax," a fee it charges cities and private companies for water that they in turn sell to the public.

The board's final decision on rate increases will come in May. Residents will have the option to see what potential cost-saving measures are selected before the vote, but board director Linda LeZotte said while the rate hikes are difficult to swallow, they could help keep the residents of Santa Clara County ahead of the curve if the drought continues.

"The board has done so much already to help save money, and we are a lot better off than other agencies by what we have done and what we have been doing," she said.

# # #

California drought: Big water rate hikes considered by Bay Area agencies
SJ Mercury News | March 7, 2015 | By Paul Rogers and James Urton

During the first three years of drought, Bay Area residents have endured brown lawns, shorter showers and dirty cars. Now, as the crisis stretches into the fourth year, they are about to feel it in their wallets.

Three of the largest Bay Area water agencies -- the Santa Clara Valley Water District, the East Bay Municipal Utility District and the San Francisco Public Utilities Commission, which runs the Hetch Hetchy system -- all are considering water rate hikes of up to 30 percent this year.

The agencies -- which serve 5.8 million people, or about 80 percent of the Bay Area's population -- say they need to increase rates because they are selling a lot less water as customers conserve because of the drought.

"We don't want to raise water rates," said Beau Goldie, CEO of the Santa Clara Valley Water District, which provides water to 1.8 million people in Silicon Valley. "But our job is to make sure there is enough clean, safe water to sustain the economy of Santa Clara County. We can't control the drought."

Because they have sold less water, the agencies have lost tens millions of dollars in revenues. They also have had to spend more money on drought-related expenses such as buying extra water from outside the Bay Area to help meet demand, expanding public relations budgets to ask the public to use less water amid shortages, and offering rebates to homeowners who replace lawns with drought-tolerant plants or old, leaky appliances with water-efficient ones.

The Santa Clara Valley District's staff has proposed a hike of up to 31.5 percent on its "pump tax" -- what the district, a wholesale water provider, charges cities and private companies such as Santa Clara and the San Jose Water Co. The district's seven-member board will discuss the proposal at its next public meeting on Tuesday; a final vote is scheduled for May.

Over the past year, Santa Clara Valley residents cut water use about 13 percent. If it hits this year's 20 percent goal, the district will lose $20 million in water sales, Goldie said. On top of that, the district is spending millions to import more water from a groundwater bank in Kern County.

"No matter how much water we put through the pipes," he said, "it still costs the same to run the water treatment plants and to fix the pipes and to pay the staff."

Some water officials are fuming about the proposed increases.

"It's shocking," said Tim Guster, vice president and general counsel of Great Oaks Water Co., a private company in South San Jose that buys water from the district. "It's too easy to say that their costs are all fixed. The truth is they're not. It's the duty of this and other government agencies to control their own costs."

Guster said the district should consider things like delaying lower-priority construction projects or dipping into its budget reserves, which the district says total $557 million.

That's what the Contra Costa Water District is doing. Despite losing an estimated $26 million in water sales and other costs associated with the drought, the agency will cover those costs by reducing its reserve fund and refinancing debt rather than hiking rates, said Jennifer Allen, spokeswoman for the Contra Costa Water District.

Taxpayer groups say that property owners in the districts can sometimes overturn rate hikes under Proposition 218, passed by California voters in 1996. Both Santa Clara Valley Water District and EBMUD will have to hold mail-in elections under Proposition 218 if they go forward with the rate hikes. The hikes also can be overturned in court if they are found to raise more money than it costs the agency to provide the service.

"If the water rates need to be increased to secure the water for their customers, they can probably justify that," said Jon Coupal, president of the Howard Jarvis Taxpayers Association. "If it's just for bloated overhead, then someone should look into that. I do know that the special districts in the Bay Area have a reputation as being, shall we say, not very careful with taxpayer dollars."

The Santa Clara Valley Water District in recent years has been the subject of several critical county civil grand jury reports that have called into question project delays, high salaries for top officials, and questionable spending -- such as the district's decision in 2008 to spend $1.4 million building a gazebo and "outdoor education center" on a vacant lot in Alviso. In January, the board gave Goldie a $10,000 raise, bringing his annual salary to $290,000. The next month, it gave him a $19,605 bonus.

For his part, Goldie said the agency has worked to cut its costs, reducing the number of employees from 903 five years ago to 731 now.

Meanwhile, the 1.3 million customers of EBMUD in Alameda and Contra Costa counties cut water use 12 percent over the past year. Along with the price of bringing in new federal water from the Sacramento and Placer County areas, that cost the district $25 million.

EBMUD, which raised rates 9.5 percent in July, will begin discussing an additional 8 percent increase at its March 24 board meeting, along with an additional "drought surcharge" of 8 to 25 percent more. The board will make a final decision April 14.

"We've gone through these first years of drought with minimal financial impact on our customers," EBMUD spokeswoman Abby Figueroa said. "But with another year of drought, the water reserves are down, and the financial reserves are down. And customers are going to have to cut back and foot more of the bill."

Reactions to the proposed water rate hikes from Bay Area residents ranged from numbing acceptance to boiling resentment.

"Honestly, it's frustrating. We're trying to do our best," said Albany resident Olga Miranda, who applauds Alameda County residents for their water conservation efforts but does not think that businesses have been held to the same strict standards.

San Ramon resident Kristina Teves said she would prefer that the districts first try to trim costs but "not at the expense of jobs or impacts to service."

The Bay Area's largest water district, the San Francisco PUC, announced last month that it plans to increase rates 32 percent this year on the 26 cities and private companies it delivers water to along the Peninsula, the South Bay and southern Alameda County. Much of that increase would be to offset $25 million in lost water sales after residents cut water use 11 percent last year.

Steve Ritchie, the commission's assistant general manager, said that the commission, whose board will vote on the plan in May, is looking at changing its rate structure to limit wild price swings by putting more of the costs on a fixed monthly charge, rather than having nearly all of it based on the amount of water used.

Some Bay Area residents think that higher rates may actually have an upside by forcing many of the remaining water-wasting residents and businesses to turn off the tap.

"People have to wake up and understand that their actions have a cost," Walnut Creek resident Patricia Zuker said. "Sometimes that means charging them more. Some people won't get it otherwise."

RATES GOING UP?

Directors of the Santa Clara Valley Water District will discuss hiking water rates at Tuesday's meeting, which will begin at 6 p.m. in the boardroom at district headquarters at 5700 Almaden Expressway, San Jose.

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Surplus water buy for Dublin and San Ramon provides relief but stirs controversy
Bay Area News Group | March 11, 2015 | By Denis Cuff

A tug of war is taking place over a plan to deliver an emergency water supply to 80,000 people in Dublin and San Ramon.

The Dublin San Ramon Services District plans to buy the water from Yuba County to ease its severe shortage -- which has resulted in some of the most severe penalties in the Bay Area.

In the fourth year of drought, customers have been paying higher rates aimed at curbing use 25 percent, and homes have a weekly cap on use.

The district won two key approvals Tuesday for the deal, which would boost its water supplies by 10 percent or more. It would be the equivalent of a four-month supply for 20,000 people.

"We hope this will relieve some of the pain of shortages even if it doesn't end all our drought problems," said Dan Gallagher, the district's operation manager.

Dublin San Ramon will spend some $2.2 million to buy the water and have it transported to the East Bay. Reserves will cover the costs without raising rates, Gallagher said.

But the Tri-Valley's wholesale water agency has objected, saying it worries it could lose money if an outside supply is piped in to one of its member agencies.

In a March 3 letter, Alameda County Zone 7 Water Agency rebuked Dublin San Ramon for seeking help for itself without considering the interest of the entire Zone 7 area, which includes Livermore and Pleasanton.

Zone 7's water service contract with Dublin San Ramon bars the district from buying water from a supplier other than Zone 7, wrote Jill Duerig, Zone 7's general manager.

"Zone 7 hereby objects," Duerig wrote. "We recommend that if DSRSD wishes to pursue any such transfer in the future, collaboration with Zone 7 and the other valley retailers be open and transparent so that a complete evaluation of all the valleywide impacts and benefits can be considered."

Officials at the Dublin San Ramon district said they were perplexed because Zone 7 last year wrote a letter encouraging local retail agencies to look for alternative supplies.

"Zone 7 has said they can't meet our water needs," Gallagher said. "We think this surplus water purchase is good for our district and the entire Tri-Valley. It reduces pressure for Zone 7 to pump water from underground basins."

The surplus water from the Yuba County Water Agency will be released into the Sacramento River and then piped and pumped by the East Bay Municipal District to an emergency pipe connection in Dublin.

On Tuesday, the Yuba County Water Agency agreed to the surplus water sale, and the East Bay water board approved to wheel the water.

For legal reasons, the surplus water must be used in San Ramon's Dougherty Valley portion of the Dublin San Ramon district.

# # #

New partnership seeks to restore Sierra forests
Sacramento Bee | March 9, 2015 | By Matt Weiser

The Sierra Nevada is many things to California: a mountain playground in winter and summer, a swath of public land stretching nearly the length of the state, and vital habitat for a broad variety of wildlife. It also provides the majority of California's freshwater supply.

With a fourth year of drought looming, state and federal agencies have launched an ambitious partnership to improve the Sierra's ability to store and filter water, as well as reduce fire risks, by restoring its forests.

Called the Sierra Nevada Watershed Improvement Program, it aims to coordinate the diverse activities of government agencies, property owners and nonprofit groups to focus on the Sierra's most serious problems. Goals include restoring streams and meadows, improving habitat and thinning overgrown forests, while also protecting economic uses of the land, such as logging and grazing.

The effort is being led by the Sierra Nevada Conservancy, a state agency, in partnership with the U.S. Forest Service, the primary landowner in the Sierra.

Jim Branham, the conservancy's executive officer, said the goal is to catch up with some of the problems posed by climate change, which has increased mountain temperatures and reduced snowpack; and correct a century of aggressive fire prevention, which caused forests to become overgrown and reduced their water-storing ability.

This set of problems was dramatically underscored by recent large fires in the Sierra, including the 2013 Rim Fire in Yosemite (255,000 acres) and last year's King Fire near Lake Tahoe (98,000 acres).

"Every indication tells us it's only going to get worse if we aren't being more aggressive and proactive in trying to restore this landscape," Branham said. "It's not that we think we have all the answers. It's that we think there needs to be a serious examination of how all of these things are working or not working."

The Sierra delivers about 60 percent of the freshwater Californians use in their homes, businesses and farms. Historically, this has come from the melting of each winter's heavy snowpack. In just a few months of winter, the Sierra can accumulate enough snow to supply fresh water that keeps streams running through the state's long, dry summers.

But climate change is upsetting this picture. More winter precipitation is falling on the Sierra as rain rather than snow, which changes the duration and intensity of runoff. As a result, healthy meadows have become a critical means of capturing and storing runoff later into the year.

Meadows are the sponges, Branham said, that soak up and slowly release each winter's precipitation. Many Sierra meadows have lost some of that absorbing power, a result of overgrown forests and decades of lightly regulated livestock grazing.

Hugh Safford, regional ecologist at the U.S. Forest Service, said climate change over the past 75 years has altered the mix of tree species in the Sierra. At all but the highest elevations, conifers such as Jeffrey pine and Ponderosa pine are decreasing, while hardwood species such as oak and madrone are increasing. This is caused by rising temperatures and a decline in snowpack.

Wildlife habitat also has been affected, with suitable terrain shrinking for several species, including spotted owl and fisher.

The state's prolonged drought is compounding these effects.

"I expect there's going to be a major problem in the Sierra Nevada in the next two, three, four years unless we see a major increase in precipitation," Safford said.

No single agency has enough resources to tackle these problems, because the Sierra Nevada is so big. Branham said the watershed partnership intends to bridge that gap by bringing agencies together to smooth out some of the barriers.

For example, controlled burns help thin overgrown forests and reduce fire risk. But air quality regulations and community objections often restrict the available days to conduct such burns. Part of the solution is to improve public understanding about controlled burns, and work with air quality regulators to ease regulations.

For at least a century, forest managers aggressively fought every Sierra wildfire, on the premise fires were bad for forest health and wildlife. More recently, scientists have shown that fire is a natural and necessary part of the ecosystem.

Another option is more mechanical treatments – logging – to thin forests. This has been controversial among environmental groups, which contend it could be used as a cloak to remove large trees that are valuable habitat. Landowners and logging companies, meanwhile, argue that some timber harvesting is necessary to pay for restoration work.

The past few decades have seen several concerted efforts to restore the Sierra, but few significant results. The conservancy and Forest Service are optimistic this effort will be different. So far, eight organizations have endorsed the program, ranging from The Nature Conservancy to the California Forestry Association.

"At this point, I think everybody has come to the mutual understanding that there is an urgency now to move forward," said David Bischel, president of the California Forestry Association. "We have to do something bold."

# # #

Droughts can expose quirks, create confusion in California water management
Fresno Bee | March 7, 2015 | By Mark Grossi

The drought isn't the only problem now facing the state's water movers. The growth of hyacinth, a water-loving plant in the Sacramento-San Joaquin Delta Delta, is troublesome, too:

• Federal water export pumping has been slowed at the delta because hyacinth can clog the pumps.

• State pumps in another spot of the south delta have not been plagued the same way, so they have pumped a lot of water, the state Department of Water Resources says.

• The CVP should be able to make up the difference later this year, say water leaders. The state will ease back pumping and allow the feds to increase pumping.

Haves and have-nots

• Some water districts in Kern County will get some deliveries, but others just to the north will have none.

• The state's two major water projects may look the same, but they are not.

• Droughts tend to expose the quirks in California's water management.

In the withering California drought, 15 water districts will deliver precious irrigation supplies to Kern County growers while 15,000 farmers face summer without their Millerton Lake allotments — a confusing repeat of last year.

How does the south San Joaquin Valley get some water in back-to-back drought years while the east side goes without? And, by the way, vast tracts of farmland on the Valley's west side also will be shut out.

The difference: The Kern growers buy from the State Water Project. The east-siders and west-siders buy from the federal Central Valley Project.

The projects are California's water titans, looking almost alike with reservoirs, canals and their gargantuan pumps in the Sacramento-San Joaquin Delta to export water.

But they are different, which can create a complex and uncomfortable flashpoint in the Valley. For one thing, the smaller state project has a somewhat lighter burden, because it does not have to provide more than 300,000 acre-feet of water for wildlife refuges as the CVP does.

The subtle difference is a big deal in a drought, when there is so little water to go around. Other below-the-radar differences, such as water-delivery pecking order dating to the 1800s, are magnified in a drought. Those with historic rights get their water first.

Still, the state project was able to deliver a tiny-but-welcome 5% last year. This year, with a little more rain in Northern California, the 20% looks a lot better than zero. Federal officials say they're trying to do the same.

"People should know we are trying to be as creative as we can to provide as much water as we can," said CVP operations manager Ron Milligan of the U.S. Bureau of Reclamation. "The State Water Project is cooperating with us to make this work."

Both projects must scramble to deal with water quality issues and restrictions to protect fish. They also cope with the Golden State's commitment to supply those with historic water rights. The system, which one expert called a "hopeless mess," needs reform, because it is impossible to track all the usage, say water scholars.

Yet all of the 29 state contractors — the biggest being in Southern California and Kern County — are getting 20% of their contractual supplies this year.

History comes first

What's holding back the larger CVP? It starts with big commitments to those who hold historic water rights.

The federal project must provide 2.6 million acre-feet of water for Sacramento Valley landowners and some San Joaquin Valley west-side farmers who have those historic water rights. Federal officials also must find some water for small city contractors, such as Orange Cove and Huron.

On the state project ledger is providing water for landowners with historic rights in the Feather River area, amounting to about 900,000 acre-feet, according to the state Department of Water Resources.

An acre-foot of water is 326,000 gallons, or a year's supply for an average family in the San Joaquin Valley.

On another front, CVP contractors are interested in revisiting an agreement dating to 1986 that divides responsibility for supplying water to high-priority rights holders in the Sacramento Valley. The Cooperative Operating Agreement requires the CVP to provide water for 75% of those needs, while the state project puts up 25%.

In wetter seasons, there is enough water in Northern California to make up for the difference between the CVP and state project responsibilities. But that's not happening in the drought, said Ara Azhderian, water policy administrator for the San Luis & Delta-Mendota Water Authority, representing west San Joaquin Valley districts on the CVP.

"There's a growing disparity in the drier years," he said. "It's probably a good time to talk about it again."

In Kern County, state water contractors don't agree. Curtis Creel, assistant general manager of the Kern County Water Agency, said he has not seen a problem with it.

"The obligation is higher for the CVP in certain years," he said. "But it's equitable."

State customers pay no matter what

Creel pointed out another difference in the projects — one that does not favor state contractors. Unlike the CVP, state water contractors pay for water deliveries whether they get them or not.

Kern farmers may have gotten 5% of their water last year, but they paid for 100% and still needed to buy other scarce supplies. The same thing will happen this year when they get 20%.

"I think the dialogue now should be about when this water crisis ends," Creel said. "We have depleted reserves. It will take time to recover. One normal year of precipitation won't do it."

Why the difference in the finances?

The state project was developed two decades after the CVP, which was built in the 1930s and 1940s with federal funding in a Depression-era economy. The CVP's financing is far more forgiving than the state project because the federal government had deeper pockets and was trying to spur business.

Another difference: CVP customers are primarily farmers. About 70% of the state project's customer base is urban, chiefly the Metropolitan Water District of Southern California.

'Wild West' water rights

Either way, nobody escapes the state's mystifying water rights, which some scholars consider an old, "Wild West" approach. Longtime researcher and academic Michael Hanemann said California decades ago chose not to empower an agency to thoroughly vet water rights dating to before 1914.

Now there are more claims than there is water, said Hanemann, an economics professor at the University of California, Berkeley. Sorting out who gets water and who does not is a nightmare in a drought, he said.

"The state had the opportunity to reform in the 1940s and 1950s," he said. "And it might have taken until now to do it. But at least it would have been done and in place for a time like this."

# # #

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California business coalition pushes for secure water supply
Santa Cruz Sentinel | March 5, 2015 | by Donna Jones

WATSONVILLE >> A diverse coalition of global businesses operating in California launched a campaign Thursday to seek and support solutions to the state's water supply crunch.

Thursday's launch of the Connect the Drops campaign comes as California enters a fourth year of drought, and days after state officials announced they could deliver just 20 percent the water requested by agencies that serve 25 million customers and irrigate 1 million acres of farmland.

"This is likely the new normal," said Kirsten James, senior manager at Ceres, an advocacy organization that's coordinating the campaign. "We do have a government action plan to start moving us in the right direction. The key is to implement it in the best way possible."

That's where companies such as Watsonville-based Driscoll's Strawberry Associates Inc. come in. As members of the coalition, the businesses plan to share their individual answers to water supply questions, press policy makers for practical solutions and adopt a watchdog stance over the $7.5 billion water bond passed by voters to ensure the money is spent effectively.

"We want to make sure every dollar gets allocated in a way that really drives this forward," Kelley Bell, Driscoll's vice president of social and environmental impact.

Miles Reiter, Driscoll's chairman and chief executive officer, has been involved in Sacramento water deliberations, and supported the bond measure and legislation aimed at better managing the state's dwindling groundwater supplies.

Bell said six years ago the company, whose California roots reach back more than a century, began focusing on water issues in the coastal communities where it operates and where saltwater intrusion due to dropping groundwater levels is a problem. Driscoll's has helped its growers cut water use, as well as worked with communities at large to find solutions.

"We are part of the problem, so we thought we also should be part of the solution."

Coca-Cola North America, Gap Inc., Symantec, KB Home and General Mills also joined the coalition.

Ellen Silva, senior manager for global sustainability at General Mills said the company counts on California farmers.

"As a global company, conserving water is not only good for the environment, it's also crucial to our business," she said.

The drought has spurred much of the effort surrounding California's push to conserve water and increase supplies. But Felicia Marcus, chair of the State Water Resources Control Board, said the issue has long been "under the radar," and it will take a "sustained effort" to resolve.

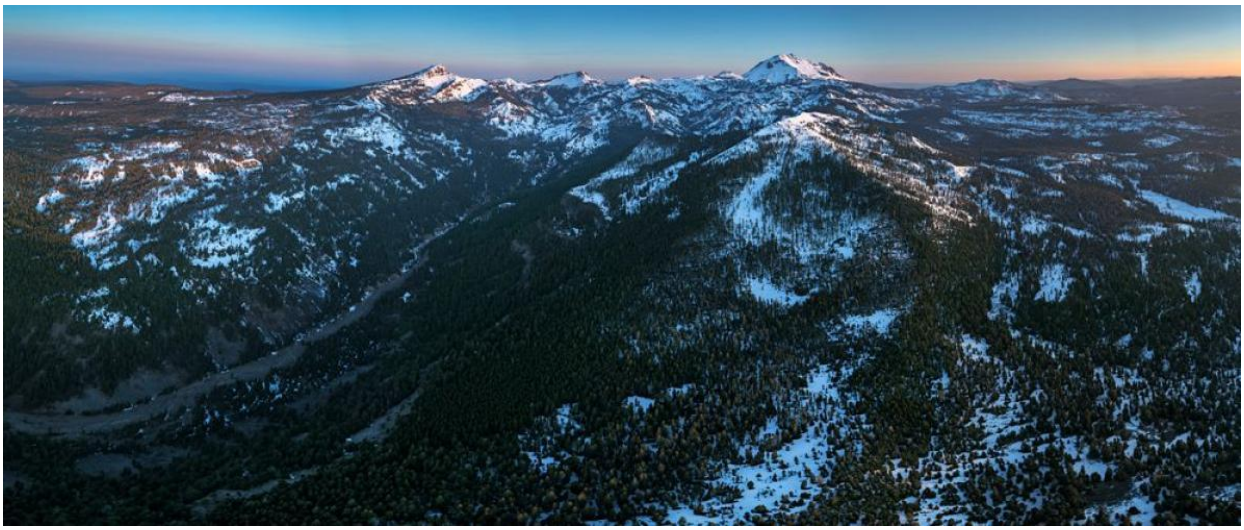
"As awful as (the current situation) is, it also is a harbinger of things to come," Marcus said.

# # #

Lack of Snow Leaves California's 'Water Tower' Running Low

Rising temperatures and declining snowpack in the mountains mean that the drought across the western U.S. is about to get even worse.

National Geographic | March 4, 2015 | By Dennis Dimick



Sparse snowpack in California's mountains in late winter 2014 is being repeated in 2015 (above, Mount Lassen in northern California). Snowmelt helps recharge the reservoirs that supply water to the Central Valley.

Snowpack—which essentially serves as a water tower for the western United States—produces vital meltwater that flows off the mountains each spring. Like a time-release capsule, snowpack refills streams and reservoirs and waters crops and cities through the dry summer in this largely semiarid region.

But the snowpack is becoming more like a snow gap, as temperatures in the Cascades and Sierra Nevadabecome too warm for the snow that replenishes the ecosystem each winter. Temperatures in the West are rising, and winter storms—which have been in infrequent for years—are bringing more rain and less snow.

As a result, the water tower of stored mountain snow—which typically provides one-third of California's water—is no longer refilling each winter, leaving a gap in summer water supplies. California now faces a fourth year of severe surface water shortages, and there isn't a broad plan to deal with the scarcity of water that's being created by persistent shortfalls of snow. Groundwater has served as a Band-Aid by compensating for the lost water, but aquifers are being pumped faster than they can replenish, and like snowmelt, aquifers are shrinking.

A California snowpack survey on Tuesday found less than one inch of water stored in snowpack, or 5 percent of historical average, at a site in the Sierra Nevada 90 miles east of Sacramento. Statewide snowpack on March 3 was about 19 percent of the multidecade average.

As winter—the region's wet season—nears its end, the harsh reality of another year with little mountain snowpack and resulting tight water supplies comes into focus.

"Clearly we are in the fourth year of a drought, but this is not just the fourth year of drought," said water scientist Peter Gleick of the Pacific Institute in Oakland, California. "It is the 11th year of the past 15 years that have been abnormally dry. We had a wet year in 2010, but most other years in the past 15 have been drier than normal."

January is usually California's wettest month, but this year no rain fell inSan Francisco. In 2014, San Francisco had its driest January since 1850, with 0.06 inches of rain recorded.

"The situation is extremely bad," Gleick said. Referring to late season snowstorms that could reduce the shortfall of mountain snowpack, he said, "we could get a March miracle, but the odds are against it."

Water-well drillers in California's Central Valley are working 24 hours a day to keep up with growing water demands amid the state's worst drought on record. As irrigation wells dry up, farmers call for help from the drillers, but how much longer will they be able to find new water sources in the ground?

Snowpacks Melting Earlier

Despite powerful December and early February rainstorms that partially replenished California reservoirs, mountain temperatures above freezing have kept snowpack from forming. Average California temperatures from October through January were 53.3°F, the hottest October-January period in 120 years and nearly five degrees above the 20th-century average of 48.6°F.

Farther north, rainfall has been near normal in Oregon and Washington, but warm temperatures ranging from 15 to 25 degrees above normalhave prevented snowpack from building in the Pacific Northwest mountains.

Hurricane Ridge in Washington's Olympic Range, which normally reports 87 inches of snow by mid-February, reported four inches on the ground. Snoqualmie Pass east of Seattle, which normally has 85 inches of snow by now, reported 21 inches. In the Oregon Cascades on February 18, water content in snowpack ranged from 9 to 17 percent of average.

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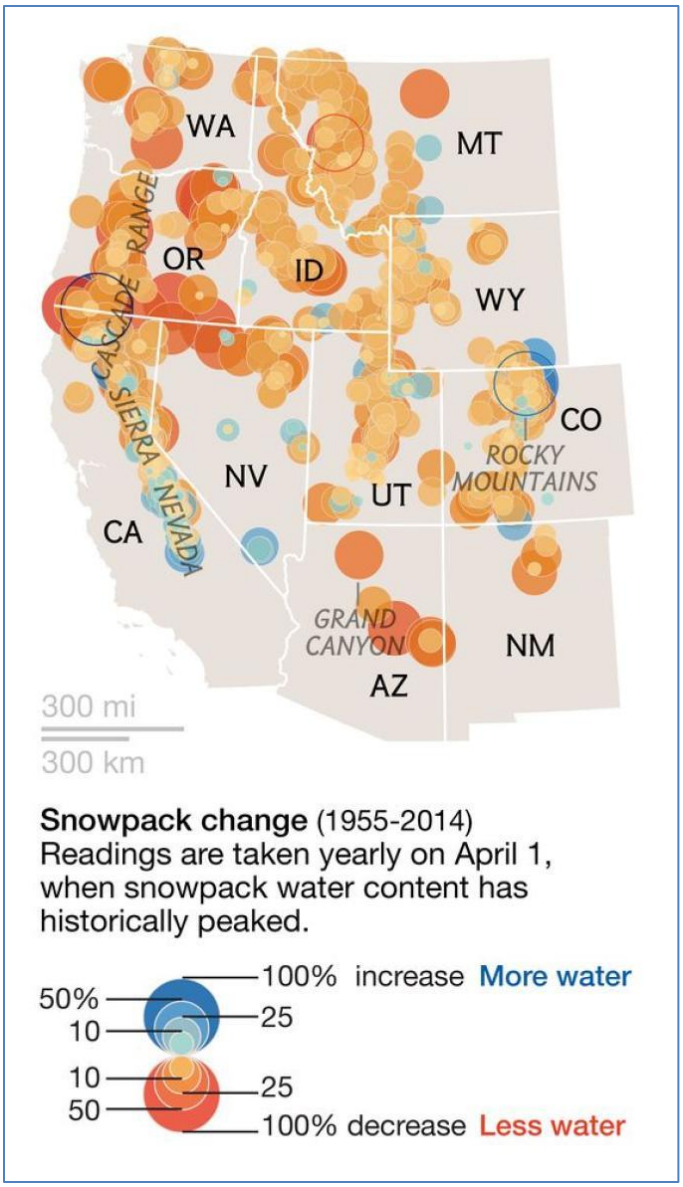


VIRGINIA W. MASON AND KELSEY NOWAKOWSKI, NG STAFF
SOURCES: NATURAL RESOURCES CONSERVATION SERVICE; CALIFORNIA DEPARTMENT OF WATER RESOURCES; DARRIN SHARP AND PHILIP MOTE, OREGON STATE UNIVERSITY

Ski resorts in California, Oregon, and Washington have suffered: Many have been closed for lack of snow. In Vancouver, in British Columbia, cherry trees bloomed weeks early, in late February. Alaska's temperatures have been warmer than Boston's, and Anchorage, with an average high temperature of 27°F in February, reached 33°F or higher 14 times in February.

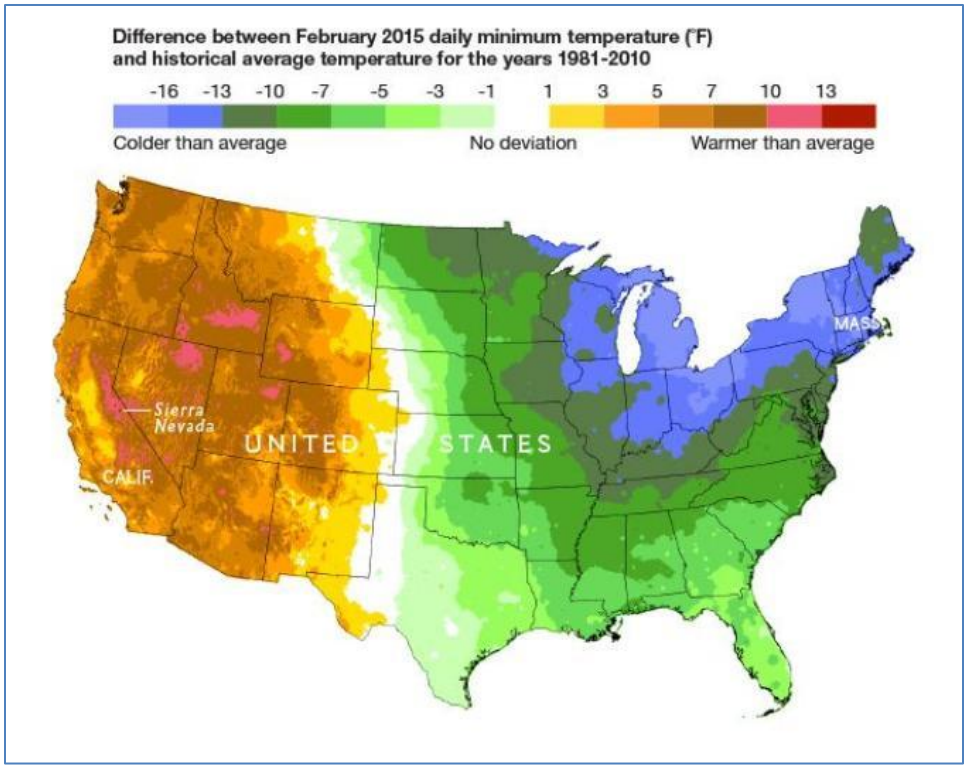
Philip Mote of Oregon State University, who studies trends in western U.S. mountain snowpack, said in the October 2014 National Geographic article "When the Snows Fail" that "warmer winters are reducing the amount of snow stored in the mountains, and they're causing snowpacks to melt earlier in the spring."

In practical terms, shrinking snowpacks and earlier snowmelts from rising temperatures mean that the region faces a persistent and worsening drought.

Why So Warm?

The jet stream—a narrow band of westerly circumpolar wind that moves weather systems from west to east—usually brings cold winter weather to western states from the Gulf of Alaska.

Like last winter, this year's persistent high-pressure ridge off the Pacific Coast pushed the jet stream north, bringing warm temperatures off the southern Pacific Ocean onto the continent. In midcontinent the jet stream has looped south, bringing frigid Arctic air to the east, similar to a "polar vortex" that brought persistent cold weather to the east in 2014.



In February 2015, while temperatures in the eastern U.S. were far colder than normal, mountain temperatures in the western U.S. were far warmer than normal, ranging from 7 to 13 degrees above average, hampering the buildup of snowpack.
NG STAFF. SOURCE: PRISM CLIMATE GROUP, OREGON STATE UNIVERSITY

Powerful winter storms such as the "Snowmageddon" storm in February 2010 have affected the eastern United States, Europe, and Asia in recent years. Researchers now focus on whether warming temperatures and ice loss in the Arctic have contributed to these unusual weather patterns.

"We are trying to understand how rapid changes in the Arctic and changing sea surface temperatures are going to influence, or are already influencing, extreme events in the western U.S.," Gleick said. "It is a very exciting area of study."

Regardless, scarce snowpack and high temperatures this year have set up another summer of water-starved fallow croplands, unemployed farm workers, desiccated landscaping, dry wells, and possible water rationing.

As surface water scarcity rises, pressure increases on rapidly depleting groundwater, which in years of normal snow and rain provide 30 to 40 percent of California's water, but in dry years supply close to 60 percent of state supply. A 2011 study led by Jay Famiglietti, a hydrologist and water scientist at NASA's Jet Propulsion Laboratory in Pasadena, California, and professor at the University of California, Irvine, reported that Central Valley aquifers have been dropping each year by an amount nearly comparable to the storage in Lake Mead, the nation's largest surface reservoir.

A Colorado River basin groundwater study in 2014 by Famiglietti and NASA colleagues showed that groundwater levels are being rapidly depleted to meet local water needs in the river basin, which also supplies surface water to California, Nevada, and Arizona.

Recognizing that aquifers are shrinking, California last year passed a law regulating groundwater use. But the law won't take effect for years, giving local agencies five to seven years to develop groundwater use plans and until 2040 to implement them.

"I fear that in California, the groundwater supply will be largely depleted by the time the groundwater legislation kicks in, which could be decades." Famiglietti said. Because of the ongoing drought, he said the state will continue relying on a "dwindling groundwater supply with no management yet in place."

Famiglietti added, "It is time to consider mandatory restrictions on water use." He is concerned that since the groundwater law passed in 2014, there has been a rush to plant water-thirsty tree crops such as almonds in the irrigation-dependent Central Valley, before groundwater water use limits kick in.

Fears for Agriculture's Future

California is the nation's most productive agricultural state largely because of irrigation, which according to state data uses nearly 80 percent of the state's managed surface and groundwater water supply. (A farm water use group contends that irrigation use is closer to 40 percent.)

Eric Holthaus wrote last year in Slate that almonds, the state's most lucrative farm export, use 10 percent of the state's water. And as surface water supplies shrink, declining groundwater must be pumped to keep these trees alive.

The challenge is not just finding adequate water supply, but also realizing that rising temperatures increase evaporation and water demand. Gleick said that "temperatures in California have been extremely high the past several years, and higher temperatures increase water demand and snow loss."

Scientists reported in January that 2014 was the hottest year in California since weather records began in 1895, with an average temperature of 61.5°F, beating by nearly two degrees the previous high of 59.7°F in 1934. Three other Western states, Nevada, Arizona, and Alaska, also reported 2014 as their warmest year since record-keeping began.

Last June, members of the Association of California Water Agencies, which manage about 90 percent of the state's water, studied what may unfold this year if the state's drought continues.

"Hundreds of thousands of acres of annual and permanent crops throughout the state would be idled," their report said, "affecting the growers, local communities, related industries and the statewide economy."

The report went on: "In a worst-case scenario for the agricultural industry, cotton production in California's San Joaquin Valley could cease completely, resulting in severe economic losses from crop revenue, employment, shipping and more."

The San Joaquin River, fed by dwindling snowmelt, navigates a dense grid of southern Central Valley farm fields as it flows northward toward San Francisco Bay. More than 70 percent of the river's water is used for irrigation.

The San Joaquin River, fed by dwindling snowmelt, navigates a dense grid of southern Central Valley farm fields as it flows northward toward San Francisco Bay. More than 70 percent of the river's water is used for irrigation.
PHOTOGRAPH BY PETER ESSICK, NATIONAL GEOGRAPHIC

Is There a Backup Plan?

Looking ahead, Famiglietti said, "My biggest fear for the immediate future, in particular in California, is that there really is no contingency plan if the drought continues. Many top-level managers will admit with honesty that they don't know what the state will do if the drought continues, and if our water supplies keep plummeting.

"Beyond the current mode of operation, which is to operate in emergency mode and to really push conservation, we need a task force to begin long-range contingency planning, immediately," he added.

Recent studies only underscore the urgency for water supply contingency planning.

A new study from Stanford University reports that low precipitation was key in starting the drought, but that heat, which has become more common in California, has been essential in maintaining and intensifying the drought. It also suggests that human greenhouse gas emissions—which keep rising—have increased the odds for more frequent warm and dry conditions across the state.

Researchers reported in February in the journal Science Advances that the U.S. Southwest and southern Great Plains will likely see drought of "epic proportions" in the second half of this century. Their assessment provides the highest degree of certainty yet on the impact of global warming on water supplies in the region.

On the study, National Geographic's Brian Howard wrote, "The chances of a 35-year or longer 'megadrought' striking the Southwest and central Great Plains by 2100 are above 80 percent if

the world stays on its current trajectory of greenhouse gas emissions, scientists from NASA, Columbia University, and Cornell University report."

Tom Painter, a snow and drought scientist at the Jet Propulsion Laboratory who was not involved with the study, told Howard, "Over the past year, water managers and the public have started paying more attention to the possibility of a megadrought.

"Water demand has passed supply in some areas," Painter said. "Throwing 30 years of drought on top of that means we're going to have to change the way we live out here."

# # #

Dennis Dimick is National Geographic's Executive Editor for the Environment, and as a native Oregonian has been concerned about western snowpack and water supply issues for decades. You can find him on Twitter, Instagram, and flickr.

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Fish vs. people frustration rages at Oakdale Irrigation District meeting
Modesto Bee | March 3, 2015 | By Garth Stapley -

OAKDALE — State and federal officials favoring fish habitat are to blame for the Oakdale Irrigation District's tentative plan to drain Tulloch Lake this summer, OID leaders told dozens of anxious lake-area residents.

The OID board also delayed until April deciding whether to impose a drought surcharge on farmers this year, and said the board is likely to cancel plans to pay farmers who agree to sell water to out-of-county buyers.

All are reactions to the drought now entering its fourth year.

"This is simple; we don't know where the hell we are," said Steve Knell, the district's general manager, moments before a 4-0 vote to begin OID's irrigation season March 16. He referred to uncertainty over how much water the district will get this year, after state and federal agencies figure the snowfall that can be captured in mountain reservoirs – not much – and factor in how much is needed to help revive the salmon population in the Stanislaus River.

OID operates dams on the river with its Tri-Dam partner, the South San Joaquin Irrigation District, but they are subject to federal authority over the river's largest dam, New Melones. Several years ago, the small districts fought hard to oppose new policies favoring fish but lost legal battles in federal appeals court. In the middle of a third dry season last year, requests to ease fish flows got no traction with California Sen. Barbara Boxer or the White House.

"People ought to come before fish," said Tulloch resident Jack Cox, who formerly worked in national politics. He urged a comprehensive, nonpartisan appeal to federal officials and Gov. Jerry Brown, whose water leaders are pursuing a separate seizure of Tuolumne, Stanislaus and Merced river water, also to boost diminished fish counts.

OID attorney Tim O'Laughlin told the standing-room-only crowd, spilling from the board chamber into an adjoining hallway, that tap water from Tulloch – supplying drinking water to nearly 10,000 people, by Cox's count – would not run out even if the districts reduce the reservoir to a veritable puddle.

That last happened in 1991, at the end of another drought. The districts discovered then that releases from the deeper New Melones kept the Stanislaus a few degrees cooler than normal – better for fish, O'Laughlin said.

Two weeks ago, OID leaders said nothing of the plight of neighbors if Tulloch were drained; the overriding motivation was saving up to 25,000 acre-feet of water for farmers.

An audience member Tuesday objected to Knell's dismissal of Tulloch concerns in an opinion-page piece in Sunday's Modesto Bee. Knell had noted that the districts and a federal agency hold

water rights on the Stanislaus, not thousands of home owners, and said the loss of pontoon boat rentals pales in comparison with the loss of the districts' hydropower sales.

OID Chairman Steve Webb assured people that the board sympathizes with everyone affected by fish policies and the drought.

Board members formally declared a drought Tuesday, but balked at having farmers pay a $6.10 per-acre drought surcharge. The board last year agreed to raise water rates this year and didn't want to hand customers a double-whammy, but they could revisit the issue April 21.

The surcharge might have raised $414,500, which could help cover costs for anticipated groundwater pumping to augment surface supplies.

Also April 21, the board might consider resurrecting water exports. OID in January had agreed to let more than 110 farmers forgo shares of water to be sold for $400 an acre-foot to Fresno-area buyers, with 20 percent of proceeds going to farmers in cash and 75 percent helping with equipment upgrades that would save water in the future.

The drought and a lawsuit threat from former board member Louis Brichetto put the idea on hold. Brichetto's attorney contended that the district should first conduct extensive studies to conform with state environmental law.

O'Laughlin said if the matter ended up in court, Brichetto likely would win. The board voted 3-1 to hold off until April 21; Al Bairos dissented, saying the export plan is sound and he would prefer keeping it on track by starting the studies, which could take three months or more.

Tri-Dam will host a town hall meeting to discuss the water situation at 10 a.m. Saturday at 920 Black Creek Drive in Copperopolis.

Bee staff writer Garth Stapley can be reached at gstapley@modbee.com or (209) 578-2390.

# # #

Action aplenty for Yuba County Water Agency
Appeal Democrat |February 11, 2015 | Andrew Creasey

The Yuba County Water Agency has filed its draft application to relicense the Yuba River Development Project, including Bullards Bar Reservoir.

Looking forward to 2014 and 2015, the Yuba County Water Agency was already preparing for hectic years.

Two major developments in the agency's history were coming to a head — the application for a new license that will determine how the water project is run for the next 50 years and the takeover of the operation of the project's hydropower plant.

But the historic drought, which has shown little signs of slowing down, has made a hectic period even more demanding.

"This year, by far, is the busiest year we've had in decades," said General Manager Curt Aikens.

The drought has meant the agency has spent considerable time requesting deviations of flow requirements for the lower Yuba River — and handling the subsequent monitoring requirements that come with it.

The agency is preparing for the possibility of curtailments to its water deliveries. The agency supplies 386,000 acre-feet of water each year to irrigate more than 90,000 acres of crops.

There's also the possibility the State Water Resources Control Board could curtail the agency's 1927 water right, which would mean the agency could not divert water to storage, Aikens said.

The board did just that last year, but made some mistakes in its rationale to do so — mistakes the agency had to take time to correct. Aikens said they're reviewing that process again this year.

On top of the drought work, the agency is working on its relicensing application to the Federal Energy Regulatory Commission.

The agency submitted the final application in April 2014. The document is thousands of pages and includes 46 studies on a variety of subjects from water quality to riparian habitat to myriad endangered or threatened species.

Completing the application has cost about $19 million, and that price tag will rise, although the agency hopes to keep it under $25 million, said Geoff Rabone, projects manager.

Rabone said the relicensing application is about 80 percent complete, but the final license is contingent on a host of approvals and certifications and could take up to 10 years to move through that process.

Finally, and arguably most significantly, the agency is preparing to take over operations of its hydropower plants when its 50-year power agreement with the Pacific Gas and Electric Co. expires on May 1, 2016.

For the agency, it means gaining sole control of millions of dollars in power revenues. But it also means taking over the maintenance and staffing, and all the costs that come it.

"The agency has been looking forward for 50 years for this day," Aikens said.

He cautioned power rates are less than half what they were before the recession.

"All the money people expected to see isn't always there, but it's still good news," Aikens said.

Water Agency preparing to power up

By Andrew Creasey/acreasey@appealdemocrat.com

As it turns out, running a power plant is complicated.

And planning for such complications has been at the forefront of Yuba County Water Agency activities as it prepares to take over operations of its hydropower plants from Pacific Gas and Electric Co.

In a nutshell, assuming control of its power operations will increase the agency's revenue by millions of dollars, which it will use to fund flood control projects, levee repairs, improve water supply reliability and possibility provide economic development support to Yuba County, General Manager Curt Aikens said.

But it will also mean maintenance of the plants, which was managed by PG&E, will fall under the auspices of the agency.

So, currently, the agency is working to increase the reliability of the plant with several upgrades.

The agency is replacing two transformers, costing $4 million each. The agency is also installing new communication systems, installing high-speed microwave and fiber optics lines that will boost efficiency and improve emergency response.

The plant will also have to run for 24 hours, which means the agency has 12 vacancies to fill. The agency will create in-house engineering sections with communication technicians and a compliance engineer.

Those improvements are funded, in part, by a $20 million up-front payment for future water transfers from the agency to the Metropolitan Water District of Southern California.

Then there is the matter of determining who will buy the power the agency produces. Negotiations are still ongoing for a power purchase agreement.

The agency is also building a $25 million reserve to pay for unexpected expenses.

In all, operating the project will cost about $27 million a year. Historically, average gross power benefits from the powerhouses at New Colgate, Narrows 2 and New Bullards Bar minimum flow average $53 million annually.

That leaves about $26 million in revenue each year, although hydropower revenue can fluctuate in wet and dry years, Aikens said.

Some of that revenue will help fund an ecosystem restoration project with the U.S. Army Corps of Engineers, which will look at ecosystem improvements, including fish passage at Englebright and Daguerre Point dams. The agency will spend $1.5 million annually for up to three years on the project.

The revenues will also help pay off $78 million in bonds the agency sold to fund the $43 million local share of the $186 million Feather River setback levee.

Power revenues will also fund two projects outlined in the agency's relicensing application to the Federal Energy Regulatory Commission.

A tailwater depression system at New Colgate Powerhouse would allow the facility's hydroelectric turbines to operate during high flows in the river due to flooding. Previously, the turbines had to be shut down during high water years, which reduces the project's ability to release water by an average of 12,900 acre-feet. The project would cost $12.2 million.

The application also includes plans for a new, $126 million flood control outlet to New Bullards Bar Dam, which would double the amount of water the dam can release during floods and add about 100,000 acre-feet of additional flood storage space, Aikens said. During the 2014 drought, Yuba County farmers were in one of the few districts in the state to receive a full supply of summer irrigation water.

But as the drought continues in 2015, the Yuba County Water Agency is preparing for the chance of curtailments to water deliveries.

Nothing is set in stone. Last year, the agency was saved from curtailments by a series of February and March storms.

Although it's too early to know what the summer deliveries will be, Curt Aikens, agency general manager, said the groundwater aquifer is healthy, and farmers with wells will be able to supplement any deficiencies in delivered surface water.

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Risk of 8.0 earthquake in California rises, USGS says
LA times | March 10, 2015 | By Rong-Gong Lin II and Rosanna Xia

Estimates of the chance of a magnitude 8.0 or greater earthquake hitting California in the next three decades have been raised from about 4.7% to 7%, the U.S. Geological Survey said Tuesday..

Scientists said the reason for the increased estimate was because of the growing understanding that earthquakes aren't limited to separate faults, but can start on one fault and jump to others. The result could be multiple faults rupturing in a simultaneous mega-quake.

Stated another way, the chance of an 8.0 or greater quake in California can be expected once every 494 years. The old forecast calculated a rate of one 8.0 or greater earthquake every 617 years.

"The new likelihoods are due to the inclusion of possible multi-fault ruptures, where earthquakes are no longer confined to separate, individual faults, but can occasionally rupture multiple faults simultaneously," said USGS seismologist Ned Field, the lead author of the report.

"This is a significant advancement in terms of representing a broader range of earthquakes throughout California's complex fault system."

The report says that past models generally assumed that earthquakes were confined to separate faults, or that long faults like the San Andreas ruptured in separate segments.

But recent large California earthquakes showed how earthquakes can rupture across multiple faults simultaneously. Many are in the Los Angeles area.

The Whittier Narrows earthquake, a magnitude 5.9, struck on the Puente Hills thrust fault system on Oct. 1, 1987. Three days later, a magnitude 5.6 aftershock hit on a different fault. That aftershock killed one person, twisted several chimneys and broke windows. Damage was reported in Whittier, Pico Rivera, Los Angeles and Alhambra.

Much larger quakes also showed how this could occur, including two that hit the Mojave Desert in the 1990s: the 1992 magnitude 7.3 Landers earthquake and the 1999 magnitude 7.2 Hector Mine earthquake.

It also happened in the 7.2 earthquake that hit along the California-Mexico border on Easter Sunday in 2010. Scientists said the border quake directed tectonic stress toward Southern California, putting the region at a higher risk for a future quake.

Data showed the April 4, 2010, quake and its aftershocks triggered movement on at least six faults, including the Elsinore and San Jacinto faults. Those faults run close to heavily populated areas in eastern Los Angeles County and the Inland Empire.

At the time, scientists said the imagery gave proof that earthquakes zipping along a fault can jump over gaps as long as seven miles. Previously, only jumps of three miles had been observed. There was also proof that earthquakes can reverse directions, an observation that had never been seen before.

Dramatically, proof of earthquakes jumping fault boundaries occurred in the massive 9.0 earthquake that hit off the Japanese coast in 2011. "The 2011 magnitude 9.0 Tohoku, Japan earthquake also violated previously defined fault-segment boundaries, resulting in a much larger fault-rupture area and magnitude than expected, and contributing to the deadly tsunami and Fukushima nuclear disaster," the report said.

"As the inventory of California faults has grown over the years, it has become increasingly apparent that we are not dealing with a few well-separate faults, but with a vast interconnected fault system," the report said. "In fact, it has become difficult to identify where some faults end and others begin, implying many more opportunities for multifault ruptures."

One particular fault ripe for a massive earthquake is the southern San Andreas, which Tuesday's forecast said was "most likely to host a large earthquake." This section of the fault has a 19% chance of having a 6.7 or larger earthquake in the next 30 years centered in California's Mojave Desert.

The chance was lower on the northern section of the San Andreas fault near San Francisco -- just 6.4% -- partly because of the relatively recent 1906 earthquake. (Still, quakes are relatively ready to go on the nearby Hayward and Calaveras faults in the Bay Area.)

The new forecast was released as part of a publication known as the Third Uniform California Earthquake Rupture Forecast. The USGS said it was created and reviewed by dozens of experts in seismology, geology, paleoseismology, earthquake physics and earthquake engineering. These predictions are factored into building codes and used by the California Earthquake Authority to evaluate insurance premiums.

Experts say they can't predict the date and time that the next big earthquake will come, but they're getting better at modeling the possibilities. Tuesday's forecast considered more than 250,000 fault-based earthquakes; the last forecast considered about only 10,000. The latest calculations use about 300 earthquake faults; the 2007 forecast relied on 200 faults, and the original 1988 report was based on only 16.

“As we’ve added more faults, we realized we’re not dealing with separate, isolated faults but really an interconnected fault system,” Field said in an interview.

Field said his team concluded that the previous forecast over-predicted the rate of “moderate-sized” earthquakes like the 6.7 Northridge temblor of 1994 “because we weren’t linking faults up.” That’s also why the previous forecast under-predicted the rate of quakes 8.0 and larger.

“The message to the average citizen hasn’t changed. You live in earthquake country, and you should live every day like it’s the day a Big One could hit,” Field said. “ But what it really does help us do is refine our estimates for those designing critical facilities: hospitals, schools, bridges.”

A higher probability of megaquakes should be a concern for those constructing large structures.

“If you’re dealing with a large bridge or maybe a large skyscraper that might not even notice a small earthquake, the waves from a magnitude-8 might be particularly problematic,” Field said.

“We are fortunate that seismic activity in California has been relatively low over the past century. But we know that tectonic forces are continually tightening the springs of the San Andreas fault system, making big quakes inevitable,” Tom Jordan, director of the Southern California Earthquake Center and a co-author of the study, said in a statement.

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