Case Study — California: Russian River Watershed

Water Resource Strategies and Information Needs in Response to Extreme Weather/Climate Events

Russian River Basin

Water Trends

The 110-mile long Russian River runs from Mendocino County to the Pacific Ocean in Sonoma County. This region typically has warm, dry summers and cool, wet winters, in which highly variable precipitation results in rapid, brief, and dramatic runoff. More than 93% of rainfall occurs in winter, so maximizing storage for yearlong water supply is a priority.

In the past 60 years, 34 of 39 floods were related to a meteorological phenomena termed "atmospheric rivers." These narrow bands, a few hundred kilometers wide and two thousand kilometers or more long, transport water vapor from the tropics toward the poles. Projected increases in rainfall frequency and intensity associated with atmospheric rivers increases flood risk.

In recent decades, this region has had more widespread drought because of precipitation deficits and higher temperatures. This is accompanied by reduced snow cover, earlier snow-melt run-off, reduced streamflow and reservoir levels, and drier soils. Periods of surface water decline often result in higher groundwater use, stressing both systems. Because of the number of extreme dry years, the National Integrated Drought Information System (NIDIS) has included this area as a pilot study for a drought early warning system for better-informed and well-timed decisions to reduce impacts and costs.

Governing Structures

SCWA provides naturally filtered drinking water to 600,000 people, as well as flood protection and wastewater services. The US ACE and SCWA operate Coyote Valley and Warm Springs Dams in the Russian River Watershed where US ACE is responsible for flood control operations, while SCWA is responsible for water supply operations. Local communities such as the City of Santa Rosa manage their own stormwater and wastewater systems.

The Story in Brief

California's Russian River watershed has a history of variable weather, but recent events reveal an emerging pattern that is more erratic and unpredictable. The 2006 New Year's Day flood, the 2007-2009 drought, and an unusually intense period of frosts in spring 2008 are examples of this pattern. Such cascading weather-driven events require management of both flood risk and water supply in balance with environmental needs, and they illuminate the interdependent challenges water resource managers face.

2006 New Year's Day Flood

Impacts

Exceptionally heavy rains hit northern California from December 26, 2005, to January 3, 2006. The Russian River rose above flood stage at all Sonoma County gauge stations. At Guerneville, the hardest-hit town, the river crested more than ten feet above its 32-foot flood stage. The city of Santa Rosa saw near-record rainfall totaling 17.6 inches.

The Federal Emergency Management Agency (FEMA) declared a major disaster. More than 100 roadways were blocked because of flooding and landslides. Some 2,100 business and residential properties were inundated and 50,000 residents were without power. Sonoma County business and residential damages were estimated at $104 million.

> **"We use the [Russian River] as a natural conveyance system and natural filtration system of sands and gravels for water withdrawal. We are very much reliant on the natural environmental system. This has a lot of consequences [related to] managing that system for extreme events."**
>
> Jay Jasperse, Chief Engineer
> Sonoma County Water Agency (SCWA)

In the Laguna de Santa Rosa wetlands, designed to protect Santa Rosa and surrounding areas, record-peak flows resulted in severe flooding, overbanking, erosion, and sedimentation. Local stormwater systems were overwhelmed, flooding streets and buildings. Meanwhile, the Laguna Wastewater Treatment Plant and its storage ponds that hold recycled water flooded, causing release of partially treated wastewater. Structural damage to roadways limited access for plant personnel during recovery operations.

Utility and Community Response

The US Army Corps of Engineers (US ACE) and the Sonoma County Water Agency (SCWA) cooperate in managing Warm Springs Dam on Lake Sonoma and Coyote Valley Dam on Lake Mendocino. Their combined efforts, in concert with information provided by NOAA's California/Nevada River Forecast Center (CN RFC), controlled releases to avoid worse flooding. US ACE and SCWA had to weigh reserving "freeboard" capacity to contain potentially more rain against using that capacity to maintain storage for adequate supply during periods of low rainfall. Flood management decisions are time-sensitive, and improved information for forecasting and modeling is needed to aid multiple types of decision making, including emergency operations. Recent work by NOAA on forcasting atmospheric rivers holds promise for local decision makers.

At the Laguna plant, operated by the City of Santa Rosa, managers installed a system to monitor water flow during future wet-weather events, and installed a combined heat and power system to provide emergency power as well as 30% of the plant's regular energy needs. SCWA instituted a stream maintenance program that tries to balance the competing goals of reduced flood risk with enhanced riparian and instream habitats.

Drought and Frost of 2007-2009

Impacts

A three-year drought hit on the heels of the 2006 flood, affecting Sonoma County's water environment, economy, and water supply. Surface water and groundwater recharge significantly declined. Lake Mendocino, a major water reservoir, was dangerously close to drying up. To preserve water supplies, the State Water Resources Control Board (SWRCB) allowed reduced releases from the lake below minimum in-stream flow requirements. Local water rationing of up to 50% also was imposed.

A series of workshops focusing on extreme events and water resources, co-sponsored by the National Oceanic and Atmospheric Administration (NOAA), US Environmental Protection Agency (US EPA), Water Environment Research Foundation (WERF), Water Research Foundation (WaterRF), Concurrent Technologies Corporation (CTC), and NOBLIS.

NOAA EPA WERF WaterRF CTC Noblis

In spring 2008, unusually intense frosts occurred during the drought. The region's world-renowned vineyards and wine-making industry dominate the local economy. While wine grapes are generally a low water-use crop, during freezes, one way to protect new spring growth from frost and potential crop loss is by spraying water on the vines, coating them with an ice shield. The combination of drought and repeated frosts created high immediate water demands.

River flows, typically 500 - 1000 cfs or more, were already extremely low due to dry conditions. When grape growers sprayed vineyards to prevent damage, flow dropped to 168 cfs. NOAA's National Marine Fisheries Service (NMFS) discovered dead juvenile coho and steelhead trout in the Russian River and one of its tributaries.

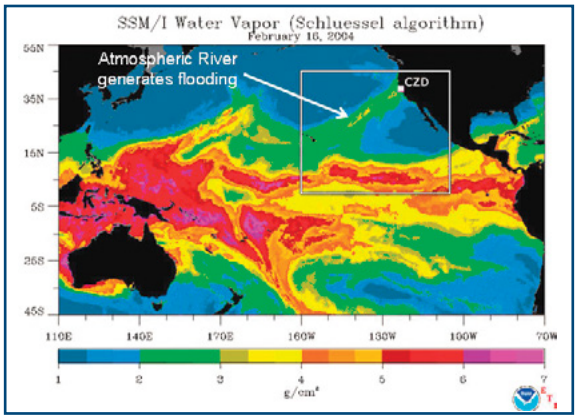
The SWRCB, already encouraging water conservation efforts, responded with regulations to restrict and govern water use for frost protection. Salmon fishermen endured canceled and shortened seasons between 2008 and 2010. Tensions between conservationists and the grape industry flared and the agricultural community challenged the legality of these regulations. (In September 2012, the court found in favor of the grape growers and set aside the frost regulations.)

Utility and Community Response

SCWA, the NMFS, and others examined frost protection practices and found that limited prediction capabilities and lack of coordination between grape growers and the reservoir releases were factors in the extreme drawdown. As a result, NOAA began working with SCWA to improve frost event forecasting, supporting SCWA's efforts to coordinate with grape growers. SCWA also worked with the USGS to increase the number of stream gauges on the Russian River to improve the monitoring network to support reservoir operations. In Mendocino County, the Russian River Flood Control and Water Conservation Improvement District led efforts with its grape growers to significantly reduce water diversion from the river during frosts by constructing storage ponds for frost protection.

These ongoing efforts have improved the use of forecasting tools, coordination procedures, and water management projects so that impacts from frosts are much less than in the past. In addition, NOAA forecasting tools are expected to improve summer heatwave predictions, thus helping growers coordinate irrigation schedules up to 72 hours in advance. Meanwhile, recognizing that "you can't do it alone," SCWA engaged in a variety of partnerships including the Sonoma-Marin Saving Water Partnership. Ten utilities have committed to provide a sustained level of funding to implement best management practices to conserve water while focusing on programs that benefit the region.

(Top/Middle) Frosts in the middle of severe drought in 2008 undermined local water management efforts when grape growers used large quantities of water to coat grapes with protective ice. (Bottom) Atmospheric rivers are narrow bands transporting columns of water vapor that result in extreme rainfall.



Managing for multiple objectives lies at the heart of integrated water resource management and guides SCWA's innovative approaches for supply management. Groundwater banking and aquifer storage systems during times of high precipitation are being explored to control flooding. Supply is being extended further by reusing treated wastewater for agriculture and urban landscaping, stemming freshwater withdrawals.

Wastewater treatment plants achieve multiple objectives by discharging in a way that supplements water supply, protects water quality, and generates energy. The Laguna Wastewater Treatment Plant conveys about two-thirds of its treated wastewater to the Geyser Project, where it is used to recharge the geyser steamfield to generate 100 MW of thermal energy daily.

Partners, such as the non-profit Pepperwood Preserve, are exploring science-based conservation to protect biodiversity and link functioning ecological landscapes using conservation easements and protected watershed areas. Scientific collaboratives are participating in a regional integrated monitoring strategy to advance understanding of the impacts of climate change on terrestrial and aquatic ecosystems. In early 2012, SCWA's Board of Directors established the Independent Science Review Panel to promote science-based management and policies. SCWA also is leading collaborative stakeholder-driven groundwater management programs in two basins.

Looking Forward

Communities in the Russian River Watershed have historically nurtured a collaborative approach for solving complex problems. Their increasingly sophisticated understanding enables an integrated resource management approach. Water and natural resource managers, scientists, and elected officials are overcoming uncertainty in climate projections by investing in the monitoring, research, tools, and dialogue needed to build resilient responses to the impacts of a changing climate.

To learn more about how the water sector is responding to extremes, visit:
http://www.cpo.noaa.gov/ClimatePrograms/ClimateSocietalInteractionsCSI/SARPProgram/ExtremeEventsCaseStudies.aspx

Lessons Learned

- Develop implications of scenarios, including low-probability events.
- Identify opportunities to address multiple challenges through integrated programs and diverse strategies that contribute to sustainability.
- Look at the entire watershed to identify the greatest benefits for the lowest cost.
- Develop partnerships to help leverage resources, coordinate activities, and incorporate innovative approaches that result in faster progress and collective learning.
- Form partnerships with other stakeholders, including regulatory agencies: work on problems ahead of regulation instead of waiting for a one-size-fits-all route.

Useful Tools and Resources

- NOAA NWS California/Nevada River Forecast Center (http://www.cnrfc.noaa.gov/) – hydrologic and meteorological data
- USGS GSFLOW (http://water.usgs.gov/nrp/gwsoftware/gsflow/gsflow.html) – coupled groundwater and surface-water flow simulation
- CocoRahs (http://www.cocorahs.org/) – precipitation mapping
- SCWA and USGS integrated flood control/groundwater recharge studies (http://www.scwa.ca.gov/srgw-studies/)
- NOAA Hydrometeorological Testbeds (hmt.noaa.gov/) – information and prototype solutions
- Golden Gate Bridge long-term, sea-level rise data (http://tidesonline.nos.noaa.gov/geographic.html)

Information Needs

- Better regional weather forecasting and decision support tools to support operational and emergency planning decisions
- Additional flow monitoring data and use of new technologies; e.g., light detection and ranging (LIDAR), radar, collaborative monitoring