

# Preparing Southern California for Extreme Weather-Related Events

A Forum of the Aquarium of the Pacific  
Co-sponsored by the  
Aquarium of the Pacific and the California Department of Water Resources

Fire Weather

## Forum Background

Coastal Southern California enjoys a Mediterranean climate, one of only five in the world and the only one in the U.S. Much of the rest of Southern California is characterized as Southwest Desert. More than 60% of the state's population lives in Southern California, the region from Point Conception to the U.S.-Mexico border, and most live along the coast. Many choose this area because of its weather and climate. Residents are used to Santa Ana winds and the occasional intrusion of the marine layer and a short winter rainy season that may be extended and intensified during El Niño years. But when Southern Californians think of natural hazards, they think of earthquakes, not weather; however, it is extreme weather-related events that pose the greatest risk to Southern California life, property, and natural ecosystems—not earthquakes.

Participants in this forum identified floods, droughts, heat waves, and wildfires as the extreme weather-

related events that should cause most concern. Although snowstorms can lead to highway closures—particularly of Interstate 5 and the Grapevine—that have serious consequences, we have not considered these events, nor have we considered dust storms. We also recognize that jurisdictional and geographic boundaries are artificial when it comes to extreme weather-related events and their impacts on people, but have chosen to focus only on Southern California.

Long before Superstorm Sandy hit the East Coast of the U.S. in October 2012, the Aquarium of the Pacific and the California Department of Water Resources had planned a forum (1) to assess the threats posed by extreme weather-related events to Southern California, and (2) to identify an action plan to reduce our vulnerability to such events and to enhance our resiliency following them. Sandy was a strong wake-up call that we often over-estimate our readiness to deal with such events and our subsequent resilience, and underestimate our vulnerability. It was

the unanimous conclusion of a group of 28 scientists, planners, and emergency responders that Southern California may experience more frequent and more intense weather-related events than have been observed in the historical record, and that the region should be better prepared to deal with them. Our existing water and power systems are not robust enough to provide uninterrupted service to even the existing population, let alone to a larger population, if weather events become more frequent or intense.

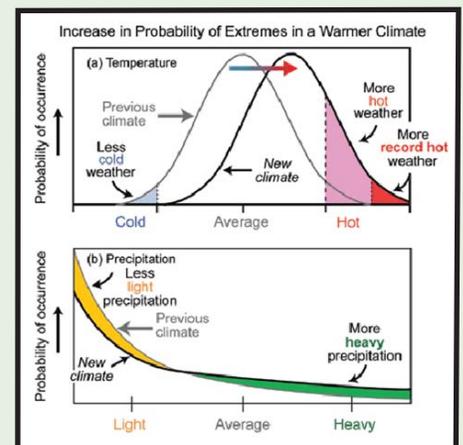
This report is a brief summary of the forum held on November 28-29, 2012 at the Aquarium of the Pacific. For each of the four categories of extreme weather-related events that were ranked as having the greatest potential to cause serious disruptions in Southern California, we present a brief summary and an abbreviated set of recommended actions. The full presentations and action plans will be found at [http://www.aquariumofpacific.org/mcri/info/extreme\\_weather\\_related\\_events](http://www.aquariumofpacific.org/mcri/info/extreme_weather_related_events)

## Climate and Extreme Weather Events in Southern California: Past, Present, and Future

*Kelly Redmond, Western Region Climate Center*

As the climate changes, the characteristics of weather may shift in the future, such as the frequency, intensity, magnitude, predictability, and time of year in which extreme weather-related events occur. Concurrent phenomena could amplify effects of such events. We are likely to see the number of heat wave occurrences, warm days and warm nights, and duration of heat spells each increase in the future. Santa Ana winds will still occur, and the season may lengthen. Warmer conditions during Santa Ana winds will increase the fire potential and number of heat wave occurrences. The general expectation is for less annual precipitation, but the very wettest days may increase in number and amount. There is likely to be more precipitation in winter with warmer temperatures, higher rain and snow levels, and less total precipitation in spring and summer. It is plausible that floods (in cool season) and droughts (in warm season, or arising from loss of the main winter season), could each increase.

Most climate models have been evaluated on their ability to simulate means and not extremes. It is very unlikely that we will forecast significant individual events very far beyond about two weeks. It is much more likely that we will first (and maybe only) develop good methods to predict the statistical descriptions of the events. Superstorm Sandy clearly showed that our ability to predict large storm impacts nearly a week ahead has come a long way in just a few years and officials were confident enough to shut down major infrastructure (e.g. subways). The coming years will likely bring even more advances in our ability to forecast extreme events. (*Efforts include The California Nevada Applications Program RISA, sponsored by NOAA; Southwest Climate Science Center, sponsored by the USGS/Department of Interior; and California Climate Change Center, sponsored by the California Energy Commission.*)



## Drought: Is Southern California Prepared?

*Jeanine Jones, Department of Water Resources*

About half of California's population lives within the Metropolitan Water District (MWD) service area, which has relied historically on imported water supplies for as much as 60 percent of its water supply. The region's large urban water agencies did not experience health and safety impacts during the state's relatively recent droughts, including the six-year event of 1987-92. Recent droughts' most immediate impacts were associated with wildfires, such as the devastating fire seasons of 2003 and 2007, and small water systems located on the urban fringe. Some small water systems on unreliable fractured rock groundwater systems experienced health and safety impacts such as being unable to maintain required system pressure or even running out of water.

### Drought At-Risk Areas

- Isolated rural communities
- Systems on fractured rock groundwater
- Small groundwater basins w/minimal recharge/storage capacities



Drought impacts are a function of drought duration. Small water systems are affected the soonest. Large water systems that prepare for drought via legislatively-mandated urban water management plans typically experience minimal impacts in the early years of a drought, but economic impacts are to be expected if long-term drought conditions persist. Droughts more severe than those in the historical record present a risk, one that can be mitigated by increased development of emergency storage and local resources. Uncertainties associated with drought preparedness include the inability to predict drought, droughts more severe than those in the historical record, and long-term climate change impacts. The gradual onset of drought offers time for larger agencies to implement local actions such as increased water recycling or desalination, but small water systems lack the financial and institutional ability to implement such measures.

## Drought Action Items

### Actions to Increase Resiliency

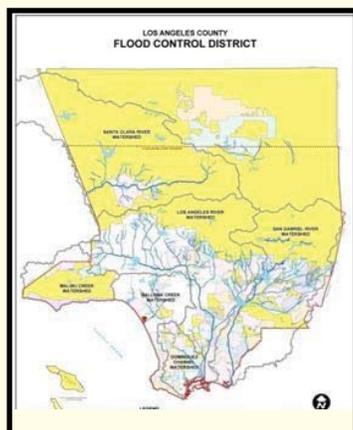
- Evaluate Southern California emergency water storage for droughts and earthquakes.
- Increase development of local water resources (stormwater, water reuse).

### Actions to Reduce Vulnerability

- Promote public education on water in Southern California—a precious and limited resource important to people and nature.
- Develop a public campaign to promote conservation during droughts.
- Continue to promote water conservation targeting landscaping, industrial and commercial uses, and agricultural efficiency.
- Evaluate opportunities to more actively manage Southern California groundwater basins to increase yield during droughts through different basin operating criteria.
- Continue actions to promote and incentivize low-impact development.
- Require that 25% of conserved water be set aside for a drought reserve, rather than being used to support new development.
- Make the policy and permitting process for ocean desalination more transparent and predictable.
- Propose legislation to require aggressive consolidation of small water systems on vulnerable groundwater sources.
- Require notice on sale of private residential property served by a private well.

## Flooding: What Do We Need to Prepare for?

*Rudy Lee, Los Angeles County Department of Public Works*



People who live where there is water tend to forget they live in a riverine system. The Los Angeles County Flood Control District (FCD) protects people, businesses, property, and habitats that are within the vast system of rivers and urban streams, maintaining a balance among the needs of all. Today the region's FCD encompasses 3,000 square miles that include a vast drainage infrastructure of over 85,600 units, all designed, operated, or maintained to decrease vulnerability to those in the path of flooding: dams, catchment basins, seawater intrusion barriers, stormwater pumping stations and drains. There are 14 major dams in the system, a few of which provide renewable hydroelectric energy. FCD's storm responsibilities are to coordinate with the U.S. Army Corps of Engineers, city or local agencies, and other flood control and water conservation agencies; make decisions related to facility operations to maximize water conservation and minimize flooding impacts; and provide safe and responsible field operations.

To balance flood control and water conservation responsibilities with the need for open space and habitat for endangered species, the FCD respects the habitat that its system provides, and has taken steps to create and conserve it. These steps include adjusting field operations to be more sensitive to habitat and carrying out restoration projects. There are challenges to meeting

the FCD's goals, but with proper planning and input, FCD is able to fulfill its goals of flood control, water conservation, water quality, aesthetic enhancement, and habitat management.

## Flooding Action Items

### Actions to Increase Resiliency

- Review adequacy of existing county-level flood alert networks and related communications tools.
- Re-evaluate adequacy of key hydraulic infrastructure under changing flood frequency conditions.
- Improve forecast and monitoring capability for large storm events, including new offshore observations.

### Actions to Reduce Vulnerability

- Improve public education on flood risks; personal safety measures, living in flood-prone areas, e.g. on alluvial fans.
- Improve education for local-level use, planning agencies, and public officials on risks of floodplain development.
- Preserve and improve forecasting and monitoring networks including USGS stream gauging stations, and NOAA and other agency climate/weather monitoring networks.
- Examine new approaches for managing debris basin sedimentation and sediment removal.
- Implement local ordinances guiding development away from alluvial fans.
- Improve understanding of debris flow hazards and management options.
- Investigate integration of remote-sensing of precipitation into operational flood forecasting/warning networks.
- Develop mapping tools for assessing infrastructure risk from floods.
- Re-evaluate capacity of older stormwater systems to handle high-intensity precipitation.

## Assessing Wildfire Risk in Southern California

*Jon E. Keeley, U.S. Geological Survey and UCLA Department of Ecology and Evolutionary Biology*



Annual wildfires in Southern California play a major role in the region's landscape ecology and have significant impacts on natural resources and people. Unnaturally high fire frequency due to human carelessness is threatening resources by converting native shrublands to weedy vegetation as illustrated in the attached figure. Santa Ana winds are the main extreme weather event impacting humans. They are responsible for most losses in lives and property. Anomalous long droughts that last much longer than the annual six month summer drought contribute to catastrophic fire events. Severe droughts stress the wildland vegetation and cause vegetation dieback. Embers in high winds land on dead vegetation, producing spot fires ahead of the fire front that results in rapid spread and contribute to catastrophic fire events responsible for major fire losses.

Vulnerability of communities has increased drastically over the last 50 years and the rate of housing losses is increasing. Currently, we are limited in our ability to predict normal versus catastrophic fire seasons. Climate modeling could be used to predict changes in Santa Ana wind seasons and intensity, but there are conflicting interpretations of what the future holds in terms of climate change impacts on these winds and what that means for wildfire activity. Increasing stress due to drought could lead to more vegetation dieback and an increase in large fire events. Currently, there is little assessment of vegetation dieback but this could be improved with better remote sensing coverage.

Preventing all wildfires from threatening urban environments is unlikely and thus we must focus on better land-use planning decisions that reduce vulnerability of communities to wildfires and enhance human infrastructure to reduce housing losses.

## Wildfires Action Items

### Actions to Increase Resiliency

- Expand the federal burned area emergency response (BAER) program to include state lands and local communities and populate these teams with staff familiar with the local ecology.
- Develop proper strategies following wildfires to minimize fires returning.

### Actions to Reduce Vulnerability

- Analyze property locations for fire risk and implement zoning decisions that reduce vulnerability to wildfires.
- Increase funding for the study of the costs and benefits associated with wildland fuel modification and develop strategies for wildland fuel treatments that balance hazard reduction and resource protection.
- Educate all California residents and visitors about wildfires and the extreme conditions associated with Santa Ana wind events.
- Improve fire prevention by increasing citizen vigilance in reducing arson fires, particularly during Santa Ana wind events.
- When appropriate, use barriers along roadways to block spread of fires into wildlands.
- Embrace fire safe land use planning to place greater emphasis on reducing wildfire vulnerability by guiding development away from fire prone areas.
- Promote existing programs of "Fire Ready Community" designation, e.g., Firewise Communities and FireSafe Counsels, and incorporate new research on the dangers of certain types of landscaping.

## Heat Waves

Forecasts indicate that heat waves in Southern California are likely to increase in frequency, duration, and intensity as we move further into this century. The effects will be more pronounced away from the coast, but they also will be experienced in coastal regions. Heat waves are at, or near, the top of all extreme weather-related events in terms of loss of life, and Southern California needs to be prepared.

### Heat Wave Action Items

#### Actions to Increase Resiliency

- Create local and regional lists of vulnerable groups with contact information for sources of assistance.
- Establish a “Neighbors Watching Out for Neighbors” program modeled after Neighborhood Watch.
- Establish a network of cooling centers modeled after “warming centers” in cold climates.

#### Actions to Reduce Vulnerability

- Educate all California residents and visitors about heat stress and how to prevent it.
- Improve public’s awareness of cooling centers: locations, the public transportation options, services.
- Support development of a “California Beat the Heat” webpage.
- Encourage continued refinement and development of excessive heat indicators, e.g. Heat Index.
- Disseminate consistent heat stress alerts through all available resources.
- Establish transportation services and partnerships with organizations that serve vulnerable populations.
- Establish a Community Emergency Response Team (CERT) program for heat wave volunteers.
- Educate the public and city, county, and state agencies about factors in urban development effective in reducing temperature rise such as reflective roofs, replacement of blacktop, new development, etc.

## National Weather Service Forecast, Watches, and Warnings— Will They Give Us What We Need?

Mark Jackson, NOAA/National Weather Service



NOAA’s National Weather Service (NWS) vision is to create a Weather-Ready Nation: a society that is prepared for and responds to weather-dependent events. Public weather safety education is a sustained effort of the NWS and is a critical part of successfully serving its mission.

To achieve this vision and mission, the NWS employs a network of 122 weather forecast offices, 13 river forecast centers, 9 national centers, and partnerships with local, state, and other federal agencies to provide weather, water, and climate forecasts and warnings.

The NWS also employs a year-round public and partner outreach program to ensure understanding and response of the public to threatening weather-related events. It disseminates information by both traditional platforms (NOAA Weather Radio and broadcast and print

media) and also via modern platforms (Internet and social media) to ensure that critical information is delivered to those threatened and to officials who help protect the public. Direct communication (phone, onsite support) also provides life-saving information to emergency response officials.

Accurate and more advance warning lead-times (the time between warning issuance and event occurrence) have improved steadily; however, information is useless unless received, processed, understood, and acted upon. More work is needed. Recent research shows society acts on weather-related threats when (1) consistent information is received from multiple trusted resources, (2) they have experienced or know someone who has experienced the event in the past, and (3) they understand the threat. These components must guide our work for further improvements.

Ensuring the public understands the threat is especially challenging in Southern California where, while the region is not immune to extreme weather-related events, the relative lesser frequency can contribute to public complacency toward understanding and responding to them. A “Weather-Ready” Southern Californian understands and responds to severe weather information. We must reach those threatened by severe weather, keep our emergency partners informed and earn their trust, and strive for improved accuracy, and longer lead-times in forecasts.

**Information Flow**

- Weather.gov
- Weather Stories
- Storm webinars and emails to partners
- Direct phone calls
- Impact-based
- GIS display tools
- Online chat
- Onsite support (IMET)
- Social media
  - Alerts on Twitter
- Text message alerts
- FEMA’s Integrated Public Alerts and Warning System (IPAWS)
- Statewide calls (Cal EMA)
- YouTube

Reaching Southern California for Extreme Weather-Related Events - December 2009-2012

### Closing Comment

The action items for heat waves, wildfires, droughts, flooding all included an emphasis on public education if we are to achieve a “Weather Ready Nation.” We must understand how society responds, keep partners informed, and strive for improved accuracy—all to minimize the impact of extreme weather-related events on lives, livelihoods, and ecosystems.