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YOUR University of California

A REPORT FROM PRESIDENT MARK YUDOF FOR FRIENDS OF UC

SEPTEMBER • 2009

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did you know?

- UCTV, with more than 18,500 subscribers, is the most watched channel on YouTube's education site (http://www.youtube.com/edu) for university and college content.
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UC: An engine of opportunity for all Californians

FROM THE DESK OF
Mark G. Yudof

It's been a tough year so far for the University of California. We've had to take difficult and painful steps for all members of the UC family: fee increases for students, furloughs and salary reductions for faculty and staff, a reduction in the size of the freshman class. But these headlines don't tell the whole story.

This month, as our students return to their campuses filled with hope and energy, it's worth reminding ourselves whom we are fighting for and what's at stake. As our students begin their hard work for the new academic year, I want you to know that we are going to be working just as hard on their behalf to build a vibrant, vocal community of political support.

We need to do a better job of telling our story in Sacramento — and beyond. I've made some 20 trips to the capital in the past year and will continue my advocacy. But frankly, I could use some help.

Continued on page 2

Compensation task force hears progress report

Three years after the Task Force on UC Compensation, Accountability and Transparency offered recommendations for improving university policies, the group met again to review university accountability and disclosure practices related to executive pay.

The independent task force, meeting at UCLA on Aug. 13, reviewed a 22-point checklist of recommendations made in 2006 after UC's handling of administrator pay practices was criticized. Of the policies targeted for change, 16 have been updated, and the remaining six are in the process of being revised.

Among the changes since 2006:

- Regents established a process to publicly disclose itemized details of executive compensation packages.
- UC now annually reports the salary and gross pay of all university employees systemwide.
- Regents established a Committee on Compensation and created oversight standards for the review and approval of compensation policies and other HR-related activities.
- Any actions taken by the president, chancellors or lab director for staff whose total annual compensation exceeds $214,000 are reported to the Regents at each meeting.
- Policies governing senior management relocation, automobile allowances, bonuses and other compensation-related items have been revised and put into practice.

"Transparency and accountability for me are two issues critical to university governance," President Mark G. Yudof told the task force. "We in higher education need not only adjust to them, but to embrace them."

Details of UC compensation practices are available at

www.universityofcalifornia.edu/news/compensation

POWER OF 10 *News from UC campuses*

UC Berkeley is the No. 1 public university in the United States for the 10th year, according to U.S. News and World Report's 2010 guide to America's Best Colleges.

UC Davis economist Christopher Knittel estimated that the federal Cash for Clunkers program was an expensive way to reduce carbon emissions when comparing the estimated price of selling carbon credits at $28 per ton with the estimated cost of $237 to $500 per ton of carbon reduction achieved with the federal rebate.

UC Irvine Medical Center's emergency department is one of the few hospitals in Southern California using lightweight, portable ultrasound scanners to diagnose life-threatening conditions.

UCLA received a grant from the Entertainment Industry Foundation to support the campus's inaugural Volunteer Day on Sept. 22, the biggest community service project in UCLA's history.

UC Merced will lead the California Advanced Solar Technologies Institute, one of 37 UC multicampus research programs the Office of the President recently funded.

UC Riverside ramped up for a new nanofabrication research center in its engineering college with the installation of a reactor to create nanostructures that will be used in solar cell research and other applications.

UC San Diego ranks among the top 15 percent of military-friendly schools for its programs for student veterans, according to G.I. Jobs magazine.

UC San Francisco scientists have found that, contrary to widely held beliefs, inducing labor need not increase a woman's risk of needing a Caesarean delivery.

UC Santa Barbara's California Ethnic and Multicultural Archives has made available online digital videos of the celebrated El Teatro Campesino theater company's vintage recordings of documentaries, interviews and performances, including excerpts of Zoot Suit.

UC Santa Cruz received an addition to its Grateful Dead Archive when composer Lee Johnson presented the score to his Dead Symphony no. 6 to the campus library after the piece was performed at the 2009 Cabrillo Music Festival.

For more about these stories, visit www.universityofcalifornia.edu/youruniversity

Yudof continued from page 1

This September, we'll be asking students, alumni, family members and other UC advocates to contact their state lawmakers to let them know what UC has meant for them – and to ask that California begin to invest again in public higher education. That's the only way UC can deliver on its promise to future generations.

We also want our political leaders to know that UC is not just a bastion for a privileged few: The university is a vital engine of opportunity, possibility and leadership for all Californians. An essential part of our story is knowing that UC enrolls a higher proportion of low-income students — some 30 percent — than other top public research universities and far more than distinguished private research universities. For 140 years, the university has worked to develop the human capital of California, to energize its economy and to advance the health and well-being of its citizens. UC education and innovation have helped power California's rise to its position of global economic and cultural leadership. We can continue to power the state — but to do so, we need the state's support.

We're not just holding out a tin cup. We're making huge efforts across the UC system to save money, achieve efficiencies, re-examine our financial models and be creative about how to operate in the new fiscal reality. And the fact is that for every dollar of state funding, UC researchers bring in nearly $5 more from private and federal sources. But state support is still critical to the core instructional program at UC, and if it doesn't rebound, the impacts on California will be more shocking than I think most people realize today.

As we look to the 2010-11 budget, we face even more challenges than we do in the current, crisis-filled year: Federal stimulus funds probably won't be continuing. Emergency measures we took this year — such as the employee pay reduction — can't be continued without doing major harm to UC's quality. Health benefit costs are continuing to rise. And a dramatic turnaround in the state revenue picture simply does not appear likely. Already, there are warnings of a $7 billion to $8 billion budget deficit in 2010-11.

While we are justifiably proud of UC's international reputation for excellence, few realize that the foundation on which UC is built is crumbling for lack of investment. If the 20-year slide in state support for public higher education is not halted and reversed, California's innovation economy and the educated work force that sustains it will wither. Today, academic quality, student access, and student affordability are all at risk. It is critical that UC retain its unique public purpose, access, quality faculty and world-class research. Each day I am privileged to lead this university, I am inspired by the dedication, intelligence and talent of our faculty, students and staff. As we all band together to advocate for ourselves in Sacramento, I think you will be too.

Contact me at president@ucop.edu. Follow me on Facebook and Twitter.

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Visit www.universityofcalifornia.edu/youruniversity for these Web-only features:

Sweet science UC San Francisco study shows value of chocolate.

Legal trailblazers Meet the inaugural class of UC Irvine's new law school.

Strike up the Band Listen to the UCLA Bruin Marching Band.

UC Irvine law school opens doors to inaugural class

The first public law school to open in California in 40 years welcomed its first 61 students on Aug. 24 at UC Irvine.

Those 61 aspiring lawyers have already reaped the benefit of selecting UC Irvine for their education — full scholarships. Orange County business leader Donald Bren, a longtime supporter of the school and UC, donated $20 million, which made the scholarships possible. The school received 2,741 applications, more than 40 applicants for each of the available spots.

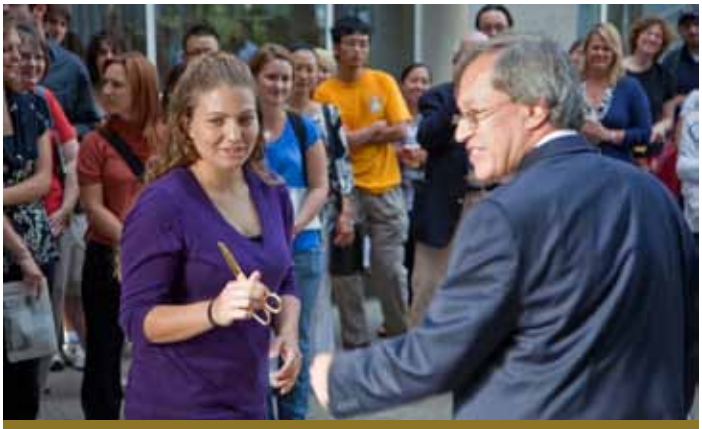
Acrivi Coromelas, the first student to commit to enrolling at the law school, cut the ribbon on the opening day of classes.

"We have ambitious objectives," said Dean Erwin Chemerinsky at the ribbon-cutting ceremony. "We're the first new law school to say that we will be a top 20 law school from the very beginning. While that might have been audacious when I first said that, it's now quite realistic."

Chemerinsky praised the quality of the faculty, students and facilities, ranking them all in the top 20 of the nation's law schools.

The inaugural class has 34 women and 27 men with an age range of 20 to 38. Twenty percent have advanced degrees including one Ph.D. and one M.D. They have a median GPA of 3.61.

At a new student orientation on Aug. 21, California Supreme Court Justice Carlos Moreno spoke to the class, encouraging students to use the skills they will learn to ensure all segments of society can participate equally in the justice, economic and education systems of our country.



Dean Erwin Chemerinsky hands scissors to Acrivi Coromelas, UC Irvine's first law school student, to cut the ribbon on the opening day of classes. Photo by Paul R. Kennedy

"Your contribution can and will make a big difference, an enormous difference," he told the students. "And don't think for a single moment that because you are just one person that you can't make a difference. Your legal training will change all of that in spades."

Sierra magazine honors three UC campuses

The national magazine of the Sierra Club has named UC Santa Cruz, UC Berkeley and UCLA to its annual "Cool Schools" honor roll ranking of eco-enlightened universities.

The three campuses ranked seventh, eighth and ninth respectively, with each scoring 96 out of 100, an A grade. Universities were rated for their energy and transportation efficiency, purchasing and waste-reduction policies, sustainable food service and academic programs focused on environmental careers. UC Davis ranked 24, UC Irvine 27, UC San Diego 33 and UC Santa Barbara 39.

This marks the third year the magazine has published the higher education environmental rankings and the first time it has rated UC's 10 campuses separately. In 2007, Sierra named UC system one of America's Top 10 coolest green universities. UC was the highest ranked public university and the only one in California to make the list. In 2008, the publication placed UC's 10 campuses "in a league of their own" calling the system a shining star in sustainability issues.

In recent years, according to the magazine, the measure of a university's green credentials has become an important factor for prospective students in selecting a college.

UC teams attack urgent state issues

The UC Office of the President recently awarded $68 million in competitive grants to 37 Multicampus Research Programs and Initiatives.

These innovative collaborations will assemble statewide teams of UC experts to focus on research important to California.

One of the research teams will work on transportation issues, including congestion reduction, air pollution and next-generation alternative fuels and vehicles.

Other research programs are working on solar energy, water shortages and education. A new program housed at UC Santa Barbara, titled "New Racial Studies in the Age of Obama," will connect UC scholars who teach and study race relations. UC has committed to funding these interdisciplinary projects for up to five years, but funding will depend on how the university fares in the state budget process in the coming years.

"UC is always looking for new ways to take advantage of the wealth of research expertise throughout the system," said Steven Beckwith, UC vice president for research and graduate studies. "By teaming the right experts, we have a unique opportunity to attack and solve some of the problems that are confronting the state."

UC doors open wider for transfer students

K Chico transferred from Shasta College to UC Merced.

K Chico could have gone to college after high school on scholarships to universities outside of California, but she wasn't quite ready to move away from home.

She'd been told going to a community college was cheaper and just as good as starting out at a four-year university. So she enrolled at nearby Shasta College, with her sights set on transferring to the University of California. She was familiar with UC through participating in 4-H.

Chico, 21, whose given name is the letter K, is now a senior bioengineering major in her third year at UC Merced after transferring from Shasta College.

UC wants to attract more community college transfer students such as Chico as a way to reduce the costs for greater numbers of students and to increase access to four-year universities for underrepresented groups. In February, UC formed a task force with California State University and state community college leaders to increase the number of transfer students.

The savings at a community college on registration fees alone are dramatic: A student taking a full load of classes at a community college typically pays about $480 a year. At a UC it's $8,700 per year.

Finances aside, community college may be the right route for students such as Chico, who don't want to move away from home just yet. Other students may not be ready for a four-year university right out of high school or haven't decided on a major. Community college gives them a chance to prepare.

"For many students, the most economical and effective way to begin higher education is to start at a community college," said Susan Wilbur, director of undergraduate admissions at the UC Office of the President.

As part of the state's Master Plan for Higher Education, UC gives admissions priority to transfer students from California community colleges. UC offered admission to a record 19,607 transfers from state community colleges for fall 2009, 12 percent more than the 17,513 for fall 2008. Each year, about 14,000 transfers from state community colleges end up enrolling at a UC campus.

The increase in transfers is part of a plan UC Regents adopted in January to raise the transfer student enrollment target by 500 this fall.

The transfer option not only benefits California students but also contributes to the quality of the university.

"The community college transfer applicants we see are typically very well prepared," Wilbur said. "Once enrolled, their persistence rate is very high and they graduate in a timely manner. They're excellent students and they contribute in many ways to the breadth and diversity of UC's student body."

Chico was ready for college before most high school students. She graduated in three years when she was 16 through an accelerated program that included taking eighth and ninth grades together.

"You don't sleep at all," Chico said of her high school years, during which she maintained a 3.75 grade point average. She was the first in her family to go to college.

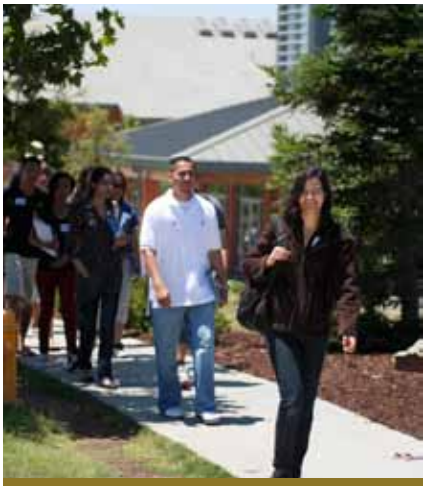
Her transition to a UC was aided by programs that all campuses have to help transfer students.

"Articulation is always something difficult," said Dustin Noji, UC Merced's assistant director of transfer initiatives. "Understanding which community college courses transfer and how that fits in with overall degree completion."

Transfer students also often need help adjusting their study habits for the rigors of UC and getting familiar with the social aspects of campus life, Noji said.

When Chico enrolled at UC Merced, which opened in 2005, there were very few transfer students on campus and an orientation process, now implemented, was not yet in place.

"Now we're making sure there are specific programs, and transfer orientation is one of the things we're doing to move toward that," Noji said.



Students walk to the transfer orientation at UC Merced.

UC Merced also created a networking group called the Student Transfer Outreach Mentorship Program (STOMP) that connects former transfer students with new ones. It's modeled after the UCLA STOMP program.

"A lot of transfer students have work experience outside of the traditional academic experience," Noji said. "Transfers are usually older students, and they can serve as mentors for younger students on campus."

State of Drought UC tackles water crisis

Struggling through a third consecutive year of drought, California faces a bleak reality: Change the way we use our scarce water supply or face recurring cycles of economic and environmental emergencies.

Given the urgency of the drought crisis, the University of California has declared water one of its top research priorities.

"UC historically has played a major role in understanding urgent problems in the state and creating solutions," said Steven Beckwith, UC vice president for research and graduate studies. "We've identified sustainable water supply as a key area of systemwide research. With our vast expertise on our campuses and throughout the state, we can hope to offer answers to this serious problem."

Throughout the UC system, researchers are tackling the water crisis head on. They play a vital role in monitoring the state's water supply, documenting the environmental side effects of drought and leading the research on water-saving strategies and even creating new sources of water.

They also advise policymakers and water managers how best to distribute water through this thirsty state – a critical public service when lawmakers now are debating a package of water legislation and conservation efforts. Water-focused research, outreach, education and resource centers are located at nearly every UC campus.

Economic devastation

No inch of California's topography has escaped the ravages of the current dry spell. From fallow farms in the Central Valley to scorched urban lawns to depleted lakes – all parts of the state are showing the devastation of water shortages. But the agriculture industry is hardest hit.

> *"The need to understand the highly complex workings of the water cycle, and the need to project its changes, has never been greater."*
>
> Jay Famiglietti, director
> Center for Hydrologic Modeling

Water shortages in the Central Valley could mean up to $960 million in lost income and a loss of 16,150 to 23,000 jobs, according to UC Davis' latest provisional estimates. In some rural cities, unemployment rates have soared above 30 percent, three times the state average.

Droughts are nothing new

Centuries ago, California suffered droughts much more severe than now. The state has continued to endure periods of drought, most recently from 1987-92. But today California's water supply faces even more pressures, from agricultural (the state produces half of the nation's domestic fruits, nuts and vegetables) to environmental to urban. The water crisis, if allowed to grow unchecked, could cripple California and have global ramifications.

Many factors exacerbate California's water crises: population growth, lack of conservation, deteriorating systems that move water, flawed allocation policies and a new player in the chronic drought story — global climate change.

"Climate change carries with it almost a certainty that we're going to see a warmer environment in California and of course that's going to affect the California snowpack," said Daniel Cayan, research meteorologist at UC San Diego's Scripps Institution of Oceanography. "We'll have to contend with drought in a warmer climate – a climate in which springs essentially end earlier, summers start earlier, our warm dry season becomes more acute and lasts longer. It's another part of the climate change future that is a huge challenge to water resources – to our drinking water, to the water that grows our crops."

The state and Gov. Arnold Schwarzenegger recognize the crisis and have set water conservation goals, including reducing California's per capita water use 20 percent by 2020.

But the drought problem certainly is not confined to California. If present climate and consumption patterns continue, two out of three people in the world will live in a water-stressed condition by 2025, according to the United Nations' World Meteorological Organization.

Tracking water cycles

The newly launched, state-funded Center for Hydrologic Modeling will link researchers at eight UC campuses and the Lawrence Berkeley, Lawrence Livermore and Los Alamos national laboratories.

They will study how water availability will shrink because of climate change and diminishing snowpack and how water supply may vary in response to climate oscillations, such as El Niño. Experts say El Niño is intensifying this year and could warm the Pacific Ocean and bring a wet winter to California. But a few heavy storms or one watery winter will not be enough to solve the state's water supply situation, experts say.

"The need to understand the highly complex workings of the water cycle, and the need to project its changes, has never been greater," said Jay Famiglietti, director of the center and professor of earth system science and civil and environmental engineering at UC Irvine.

Famiglietti knows people hit hard by the water crisis, and he pushes for comprehensive research to help bring relief to the state.

"It struck me after talking to a family whose acres of farms and livelihood are suffering because they don't have enough water," he said.

Photo/California Department of Water Resources

Lake Oroville in the Sierra foothills is one of many California lakes and reservoirs depleted by three years of drought.

The center will use satellites and field research to more accurately determine how much water exists in California and where it's located. The results will be shared with water agencies throughout the state to help them develop their policies and allocation plans.

Tapping new sources

In some parts of the state, water may be plentiful, but it isn't clean enough for drinking or farming. Scientists at the Water Technology Research Center at UCLA are finding better ways to turn seawater and the brackish water found in bays and deltas into fresh water.

Desalination offers a potential way to produce great amounts of consumable water, but the price of building desalination plants is hefty. High amounts of electricity are needed and, paradoxically, desalination produces a salty waste stream of brine that can be difficult to dispose of, as pumping brine back into the ocean disrupts the marine ecosystem. When it comes to costs and risks versus rewards, most researchers agree that without new technologies, it's right now a wash, at best.

Yoram Cohen, a UCLA chemical engineering professor and director of the center, is improving a method of reverse osmosis desalination, which was pioneered at UCLA in the 1960s. The process normally turns into freshwater only about 30 to 80 percent of the brackish or seawater put into the system. The remainder is left as highly salty wastewater. After a more efficient osmosis membrane was developed, Cohen added a process aimed at achieving 95 to 98 percent recovery of freshwater. In the end, it's a system that produces much more usable water and at a lower cost than conventional osmosis systems.

The Water Technology Research Center's graduate students recently tested this technology with a new mobile water desalination system in the San Joaquin Valley. It can generate 6,000 gallons of drinking water per day from the sea or 8,000 to 9,000 gallons per day from brackish groundwater. That's enough to produce drinking water daily for up to 12,000 people, Cohen estimated.

These systems can be set up all around the world, he said, and monitored from a central location. His team is working with U.S. and international water agencies and industries.

"The research comes out of necessity, certainly, for California, but there are also many places around the world that share our same challenges," Cohen said. "I feel we have an opportunity to make a real impact with our work. We're pointing out where advanced technology can make a difference."

Gen H20 gets down and dirty

As a child, Jessica Oster developed a fascination with caves. Growing up in Kentucky, she often visited the Mammoth Cave, the longest in the world. She enjoyed the eerie silence and marveled at the wondrous natural sculptures. For the curious and science-minded youngster, it was a geological Disneyland.

Now, once a month, the UC Davis geology graduate student explores the caves deep beneath the Sierra. As a climate change and water detective, she looks for clues about rainfall and temperature patterns.

Oster studies stalagmites, crystalline cones that form over thousands of years on cave floors. Serving as a kind of time capsule, caves preserve a record of the environmental events in their surroundings.

"Stalagmites grow from groundwater, and groundwater starts as rain and it trickles down into the cave," Oster said. "And while it's doing this, it's picking up signals related to the weather and climate outside the cave."

Oster is one of hundreds of graduate students, the vital cog of UC research, studying the state's water problems in laboratories, in rivers and on top and beneath mountains.

These graduate students perform some of the dirty but critical work for research projects, said Yoram Cohen, director of the Water Technology Research Center at UCLA.

"They are not only bright and creative, they are driven and committed to helping solve what has become a world crisis," Cohen said.

Clues in the caves

Just several inches of a stalagmite, like the one Oster obtained from Moaning Cavern in the Sierra four years ago, offer a 20,000-year archive of weather and rainfall, including during megadroughts that hit California long ago.

In her laboratory, Oster studies mineral traces captured in the stalagmite, whose growth layers can be read like the rings in a tree trunk. And these rings reveal thousands of years of climate records.

"If what we observe in the past is going to hold true for today, then as the climate warms we could expect it to get drier here," she said.

As Oster's fascination with caves continues, so does her drive to apply prehistoric natural events to the future. Her findings in stalagmites will add information from California to a worldwide database that will help other scientists and policymakers better understand, predict and prepare for global climate change.

Transforming the undrinkable

In the spring, Aihua (Richard) Zhu and seven UCLA graduate students packed up the van and headed for the San Joaquin Valley.

But it wasn't your typical spring break. They got down to business, testing a new mini-mobile-modular (M3) "smart" water desalination and filtration system in remote areas of the San Joaquin Valley where agricultural wastewater is the most brackish around.

The M3, developed by UCLA researchers at the Water Technology Research Center, can turn the yucky, salty water into potable water. "It's a harsh environment," said Zhu of their mini water desalination station. "But it's exciting when you're able to turn unusable water into water that you can even drink."

The system employs a process – reverse osmosis desalination – that forces saline or polluted water through the pores of a semi-permeable membrane. Water molecules are pressured to pass through these pores, but salt ions and other impurities cannot, resulting in purified water.

The M3 is capable of generating 8,000 to 9,000 gallons per day from brackish groundwater, said Zhu.

The system also acts as an all-in-one mobile plant that can test almost any water source, said graduate student Alex Bartman, who helped design the monitoring system and data acquisition computer hardware. Also its size and mobility – it indeed fits in the back of a van – make it handy and inexpensive for water testing and desalination.

It also can be easily deployed to various locations to produce fresh water in emergency situations, said Bartman.

Amazing GRACE

J.T. Reager, a UC Irvine graduate student in earth systems science, doesn't need hiking boots, nor does he pack a lot of equipment to do his research. He stays mostly in a computer laboratory, but has one of the broadest looks of the water supply in the state or any part of the world.

Reager's "eyes" are a pair of satellites, which fly 130 miles apart while circling the earth once every 90 minutes. The satellites, part of the NASA-sponsored Gravity Recovery and Climate Experiment (GRACE), measure the gravitational field of the Earth and show where water is and where it's going.

"I retrieve data from the satellites and turn them into color maps that tell a story of how water is distributed in selected regions," said Reager.

An advantage of GRACE is its ability to track water storage underground. Without GRACE, it would take an army of

Continued on page 11

UC water wonks help shape state's future

Water in California has always involved conflicts: north versus south, urban dwellers versus farmers, fish versus people.

With so many opposing forces, the state's policies to manage where water flows and who uses it are a patchwork of laws, court decisions and decades-old rights agreements. With no uniform distribution system and with global warming and population growth stretching water supply, California is at a breaking point, many researchers say.

"There's a broad consensus that the current government structure is dysfunctional and unacceptable," said Richard Frank, executive director of the California Center for Law, Energy & the Environment at UC Berkeley. "There's far less agreement on what the solution is."

Frank said a dramatically changed governing structure for the Sacramento-San Joaquin Delta and new environmental policies "to fix decisions made decades ago" are needed. He is part of a group of UC Berkeley researchers preparing a white paper with recommendations for reforming state governance of the Delta, a major source of California's water. A grant from the Berkeley Institute of the Environment is funding the report, which is being written by Frank, Berkeley law school professor Holly Doremus and environmental planning professors Matt Kondolf and Robert Twiss and will be made public in September.

"It cries out for an interdisciplinary approach," Frank said. "We at the university are well equipped to do that."

Support for decision-makers

Researchers throughout the University of California are helping reform environmental and government policies to combat the effect of drought, increased population and global warming on the state's water supply.

Frank and UC Berkeley environmental engineering professor Raymond Seed served on Gov. Arnold Schwarzenegger's Delta Vision panel that called for restoring the ecosystem, creating a more reliable water supply, promoting conservation and establishing an oversight commission to manage the Delta. A package of five water bills working their way through the state Legislature has many of the same goals as Delta Vision's strategic plan.

Nearly every UC campus has a research center or programs dedicated to water issues. In addition, the UC Center for Water Resources housed at UC Riverside is one of the 50 (one for every state) federally designated research institutions mandated by the1964 Water Resources Research Act. The center supports water policy and management research inside and outside UC through grants. It also collects historic documents and research related to water topics through the Water Resources Center Archives (located at UC Berkeley).

"I can always find what I need somehow in the (UC) system," said Alf Brandt, principal consultant for the state Assembly's Committee on Water, Parks and Wildlife. "I've been very impressed. Often UC is the neutral party that gives us an independent view of things."

Not all water created equal

Climate change is reducing precipitation, which, along with population growth, is putting pressure on the state's water supply. The problem of deciding who gets water is even more contentious.

"That's been the big question throughout California's history," said David Feldman, professor and chairman of the Department of Planning, Policy and Design at UC Irvine's School of Social Ecology and a faculty member of the campus's Urban Water Research Center.

Feldman's research area is water policy and social equity, and he is writing a book about how the control of water affects global environmental justice. Cheap, subsidized water in California encourages population growth in dry, urban areas, which in turn drives up demand, Feldman said. He advocates reforms that would decrease demand and wasteful practices (landscaping accounts for about half of urban water use), encourage conservation and promote recycling. He also said that the way policies are enacted must be inclusive and not just benefit those with the most power or money, as has happened in past.

Decades of water wars

Californians have been fighting over water for decades as the population centers in the San Francisco Bay Area and Southern California boomed.

"It's a long, fairly complicated history," said Bob Wilkinson, director of the Water Policy Program at UC Santa Barbara's Donald Bren School of Environmental Science & Management. "Environmental consideration came very late in the game. Until a few decades ago, it was legal to de-water a river."

In 1923 the O'Shaughnessy Dam flooded Yosemite's Hetch Hetchy Valley to supply water to the Bay Area, over the objections of environmentalist John Muir and the Sierra Club. And protests have dogged the Los Angeles Aqueduct for decades over water diversions from Owens Valley and Mono Lake. Under the Colorado River Compact signed in 1922, water is transported by canals to Southern California. Canals also divert Sacramento-San Joaquin Delta water to the Central Valley's farms and to Southern California and Bay Area cities.

Managing supply

"California has enough rainfall to satisfy all its needs. The problem is, it's geographically mal-distributed," said Steven

Continued on page 11

Growing more with less water

John Diener is neck-deep in the drought. In three decades of farming, he said this is the worst year for water allocation. But his business has survived, and he credits the University of California with helping him make the most of his water. Diener runs Red Rock Ranch in Five Points, southeast of Fresno, where he grows almonds, grapes, tomatoes and wheat. As a result of working with the UC system, he has turned to pivot irrigation, drip irrigation and other practices to optimize his water use.

"It's an ongoing relationship between agriculture and the university," said Diener, a UC Davis alumnus. "The university is the independent third party that helps the community and the legislators."

Water is the lifeblood of California's $37 billion agriculture industry. With the state in its third straight drought year, the race is on to use water more wisely. Over the years, UC has saved farmers millions of dollars with efforts to improve irrigation monitoring and management. Now UC researchers are rising to the current challenge by refining irrigation strategies, applying technologies such as aerial mapping and lasers, and developing drought-resistant crops.

The drought already is hurting the economy. Water restrictions in the Central Valley could mean up to $960 million in lost income and 16,150 to 23,000 fewer jobs, according to the latest provisional estimates by UC Davis agricultural economist Richard Howitt. But it would be worse if not for people such as Blaine Hanson, a UC Cooperative Extension irrigation specialist who has worked with Diener and other farmers.

"The drought definitely has (farmers') attention, and they're interested in some of these strategies to get by with limited water supplies," Hanson said.

Hanson is among the contributors to the UC Drought Management Web site, which launched in December at http://ucmanagedrought.ucdavis.edu. The site gives growers an easy way to view current research and appropriate drought strategies. It has irrigation information for almonds, pistachios, stone fruits, walnuts and alfalfa and soon will add wine grapes. UC also holds field days and short courses and offers helpful handbooks through the Agriculture and Natural Resources Catalog.

"We are providing information to farmers to help them irrigate more efficiently," said Terry Prichard, a UC Cooperative Extension water management specialist.

California growers annually save an estimated $65 million and reduce water use by about 100,000 acre-feet thanks to CIMIS, the California Irrigation Management Information System, a network of computerized weather stations. Diener is among its users, who can access data online for free about precipitation, temperature, wind speed and evapotranspiration, the combination of water transpired from the plant and evaporated from the soil.

Stressful irrigation

Two other steps that can improve irrigation efficiency are better scheduling (for example, not over-irrigating) and deficit irrigation (stressing crops at certain times to reduce water use with minimal impact on yield and quality).

UC's deficit irrigation research has helped Northern California wine grape growers reduce water use by 30 percent and increase the quality of their crop, Prichard said.

Deficit irrigation also works with almonds, pistachios and some orange varieties, said David Goldhamer, a UC Cooperative Extension irrigation specialist.

Lasering in on water use

A new generation of UC researchers has a well of ideas. Jan Kleissl, a UC San Diego assistant professor of environmental engineering, is looking to help with lasers.

The large aperture scintillometers – instruments originally intended for military target tracking – use lasers to help measure evapotranspiration. Kleissl has tested the technology in the Imperial Valley and New Mexico and is seeking a grant so he can analyze the data. The technology isn't cheap: Each scintillometer costs $25,000 and it's best to use two. Kleissl said it's a way to calculate evapotranspiration over a long distance – the instruments cover up to 3 miles – that could cut agricultural water use by at least 10 percent.

Developing drought-resistant crops

UC researchers aren't only trying to improve irrigation efficiency, they're also trying to engineer drought-resistant crops for use in California and around the world.

A study published this spring by UC Riverside assistant professor of cell biology Sean Cutler suggests that stable synthetic chemicals could be sprayed on plants to enhance drought tolerance and improve yield. UC Davis professor of cell biology Eduardo Blumwald has been working for seven years to develop genetically engineered plants that can survive droughts and grow with significantly less water. Collaborating with Arcadia Biosciences of Davis, he began testing with tobacco plants and now is experimenting with rice, wheat and tomatoes. Greenhouse trials are taking place now, with commercialization a few years away, he said.

Blumwald, who came to UC Davis in 2000 from the University of Toronto, said he feels a clear mandate to address the state's needs.

"We have taken the drought as a very personal challenge in California," Blumwald said. "There is no choice. We are really racing time."

Climate change stresses water, ecosystems

Peter Moyle has had his ups and downs during fishing trips on the Sacramento-San Joaquin Delta.

The UC Davis biology professor has been catching, counting and releasing fish in the Delta for more than 35 years. He's seen populations spike and fall, but mostly it's been a downward trend, in particular for native species.

"The Delta itself is not a good place to be a fish these days," Moyle said.

Global warming and an insatiable thirst driven by population growth are conspiring to put California's water sources and the ecosystems that depend on them at risk.

The Delta, which supplies water for two-thirds of Californians – nearly 25 million people – has experienced a collapse in native fish species that scientists blame partially on diversions for agricultural and urban use. In the Sierra Nevada, global warming is changing the snowpack and runoff patterns, threatening another large source of the state's water supply.

With so much at stake, the University of California has made water one of its top research priorities. As UC scientists study the effects of temperature change and human activity on the state's key water supplies, they are exploring solutions for balancing population needs with the long-term health of California's unique ecosystems.

Delta crisis

In the Delta, native fish species are declining; six are listed as endangered or threatened. For 50 years, water at the southern part of the Delta has been exported for agriculture in the Central Valley and for millions of users in Southern California and San Francisco Bay Area cities. Fish can be sucked into the gigantic pumps used to divert water, but scientists surmise that altered river flows, in combination with pollution and invasive species, also have damaged the Delta's ecology, leading to the collapse in fish populations.

In addition, many of the levees that protect islands in the south and central Delta are in danger of failing due to age, poor construction and rising sea levels. Maintaining most of these levees is not cost-effective and is a poor way of managing land and water, according to recent research studies.

Peripheral canal revisited

All these factors lead some scientists, including a group of UC Davis researchers, to support building a peripheral canal that would take water from the Sacramento River and bypass the Delta on its way to end users. A plan for a peripheral canal was voted down in 1982, largely by Northern California residents concerned about a Southern California water grab. An advisory panel on the Delta, convened by Gov. Arnold Schwarzenegger, called for restoring the ecosystem, creating a more reliable water supply, promoting conservation and establishing an oversight commission to manage the vast waterway.

Legislative solutions

Five bills with goals similar to those of the governor's Delta Vision panel are making their way through the state Legislature. The legislation includes a proposal to create a Delta Stewardship Council, which would have the authority to pursue restoration projects, including a peripheral canal.

The best thing for fish and the environment would be to stop pumping and water diversions, according to a 2008 research report. "We figure that's not going to happen," said Moyle, co-author of the Public Policy Institute of California report that calls for the construction of a peripheral canal and for allowing some Delta islands to flood permanently.

Proponents of a canal have the governor on their side. But opponents say a canal could lead to salt water incursions that would hurt the environment, farmers fear their irrigation allotments will be cut and many landowners of islands that would be flooded aren't keen on the idea.

"If you have to export water, you can't do what you're doing today," Moyle said "The peripheral canal is one of few options that seem to make some sense."

A canal would remove the effect of the pumps and restore a more natural water flow. It is also the most cost-effective way to manage water in a way that provides for human needs and the environment, concluded the 2008 report, which was written by Moyle with Jay Lund, William Fleenor, William Bennett, Richard Howitt and Jeffrey Mount from UC Davis and Ellen Hanak from the Public Policy Institute.

"This is one of these things that the devil is in the details," Moyle said. "You have to do it in a smart way."

Surveying the snowpack

Climate change is putting another source of state water at risk. In the Sierra Nevada, global warming causes snowpacks to melt earlier in the year, which leads to less water for reservoirs during the dry summer months, according to Roger Bales, director of the Sierra Nevada Research Institute at UC Merced.

"The big concern is how and where the transition from snow to rain occurs, when and where it's going to occur with climate warming, and what are we going to do about it as far as the changing water cycle," Bales said.

Since 2004, researchers from UC Merced and other UC campuses have used satellite data, modeling and on-the-ground observations to take precise measurements of the snowpack, giving scientists a better picture of how much water is in the Sierra.

"We're finding that more of the runoff comes from the higher elevations and there's more snow at higher elevations than previously thought," Bales said, "which is good for water supplies because it's colder at higher elevations."

Is more water up there?

Snow at high altitudes is less vulnerable to global warming, but generally is not measured, and the research is finding new technology that can measure the amount of snow and runoff. The data help water agencies predict how much supply they will have, which is vital to California's cities, farms and the entire economy, Bales said.

"We're providing a blueprint for a new water information system and for how to measure water supply and make forecasts in future," he said.

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people over several months to literally dig up the needed information. Reager, for example, has produced maps and charts showing a not so pretty story – depletion of groundwater in the state's Central Valley.

In the combined Sacramento-San Joaquin drainage basins, where water from snowpack already is diminishing rapidly, it is likely that groundwater pumping for irrigation is causing bigger water losses. Such data may sound an alarm to water managers and policymakers regarding water allocation.

And Reager wants his research – now and in the future – to bridge the information gap between scientists and policymakers. His current project uses GRACE to study the water storage capacity of large river basins in the U.S. and their potential for flooding.

Reager received his bachelor's degree in engineering, his master's in oceanography, and now his studies in earth system science give him not just depth, but also breadth of knowledge in climate change.

He won't always confine himself to the laboratory. Reager hopes to wind up in a place like Washington, D.C., where his scientific expertise and advice will be useful to policymakers – and perhaps make a difference.

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Erie, a UC San Diego political science professor and author of "Beyond Chinatown: The Metropolitan Water District, Growth, and the Environment in Southern California." "Much of the water is in the north. The population is in the south."

Historically, California has dealt with increased water demand by creating more supply through canals, dams and reservoirs, said David Sunding, a professor of agricultural and resource economics at UC Berkeley and co-director of the Berkeley Water Center.

"We're really reaching the limit of that," he said. "What's happening in the Delta is a measure of that. The ecosystem is really collapsing."

The pumping of water out of the Delta has been blamed for the decline of fish species. Recent court-ordered pumping restrictions may help the fish but are pinching water supplies for humans.

Sunding, whose expertise is water supply, pricing and efficiency, said setting up a marketplace to sell water rights could alleviate supply problems. Guidelines for what users are entitled to, how water is traded and a marketplace for trading would need to be created.

"If we have a crisis in water, it's really more of a management crisis than a scarcity crisis," Sunding said.

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