

One Geographer's Assessment of California's Changing Environments and Natural Hazards: a 2006 Snapshot

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Introduction

ACCORDING TO THE California Department of Finance, California's population grew by 444,000 people (1.2 percent) in 2005, bringing the total over 37 million by the start of 2006. Californians now account for about 12.5 percent of the U.S. population as the state's gross product grows toward \$1.7 trillion, accounting for an even larger share of the U.S. economy. California continues to rank around sixth or seventh among the most powerful economies in the world. The state's cultural diversity has no rival, while attempts by its citizens and leaders to make the great cultural experiments work remain in the world spotlight. How is California living up to its responsibilities as a world leader? These are powerful forces shaping the state and its human landscapes, and they deserve attention in a separate sort of state-of-the-state update focusing on human trends and landscapes.

In this paper, the focus is on human-environment interactions in California. Specifically, how do Californians perceive and how are they working with and adapting to particular natural hazards and accelerating environmental changes? Also, how are Californians impacting their natural environments? We might consider this a brief summary and update, a kind of 2006 state-of-the-state of how we are working with natural forces, sharing and living on the land, and adapting to the changes and surprises nature throws at us. In this limited space, I will focus on just a few of the hazards and changes that (arguably) deserve or are already getting the most attention in our state. It takes some courage to present a generalized unconventional paper for such a scholarly publication. Consider it an entertaining challenge, another call to geographers to use your diverse skills and become more involved in the tough decisions

being made in your community and your state, decisions that will affect California life and landscapes for a very long time.

Natural Hazards

April 18, 2006, marked the 100th anniversary of the great San Francisco earthquake. This was more than just an extraordinary annual commemoration. It gave San Franciscans and Californians one more opportunity to reflect upon the devastation caused by an approximately magnitude eight seismic event near The City. Officials and citizens met on Market Street to remember the poorly built buildings that crumbled to the ground. They and other Californians have learned plenty from this event, including the consequences of poor planning and corrupt political deals made with contractors who designed and built faulty buildings. Not only did the tenements collapse south of Market, but City Hall and many downtown structures were leveled. Still, it was the more than fifty fires started that morning that caught most people by surprise and eventually nearly destroyed a helpless city. (San Francisco's fire chief had warned officials in 1905 about The City's substandard water system.) The fires merged and burned for four days before the conflagration was con-



Figure 1. The old Bay Bridge is being replaced with new seismic engineering.

trolled with the help of dynamite. As with other California disasters that have forever changed us and our landscapes, opportunity and renewal erupted out of the devastation and misery. Rapid recovery and reconstruction produced a new urban landscape with a new government in a city reborn.

Californians have suffered from many earthquakes and other natural disasters since. But geographers and others continue to ask what we have learned from them, how they impact our landscapes, and if we are prepared for the next event that is certainly on the horizon. From earthquakes and volcanic events, to weather anomalies and climate change, to mass wasting and wildfires, what are the risks and which of them should get our attention? These topics are difficult to write about, partly because life in twenty-first-century California is challenging enough without considering the inevitable disasters awaiting us and also because once science pins down the most likely threats, nature sends a surprise. Acknowledging that such a surprise may have occurred by the time you read this, here are a few natural hazards that are most likely to impact Californians and change the state's landscapes. These are hazards that geographers and other scientists must keep officials and the public educated about and focused upon. Though we may see them as geographic realities, the way many Californians continue to perceive them and react to them can be embarrassingly absurd.

The Big One

Compared with the 1906 quake in northern California, it has been much longer since a major earthquake released substantial energy on the southern section of the San Andreas Fault, trending south from Parkfield and finally into the San Gabriel Mountains (Ft. Tejon, 1857). As geologists have estimated average recurrence intervals along that section of the fault at somewhere around 130–185 years, you can do the math. Still, it is the slice of San Andreas trending farther south from Cajon Pass and San Bernardino across the eastern edge of the Coachella Valley that has been locked since about 1690. Seismologists are most concerned that something must soon give. Since geologists have estimated chances of the southern section breaking at roughly sixty percent in less than thirty years, that more southern section into the Coachella Valley may be even more likely to produce a big event. Regardless of which segment finally breaks, we are talking about violent shaking that will affect more than ten million people. Compared to a few decades ago,



Figure 2. New housing projects compete with Joshua trees near the San Andreas Fault, western Antelope Valley.

millions more people have located in harm's way as the Inland Empire population continues to multiply. Add threats from other faults that lie directly below major cities (such as the Hayward and Newport-Inglewood) and reality sets in: Californians must prepare for a catastrophic earthquake that will be the worst natural disaster in the history of the U.S.

Of course, this is why new buildings must meet stringent building codes while retrofits continue to make many of our older structures safer in a race against time. Such standards continue to impact urban architecture and landscapes across the state. Perhaps the most dramatic example is the current replacement of the Oakland-San Francisco Bay Bridge with a new structure that should be left standing after a major seismic event. Such projects costing billions prove that Californians recognize the dangers and are willing to pay in the short term to decrease long-term risks and costs.

There is plenty of new information coming out of seismologists' recent research. One of the most-recent projects involves the San Andreas Fault Observatory at Depth (SAFOD). Funded by the National

Science Foundation in collaboration with the USGS, seismologists are gathering new data from deep inside the fault.

Still, after all the scientific studies and reminders of the inevitable, are we really ready? When I ask my classes if they have prepared for the big one with just a minimum of water and food for several days and a few other items in a survival kit, only a small minority of students answer yes. One specific example appeared last fall in our student paper, *The Corsair*, at Santa Monica College, after the fallout from Hurricane Katrina left its mark on America. Here are two sample replies from students who were asked, "Are You Prepared for a Disaster?" One student said, "I can't say I am, I've never been through one before." Another student replied, "I haven't made my preparations for a disaster. I don't think anyone is ready for a disaster. I am not scared of any type of catastrophic event, whatever happens, happens, it's meant to be."

Various surveys across the state yield similar troubling results. And when you watch our political leaders falling over themselves to initiate more deficit spending, including bonding our way into debts that will last decades, you must ask whether anyone is visualizing the day after. Imagine the sixth or seventh most powerful economy in the world brought to its knees by the big one as its residents compete for the remaining food, water, and medical care. Think of the impact this will have on the already stretched-to-the-limit U.S. economic deficit and such agencies as FEMA and our armed forces. And if you think there is any exaggeration in this vision, I have this reminder for you: Hurricane Katrina.

So, if anyone is paying attention out there, it had better be us geographers—and that is where there is plenty of hope. Many public officials and agencies do get it and are making preparations as I write this. But the educational wake-up call about the inevitable earthquake catastrophe (whether it hits northern or southern California) must be directed to the average Californian. It's not about trying to scare people; it's about living smart by learning your basic geography and preparing for the inevitable. It's called empowerment. And if the Chambers of Commerce are uncomfortable with such discussions, we might remind them that they can always move themselves and their businesses away from the prosperous Pacific Rim to hurricane country, tornado alley, or a place that has real winters where they can experience sub-zero-degree weather. I'm staying in California, where I can experience some of the most dramatic landscapes

sculpted into mountains built by the very forces that threaten us, but I'm also hoping my neighbors are ready.

The Great Delta Flood

Now we move on to another disaster that will surprise a lot of hydrologists if it does NOT happen: an unprecedented flood on the Sacramento-San Joaquin Delta system. Prior to our great water projects and the suburbs sprawling east into the Central Valley from the Bay Area, such a disaster would not be as noteworthy. But the stakes are much higher now as thousands of Delta residents look around from their new tract homes near sea level at earthen levees built during the 1800s by Chinese laborers.

Similarities to the Mississippi River Delta and New Orleans are startling. Here is a delta that was fed with sediment during each natural flood. Organic material grew on top of that and the entire system was a vast spongy wetland filter where fresh water mainly from the north and the Sierra Nevada trickled and meandered toward the west into Carquinez Strait and San Pablo Bay. Meanwhile, salt water intruded from the west and into Suisun Marsh and the Delta. Ordi-



Figure 3. Excess runoff floods into Yolo bypass with Sacramento in the distance, spring 2006.

nary tides flooded nearly three-fifths of the Delta, and nearly all of it was submerged when flooding combined with the highest tides. Runoff from hydraulic mining in Sierra Nevada's gold fields in the mid-1800s brought frequent floods with enormous sediment loads down the Sacramento River. Individual farmers sometimes tried to control the flooding on their land by competing to build higher levees. The result was water chaos. Diking and filling in the Delta began in 1850 and continued for more than 100 years. Agencies such as the U.S. Bureau of Reclamation, the California Reclamation Board, and the U.S. Army Corps of Engineers brought some order, working since the early 1900s to control flooding and successfully reclaim large areas of the Delta, much of it for farming.

The price of this control and reclamation has been subsidence of huge tracts (islands) of Delta land below sea level due to the decomposition of exposed organic material and continued farming. If some of the old levees were to break, the breach could pull sea water in from the west and an uncontrollable and almost irreversible flood to the Delta. Enter one of California's top hydrologists: Dr. Jeffrey Mount from UC Davis. He correctly refers to the Sierra Nevada/Central Valley geography as the perfect flood machine. During normal years, runoff from seasonal rains and melting snow is carried in rivers flowing down from Sierra Nevada peaks into the Central Valley flood bowl and toward the Pacific. Reservoirs and other flood control projects along the way are designed to discharge safe quantities of water into the Central Valley and Delta river systems and to store the rest. Much of this flow is pumped out of the Delta and diverted south for irrigation and urban consumers, using some of the greatest water projects on Earth. An unusual spring storm, such as a warm heavy rain event on top of a thick Sierra Nevada snow pack, could overwhelm the system. Once the levees are breached, sea water will rush in and there will be no fresh water to pump south. It could take more than a year to fix the system and restore the water projects, cutting off water to thirsty water agencies, farms, and millions of urban residents to the south.

Agriculture would suffer losses in the billions while cities would be forced to find other water sources for industries and residents for many months. Adding to the risks are recent studies (reported throughout California media) that an earthquake over six magnitude in the nearby Bay Area could cause up to thirty of the major earthen levees to fail, submerging more than 3,000 homes and 85,000 acres of farmland. Adding almost unbelievable drama to all

of this are the thousands of new homes and tens of thousands of people who are spreading across some of the very low-lying Delta lands that are at risk. People who can no longer afford to live in the Bay Area but still work there are purchasing their California commuter dream, gambling that earthen levees built in the 1800s will keep their suburban sprawl dry. Simply put, we may be recreating the environment for a New Orleans-style disaster, as if we are so jealous of their 2005 nightmare.

Though Californians have manufactured this whole complicated Delta crisis, there might be some pretty simple geographical solutions. One of the most complicated involves moving water around the Delta using a peripheral pipeline. Though this is much more than a rehash of the failed Peripheral Canal concept from the early 1980s, there are some stakeholders who might take advantage of the pending Delta doom to push their agendas. Such plans carry plenty of questions and problems regarding water quality, the impacts on fish and other species, and more general impacts on ecosystems all the way into San Francisco Bay. Keep your eye on the environmental groups, farmers, water agencies, and other leaders who are compromising, hoping to make the state-federal CALFED Bay-Delta Program a success.

There are some simpler solutions. First, stop building at or below sea level, especially behind levee systems that are considered unsafe. We all agree that the Sacramento River and parts of the Delta occasionally flood. As Dr. Mount has argued for years, we can give the rivers room to do what they naturally do with smart land-use planning that preserves enough adjacent farmland and open space to absorb occasional floods. There is also the recent media standard solution: we must spend the necessary resources to reinforce the old levee systems to protect what is already there, including our water projects. Fine, but don't confine these river systems into smaller channels so that we can squeeze more developments closer to their banks. That will require billions of our tax dollars to build enormous super levees, not to mention the inevitable exorbitant costs to taxpayers when the rivers finally and inevitably flood over those levees. And if you are wondering why some of these risky developments are still getting permitted to spread farther into harm's way, try looking at the enormous pressures on families who are trying to afford a piece of their own California dream. Then, investigate the sources of campaign dollars that fund the politicians making these decisions that allow developers to build in harm's way. Yes, it

may be somewhat unconventional to include such obvious political controversies within such a scholarly journal. But, regardless of your political philosophies, we all know how politics continues to play a powerful role in shaping our landscapes and how money is shaping the politics. The way we are repeatedly taught these same lessons would be hilarious if it weren't so tragic for some and costly to the rest of us. It is easy to be entertained when considering such geographic absurdities.

Other Hazards

Now that we've summarized what many argue are the top two imminent threats, there is a variety of other environmental changes and natural hazards that earn our attention, threaten lives, and mold landscapes. During the spring of 2006, we were reminded of the sometimes dangerous volcanic activity surrounding the Long Valley Caldera and Mammoth Mountain. Three Mammoth Mountain ski patrol members died within minutes of being trapped in a volcanic vent. The U.S. Geological Survey measured ninety-eight percent carbon monoxide emissions from the same vent a few years earlier. Numerous other volcanic features and events in the region include hot springs, eruptions of toxic gases, and relatively recent lava flows. Though Long Valley's catastrophic eruption occurred hundreds of thousands of years ago, smaller eruptions in the region date back only hundreds of years. And after numerous earthquake swarms since 1980, the caldera has risen more than sixty centimeters. Though volcanic hazards are not as widespread as earthquakes in California, there are a few spots, such as this region from around the Owens Valley north to Mono Lake, but also especially in the Cascades, where we must prepare for the possibility of dangerous volcanic eruptions and the new landscapes they may create.

As expected, California has also had its share of mass wasting events during the past few years. One landslide that many of you are familiar with is found along that steep cliff dropping to the Pacific, called Devil's Slide, just north of Montara on the way to San Francisco. (It is said the slide earned its name when bodies were dumped there during Prohibition years.) Engineers had to close the Pacific Coast Highway again in the spring of 2006 as Devil's Slide became more unstable during the steady March rains. The transportation problem should be solved by 2011 when two tunnels are completed through the mountain. Since each mass wasting event presents its own expensive challenges, scientists and communities scattered across the

state continue to debate about how to allocate precious resources to decrease such threats.

The frequency and nature of catastrophic wildfires in California during the past several years also deserves attention in a separate paper. Residents of more than a few parts of the state would rank fire as the top natural hazard, especially after conflagrations have repeatedly scorched landscapes and destroyed property. With our cool, moist winter and hot, dry summer Mediterranean environments, it would be difficult to write a script to purposely create greater fire hazards. The effects of forest management, fire suppression, land use, and climate change have created ominous fire environments in California, rich for research and analysis.

Recent research confirms the threats from other natural hazards in California, such as tsunamis, that also deserve specific recognition and analysis in separate papers.

Water, Watersheds, Habitat Destruction, and Species Extinction

As the state's population and economy grow, Californians continue to struggle over how to use land and water resources. These controversies occur within a global environment where biologists and ecologists warn that during this century, we may be participating in one of the five greatest periods of mass extinctions in the history of the planet. Some of the reasons for these accelerated extinction rates include habitat destruction, climate change, pollution, and the introduction of exotic species. Californians are fighting battles on many fronts to deal with these crises. Here are just three examples of how we are coping with the complicated issues and problems that erupt when more people with varied interests and needs compete for limited resources that include land and water.

The Klamath River

One of the classic water dramas of this young century continues along northern California's Klamath River. During a drought that dragged through the first years of this century, potato farmers in the upper basin near the Oregon Border complained and demonstrated that they needed more diversions from the Klamath watershed. The fishing industry and Native Americans in the lower basin and along the north coast worried that more diversions would devastate annual salmon runs. Still, the federal government sided with the farmers in

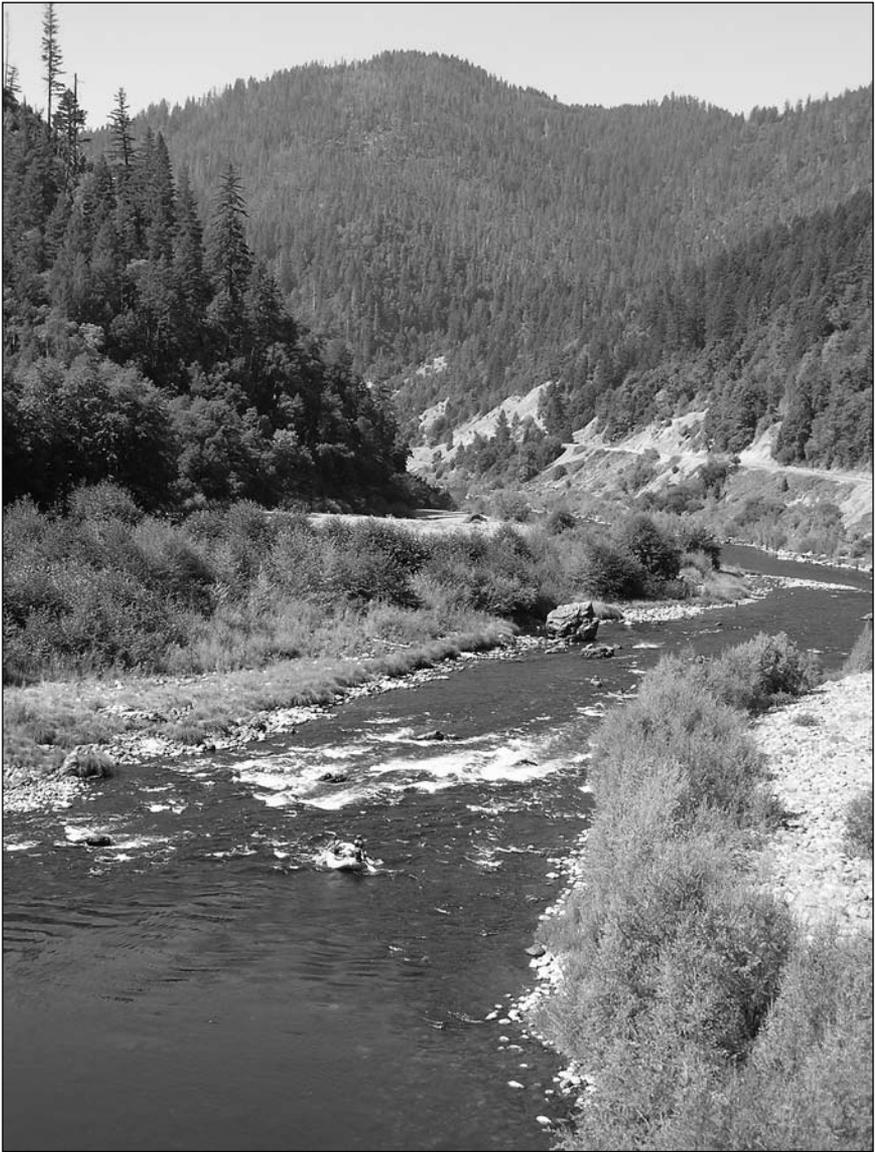


Figure 4. Diverse stakeholders rely on Klamath River resources.

2002 and allowed the diversions—despite a lack of scientific data to predict what might happen to the fish downstream. Sure enough, the resulting low flows were blamed for the greatest salmon die-off in history. Up to 70,000 returning Chinook salmon were killed by parasites in the trickle of remaining water that year, and by 2006 the total die-off was estimated in the hundreds of thousands. Not

only was this devastating to Native Americans on the lower Klamath River, but it was determined that the region's threatened fishing industry was worth at least as much as the crops being grown with the diverted water upstream.

By 2006, regulators had to enforce a weekly catch limit and a shortened season from the Oregon coast down to Point Sur so that enough salmon would return to reproduce in the fall. Since one of the Pacific Northwest's most important salmon spawning grounds was in danger, the federal government declared a commercial fishing failure and offered disaster relief to the region's fishermen in 2006, the worst fishing season on record. The Commerce Department estimated losses at \$16 million, while politicians and others closer to the disaster estimated losses closer to \$80 million as local fishermen struggled to keep their boats and learn new trades. Meanwhile, fish ladders and dam demolitions are among other options being considered to restore the Klamath River's great fisheries.

Forest Resources and Watersheds

California's forested watersheds represent billions of dollars of ecosystem services. Besides providing the obvious forest products, recreational opportunities, wildlife habitats, and air sheds, they act as great flood-control sponges, absorbing huge volumes of snowmelt and rainfall that is gradually released into streams, often during dry seasons when we need it most. So, it is no surprise that one of the more important reasons for establishing our National Forests and other public forestlands was to manage valuable watersheds that protect the people and activities downstream. Californians have debated and fought since the 1800s about how best to manage these resources. Too often, diverse stakeholders do not find common ground: the results can be poor management of our common resources and inevitable disaster.

The good news is there are California examples where timber and wood products industries, environmentalists and ecologists, and local communities are trying to cooperate, finding win-win compromises that everyone and our resources can live with. Consider this mission statement from the WRTC in little Hayfork, way up in the mountains west of Redding, a stop during a California Geographical Society 2006 field trip:

The Watershed Research and Training Center (WRTC), a community-based nonprofit organization, was started in 1993 to

promote healthy communities and sustainable forests through research, education, training, and economic development. This work centers around the belief that the relationship between local communities and the public forest must change so that the economy can rebuild itself based on an ethic of land stewardship. The following program activities reflect this attempt to develop and encourage sustainable forest-based activities and a vibrant economic system for Hayfork and all of Trinity County.

When you talk to the folks up at Hayfork, it becomes clear that this mission is not just a façade or some kind of public relations ploy. Local stakeholders seem very sincere about working together to solve local environmental and economic problems. And the next time you step into a Whole Foods market, check out the wooden crates used for their food displays; it is likely you will be inspecting a wood product from little Hayfork.

There are other examples of responsible leadership within California's forests. Consider the work of the Conservation Fund, a conservation organization that has been acquiring forestland along the Garcia River, Salmon Creek, and Big River watersheds south and east of Mendocino. Using the latest forest management techniques and



Figure 5. CGS field trip tours wood products industry in Hayfork.

input from the region's stakeholders, it protects the most sensitive resources while using sustainable logging to fund its operations.

Coastal Wetlands

Also important to Californians and our landscapes are the efforts to save what is a very small remaining percentage of our rich coastal wetlands, unique habitats where fresh water finally reaches the sea. Specifically, keep an eye on what is sometimes considered the "string of pearls" that includes Upper Newport Bay and the new multi-million dollar Bolsa Chica restoration project in Orange County that is just being opened to the sea. Another potential restoration site near the mouth of the San Gabriel River on the border of Seal Beach and Long Beach (Los Cerritos wetlands) is also earning attention. And then there's what's left of the Ballona Wetlands near Marina del Rey, now that the developments are in. These serve as productive rest stops for migrating birds and rich, nurturing habitats where fresh and saltwater meet and local species reproduce. But they also represent prime real estate, especially when developments are planned. How many similar dramas can you remember when competing interests set their sights on remaining undeveloped but valuable land along



Figure 6. Wildlife meets developments in upper Newport Bay.

the California coast? Sounds like another perfect topic for a more specific paper in *The California Geographer*.

Future Water Choices

California's water struggles already represent some of the greatest dramas in the state's history. But when it comes to current and future water resources in California, our growing demands and diversion projects raise some serious questions, especially if we take more than nature provides. Greater demands for this limited resource may cause a decrease in water quality, an increase in costs, and negative impacts on ecosystems and species that depend on water. Additionally, as pressures grow on aging existing facilities and infrastructure, competition between agriculture, domestic and industrial use, and the environment also increases.

Historically, Californians have taken the supply-side management approach by building more infrastructure and increasing diversions. Two of the most recent trends on the supply side that will carry well into this century are the planning of desalination plants along our coast and the transfer of water originally meant for agriculture to the cities. Still, most Californians and water agencies are finding easier and less-expensive solutions by managing on the demand side. This includes cutting waste with more-efficient irrigation systems, plumbing, and fixtures, and it even includes recycling systems that can capture water otherwise lost. California cities and suburbs are realizing some of the greatest water savings with smart landscaping, including the use of natives or other plants requiring less water.

Climate Change

One of nature's more recent wild cards involves the frequent anomalous weather events that have impacted our state in the past several years. As I write this, the most recent event is the July 2006 heat wave that broke records from north to south across the entire state, except on the very north coast. A stubborn high-pressure ridge hovered over the southwestern U.S., wandering over and east of California. When it meandered east of us, the clockwise flow of air from the southeast brought unusually high dry-season dew points along with soaring temperatures, especially across southern portions of the state. The results were remarkable.

Los Angeles recorded its hottest July ever, with an average high temperature near 90 degrees. Woodland Hills recorded more than

20 straight days over 100, including the hottest temperature ever recorded in L.A. County: 119. Sacramento experienced more than 10 straight days at 100 or above for the first time, while some hotter Central Valley cities topped 115 for several consecutive days. As records were set from the central and south coast to the inland valleys and deserts, even southern coastal areas were surprised by several different lightning displays and monsoon thunderstorms more typical of Arizona. The unusually high humidity also helped produce record-warm overnight lows, often dipping into the 70s only by early morning, even along the coast. A few desert locations, including Needles, experienced overnight lows of 100. In the absence of northwest winds, coastal upwelling stopped. Ocean water temperatures off Orange and San Diego counties soared into the high 70s and a few spots briefly topped 80. Coastal residents sweltered even at night, and a few days later scores of dead sea urchins washed on to some southern California beaches, likely victims of the warm water. As air conditioners continued working through the heat, the state set new power-consumption records while older transformers failed under the load. More than 140 people, many in Central Valley cities such as Fresno, died from health complications caused by the heat.

This is just one more example of anomalous weather events and patterns that have become more frequent, though residents and state officials were and are not expecting or prepared for them. You might remember just two years ago when some climatologists stuck out their necks and used the Pacific Decadal Oscillation to explain and analyze natural climate cycles in California. Some predicted that we were in a period that would bring cooler-than-normal ocean temperatures to the California coastline, resulting in more-frequent droughts and more fog along the coast. After these confident messages got out in the media, southern California experienced its second-wettest year in history and that epic July 2006 heat wave. These events remind us that natural climate cycles are complicated enough, but when we throw anthropogenic factors such as greenhouse gases into the equation, we have an experiment never seen before with unpredictable results. As records continue to fall, climate change is altering our state faster than we can understand it. Scientists are already measuring the results.

During the past several decades, the Sierra Nevada snow pack has been melting earlier, decreasing spring runoff by about ten percent. New studies are finding Sierra Nevada animal species migrating to

higher elevations than in any previous time. Sea levels along the California coast have risen more than eighteen centimeters (seven inches) in the past 150 years. In a July 2006 study published online in the journal *Science*, researchers show a direct correlation between increasing temperatures over thirty-four years and the increase in western forest fires. The length of wildfire seasons increased by seventy-eight days and the time each fire burned increased by nearly thirty days. Scientists from many different fields have been surprised to already find such measurable responses to climate change in California. These trends have also captured the attention of insurance companies and emergency service and other state officials, for good reason. How should we respond to these climate changes that are impacting California landscapes faster than most researchers had predicted? In California the answer is more than just responding to severe weather events. Instead, scientists and state officials have been exploring ways to decrease our impacts on natural climate cycles. New knowledge is leading to empowerment that is producing the leadership people might expect from California.

By 2005, you could find some scientists and state officials working together at the California Climate Change Center on the state's climate-change-portal Web site. A declaration from U.S. West Coast Governors read:

“Global warming will have serious adverse consequences on the economy, health, and environment of the West Coast states. These impacts will grow significantly in coming years if we do nothing to reduce greenhouse gas pollution. Fortunately, addressing global warming carries substantial economic benefits. The West Coast region is rich in renewable energy resources and advanced energy-efficient technologies. We can capitalize on these strengths and invest in the clean energy resources of our region.”

Like so many corporations and organizations, California has discovered the green (\$) in turning green to clean up the environment and slow climate change. Skyrocketing oil prices are helping to fuel this trend. There are plenty of examples. California continues to lead the world in clean-car technology, and Californians are investing in popular wind and solar energy (such as solar roofs) initiatives, which are already saving millions of energy dollars and cleaning our air. Sustainable industries and jobs are being created as the state tries to lead the nation into this new era of economic and resource efficiency. As one specific example, during the summer of 2006,

Los Angeles and San Francisco joined a consortium of major world cities proposing to share technical assistance to reduce greenhouse gas emissions and to purchase energy-saving products. The long-term results may include saving financial resources while making our cities cleaner and more livable.

Small businesses have been discovering the profits in running green, efficient operations for several years. Unlikely corporations doing business in the state, such as BP/Arco, Shell Oil, and even WalMart, Home Depot, and GE, have not only acknowledged the problems, but are finding ways to decrease their negative impacts as they increase profits and even help their customers become more efficient. Those who are stuck in the inefficient ways of the past will be left behind.

Summary

Too often, environmental changes and natural hazards get attention only when they finally become inconvenient or are perceived as immediate threats to humans. It is also difficult to get any two experts to agree on what are the most important changes and hazards that confront us and which deserve our immediate attention. The attempt here has been to summarize the risks posed by earthquakes, floods, climate change, and a few other environmental changes and natural hazards, and to consider how they are shaping our state's landscapes. There are many other natural disasters, cycles, and trends worthy of consideration that were left out of this discussion due to limited space, so I hope I didn't frustrate too many readers with this unconventional update. This paper provides a convenient target, a starting point for others to assess specific natural hazards and environmental change in California.

For instance, successes and failures in the battle to curb air pollution, especially in the polluted Los Angeles Basin and Central Valley, continue to be debated. (One specific example of recent cooperation is the joint agreement between the ports of Los Angeles and Long Beach to reduce pollution from ships, trains, and trucks by more than fifty percent.) These are large-scale problems that also deserve more attention. The purpose within the limits here is to keep the discussions alive; your comments and opinions are welcome.

Again, if there were more space, a logical second part of this paper would focus on the state of our human landscapes in California. For now, consider how our population and migration patterns, our

growing cultural and economic diversity, our connections to the world economy, and our urban trends and suburban sprawl continue to present some challenging problems as they dramatically change California. Consider how suburban growth keeps spreading inland as people look for affordable housing in a state where only thirteen percent of its residents can afford to buy. Consider how our cities are accommodating those who want to shed their long commutes from the suburbs for a more cosmopolitan life experience. These and related topics will make for an excellent paper full of updates on the state of our state's human trends and changing human landscapes.

All this serves as a reminder that we geographers have the diverse skills to help make more-informed decisions about how we will live on and use the land. Sometimes as we observe and study the drama, it is important to remember that we are all in it together and are empowered to move it in a more positive direction. Put in other words, helping to direct the train and avert the wreck might be more difficult than just observing, but it is also more rewarding, and geographers are equipped to do both. One thing is certain: in California, we will never be bored trying.

References

Since this paper focuses on some recent trends and events, this general list emphasizes a few recent links and living documents to provide updated sources for beginning research on these topics. (Recent events and research are also being summarized and updated in newspapers such as the *L.A. Times*, the *Sacramento Bee*, and the *San Jose Mercury News*.)

California Statistics

State of California Home Page: http://www.ca.gov/state/portal/myca_homepage.jsp

California Department of Finance: <http://www.dof.ca.gov/default.asp>

California State Legislative Analyst's Office: <http://www.lao.ca.gov/main.aspx>

Natural Hazards

California Office of Emergency Services: www.oes.ca.gov

Earthquakes

California Earthquake Authority: www.earthquakeauthority.com

California Geological Survey: www.consrv.ca.gov/cgs
California Seismic Safety Commission: www.seismic.ca.gov
Historic Earthquakes in Southern California: www.data.scec.org/clickmap.html
San Andreas Fault Observatory at Depth (SAFOD): http://www.icdp-online.de/contento/icdp/front_content.php?idcat=712
Southern California Earthquake Center Earthquake Country Web Portal: www.earthquakecountry.info
Southern California Earthquake Center and USGS, 2006. Putting Down Roots in Earthquake Country: <http://www.earthquakecountry.info/roots/roots.html>
United States Geological Survey: www.usgs.gov
USGS Seismic Shaking Hazard Maps of California: www.consrv.ca.gov/CGS/rghm/psha/pga.htm

Other Hazards

ICDP Long Valley Coring Project: http://www.icdp-online.de/contento/icdp/front_content.php?idcat=710
USGS Long Valley Observatory: <http://lvo.wr.usgs.gov/index.html#glance>

Landslide Information

California Geological Survey: http://www.consrv.ca.gov/cgs/geologic_hazards/landslides/

Water and Delta Flooding

California Bay-Delta Authority: <http://calwater.ca.gov/>
California Department of Water Resources: <http://www.water.ca.gov/>
California State Water Resources Control Board: <http://www.swrcb.ca.gov/>

Hundley, Jr., Norris. 1992. *The Great Thirst: Californians and Water, 1770s–1990s*. Berkeley, CA: UC Press.

Mount, Jeffrey F. 2000. *California Rivers and Streams: The Conflict between Fluvial Processes and Land Use*. Berkeley, CA: UC Press.

Water, Watersheds, Habitat Destruction, and Species Extinction

California Coastal Commission's California Coastal Resource Guide. *California Coastal Wetlands*. UC Press: <http://ceres.ca.gov/ceres/calweb/coastal/wetlands.html>

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