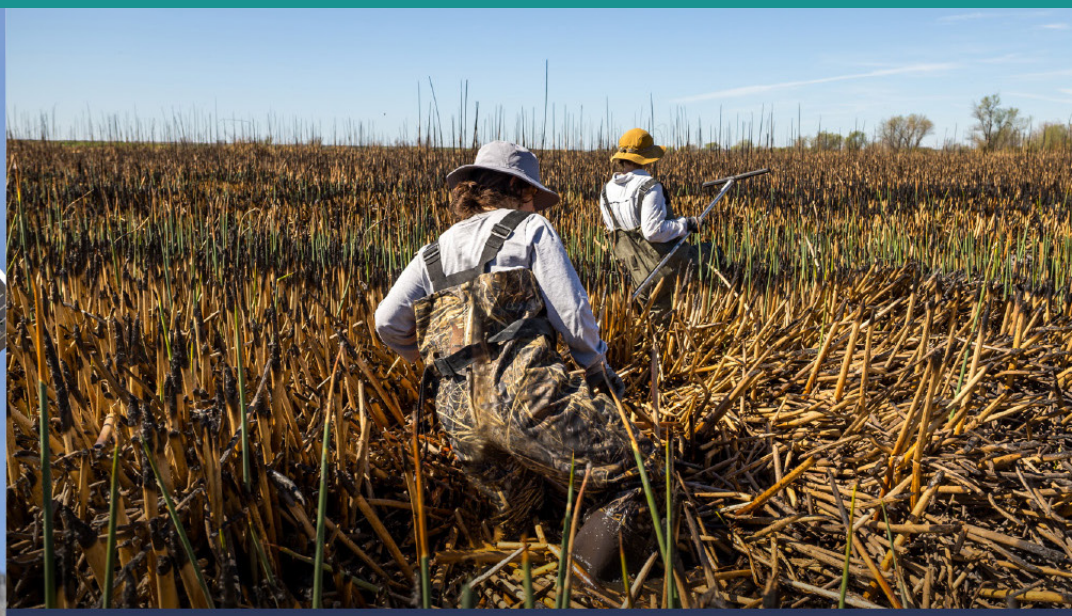
CALIFORNIA'S FIFTH
CLIMATE CHANGE
ASSESSMENT





Collaborating for Climate Resilience:
THE POWER OF SCIENCE AND PARTNERSHIPS



State Agency Report | OCTOBER 2026

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

CALIFORNIA'S FIFTH
CLIMATE CHANGE
ASSESSMENT

Collaborating for Climate Resilience: The Power of Science and Partnerships

A State Agency Report for:

California's Fifth Climate Change Assessment

Prepared by:
California Department of Water Resources

CALIFORNIA DEPARTMENT OF
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About California's Fifth Climate Change Assessment

California's Climate Change Assessments are the state's scientific foundation for understanding future climate-related vulnerability across California's regions and systems. Senate Bill 1320 (Stern, 2020) requires the State to report the impacts and risks of climate change across California at least every five years, beginning with California's Fifth Climate Change Assessment (Fifth Assessment). Building on decades of climate research and previous Assessments, the Fifth Assessment presents new findings about California's climate future, with a dedicated focus on Tribal partnerships, public engagement, and communities most vulnerable to climate impacts.

The Fifth Assessment's research and tools are designed to fill knowledge gaps about California's climate future, inspire strategic climate actions, and shape planning, investments, and policies at the state, regional, and local scales. Guided by research priorities identified by state, Tribal, and local leaders, community representatives, and subject matter experts, its findings are designed to help illuminate potential climate futures, the challenges they may present, and the opportunities to build resilience through adaptation pathways.

For the full suite of Fifth Assessment research products, please visit: www.ClimateAssessment.ca.gov.

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Suggested Citation:
California Department of Water Resources. (2026). *Collaborating for Climate Resilience: The Power of Science and Partnerships* (California's Fifth Climate Change Assessment). October 2026. https://www.climateassessment.ca.gov/2827/

Letter from the Director

California is a land of extremes and getting more so as average global temperatures rise. Californians feel the effects of climate change profoundly through water – rainfall absorbed by dry soils, storms arriving in more erratic bursts, disappearing snowpack, surf that surges inland. The California Department of Water Resources leads the State effort to adapt water systems to a changed climate.

Science and partnerships center DWR's day-to-day work. This report describes that work. The report is a component of California's Fifth Climate Change Assessment, a compendium of data and research that sets the scientific foundation for understanding climate-related vulnerability throughout California. DWR has contributed heavily to California Climate Change Assessments since first published in 2006.

Our department's commitment to science-based decision-making and climate leadership stretches across decades. Today climate experts are embedded within all divisions of our 3,500-person organization, and a keen awareness of the potential risks of climate change informs our work, from helping local communities prepare for drought to operating the State Water Project. The Department's 2023 strategic plan has five major goals, and this report demonstrates how our climate science work aligns with each.

I'm proud of DWR's scientific prowess. We typically support authorship of more than 100 scientific publications each year. I also appreciate the DWR culture that ties decision making to best available science and prioritizes accessible, useful science DWR's Basin Characterization Program, for example, uses state-of-the-art data like airborne electromagnetic surveys of groundwater basins to create images and other tools that help local water managers better understand the aquifers beneath their feet.

Many partners make possible the work described here. For example, the Water Education Foundation helps DWR host workshops for teachers who want to incorporate climate change into their curriculum. More than 140 agencies provide information to DWR's real-time hydrological data website – a website that proves crucial information to emergency responders in every major storm.

As the following report illustrates, through partnerships California will build the shared capacity we need to endure the record-breaking fluctuations in precipitation we expect, and rigorous scientific inquiry will be our best guide for making decisions in the face of these new risks.



Karla Nemeth
Director, California Department of Water Resources

Dedication to Maury Roos

DWR's State-led report for the Fifth Climate Change Assessment is dedicated to Maury Roos. For nearly 65 years (43 years full-time and 20+ years as a retired annuitant), Maury Roos shaped California's water management, pioneered work on climate change, and mentored water professionals worldwide. Maury founded DWR's Hydrology Flood Center, served as Chief Hydrologist, and oversaw work on forecasting floods, snowmelt, and water supply. He contributed to many California Water Plans and documented climate change impacts on water resources.

Maury was among the first to detect climate-driven shifts in Sierra Nevada snowmelt noting that, *"since the snowpack and runoff are so variable … the way to look at it for trends was to compare the ratio of the snowmelt volume with the total water year. I did that, and lo and behold, it looked like there was a declining slope starting in the 1960s."** At the 1987 Pacific Climate Workshop, Maury's paper and presentation on the Possible Changes in California Snowmelt Patterns showed a reduction in the percentage of water coming during the snowmelt period at more than 10% per century. Some people refer to this as the "the Roos Effect" which continues to show declining snowmelt runoff. Two years later Maury coauthored ***The Impacts of Global Warming on California (1989)***.



Maury Roos, retired Chief Hydrologist, at his desk at the California Department of Water Resources

Even after retiring, Maury remained deeply engaged by continuing to investigate climate change and teaching part of DWR's Climate Literacy class that links fundamental climate concepts to water-management practice. Maury also coauthored DWR's First Climate Change Assessment Report ***Progress on Incorporating Climate Change into Management of California's Water Resources***. Maury continued to update the Golden Gate sea level rise charts every year and even posted them on the bulletin board at his church. DWR dedicated the ***Hydroclimate Report Water Year 2021*** to Maury noting, "From growing up on a farm in Ripon, California, earning his engineering degree in 1957, and over a half century of public service, Maury has made tremendous contributions to hydroclimate knowledge."

* *From Ripon to The Hague: 58 years of Water Management with Maury Roos*, The Groundwater Act Blog, November 2, 2015.

List of Acronyms

AEM	Airborne Electromagnetic
AR	Atmospheric River
AR Recon	Atmospheric River Reconnaissance
ASO	Airborne Snow Observatories, Inc.
CDEC	California Data Exchange Center
CDETS	California Data Exchange Technological Services
CW3E	Center for Western Weather Water Extremes
Delta	Sacramento-San Joaquin Delta
DRIP	Drought Resilience Interagency & Partners
DSC	Delta Stewardship Council
DWR	California Department of Water Resources
EcoFIP	Ecological Floodplain Inundation Potential
eDNA	Environmental DNA
FCO	Forecast Coordinated Operations
FEMA	Federal Emergency Management Agency
FIRO	Forecast-Informed Reservoir Operations
FIRO-MAR	Forecast-Informed Reservoir Operations and Managed Aquifer Recharge
Flood-MAR	Floodwater used for Managed Aquifer Recharge
GSA	Groundwater Sustainability Agency
JFP	Joint Federal Project
MAR	Managed Aquifer Recharge
NOAA	National Oceanic and Atmospheric Administration
Project WET	Project Water Education Today
SGMA	Sustainable Groundwater Management Act
SWP	State Water Project
UC	University of California
USACE	U.S. Army Corp of Engineers
USGS	U.S. Geological Survey

Web Resources

Data and Water Management Tools

Department of Water Resources

- Airborne Electromagnetic (AEM) Surveys
- California Data Exchange Center (CDEC)
- California Water Watch
- Central Valley Flood-MAR Dashboard
- Delta Resilience Projects Map
- DWR Peer Reviewed Publication Inventory
- DWR Science and Technology Partnerships Dashboard
- Dry Well Reporting
- Groundwater Live
- Water Shortage Vulnerability Tool
- Snowtrax snowpack monitoring and forecasting
- Stochastic Weather Generator tool for plausible future climate scenarios
- Sustainable Groundwater Management Act Data Viewer
- Water Shortage Vulnerability Tool

Partner Resources

- Advanced Quantitative Precipitation Information (AQPI) User Dashboard pairs the high-resolution precipitation observations from AQPI with advanced weather forecasts for the San Francisco Bay area
- ARkStorm 2.0 Scenario Explorer
- Atmospheric River Forecast Products
  - Atmospheric River Landfall Tool
  - Atmospheric River Scale Forecast
- California Climate Tracker

DWR Programs

(see DWR website for information on additional programs and projects)

- Agriculture and Land Stewardship Program
- Basin Characterization Program
- Climate Change Program
- Delivery Capability Report for the State Water Project

DWR Programs (continued)

- Dutch Slough Tidal Wetland Restoration Project
- Flood-Managed Aquifer Recharge (Flood-MAR)
- Los Angeles County post-fire watershed protection (2025)
- Lookout Slough Tidal Habitat Restoration and Flood Improvement Project
- Modeling & Analysis
- Snow Surveys
- Statewide Groundwater Management
- Thompson Meadow Restoration Project
- Tide's End Multibenefit Restoration Project
- Watershed Resilience Program
- West Delta Program

Guidance, Plans, and other Reports

Department of Water Resources

- California Water Plan 2023
- California Water Plan 2028 (in progress)
- California's Water Supply Strategy: Adapting to a Hotter, Drier Future
- California's Groundwater Bulletin 118
- Central Valley Flood Protection Plan (2022)
- Climate Action Plan
  - Phase I: *Greenhouse Gas Emissions Reduction Plan, Update 2023*
  - Phase II: *Climate Change Analysis Guidance*
  - Phase III: *Climate Change Vulnerability Assessment* and *Adaptation Plan*.
  - *A Climate Action Plan for the California Department of Water Resources*
- Cosumnes River Multibenefit Floodplain Restoration Pilot Study Summary (2025)
- Environmental DNA (eDNA) Strategy (2024)
- California Hydroclimate Reports
- History of the California Department of Water Resources
- Incorporating Climate Data into Emergency Planning and Exercises – A Primer for Emergency Management Practitioners and Data Developers (2024)
- Merced River Watershed Flood-MAR Reconnaissance Study (2024)
- Roadmap for Climate Resilient Forecast Framework
- San Joaquin Basin Flood-MAR Watershed Studies (2025)

Guidance, Plans, and other Reports (continued)

Department of Water Resources (continued)

- *State Water Project Adaptation Strategy (2025)*
- State Water Project Delivery Capability Report (2023)
- Statewide Groundwater Management Assistance and Engagement
  - Best Management Practices and Guidance Documents Website
  - Guidance Document for the Sustainable Management of Groundwater: Engagement with Tribal Governments
  - Considerations for Identifying and Addressing Drinking Water Well Impacts
  - *Outreach and Engagement*
  - *Stakeholder Communication and Engagement Guidance*
- Strategic Plan (2023)
- Yuba-Feather Forecast Informed Reservoir Operations Final Viability Assessment

Partner Resources

- California's Climate Adaptation Strategy
- Ecological Floodplain Inundation Potential (EcoFIP)
- Federal Emergency Management Agency (FEMA) Cooperating Technical Partner Climate Risk-Informed Flood Inundation Mapping Project and report
- Independent Science Review of the SWP Delivery Capability Report
- Indicators of Climate Change in California
- National Aquatic Environmental DNA Strategy
- Safer Drinking Water Needs Assessment 2024
- SAFER Drinking Water program
- Senate Bill 19's Stream Gaging Plan
- Water Utility Climate Alliance

Documentary

- Climate Conversations Tribal stories adapting to climate change

Partnerships

- Advanced Quantitative Precipitation Information
- Airborne Snow Observatories
- California Cooperative Snow Surveys

Partnerships (continued)

- California Nevada River Forecasting Center
- California Water Data Consortium
- Center for Western Weather and Water Extremes (CW3E)
  - Atmospheric River Reconnaissance
  - Forecast-Informed Reservoir Operations (FIRO)
- Central Sierra Snow Lab
- Cooperative Institute for Research in the Atmosphere at Colorado State University
- Delta Science Program
- Drought Resilience Interagency and Partners (DRIP) Collaborative
- Earth Knowledge application of Basin Characterization Model
- California's Fifth Climate Change Assessment
- National Oceanic and Atmospheric Administration (NOAA)
  - NOAA Physical Sciences Laboratory
  - Subseasonal to Seasonal Forecast Improvement
- Project WET
- Sonoma Water Forecast-Informed Reservoir Operations (FIRO) Pilot and adoption of FIRO into their Water Control Manual
- Western Region Climate Center
- U.S. Geological Survey soil moisture monitoring

Executive Summary

Preparing for and addressing rising risks driven by climate extremes are the new normal. Water managers are confronted with complex decisions that demand increasing creativity, integration, and innovation to meet multi-benefit goals. The California Department of Water Resources (DWR) is committed to science-driven decision-making and partnerships to inform climate-resilient water management decisions that plan for, cope with, and adapt to changing climate conditions and extremes such as floods and droughts. DWR has partnered with the State's Climate Change Assessments, dating back to the first in 2006, to support actionable climate science. This report – Collaborating for Climate Resilience: The Power of Science and Partnerships – is one of DWR's contributions to California's Fifth Climate Change Assessment.

This report highlights the role of science and partnerships in decision-making at DWR, and it is organized around DWR's strategic goals (DWR 2023): Be an Employer of Choice, Build Community Capacity, Pursue Innovative Infrastructure Solutions, and Respond to Public Safety Emergencies. The fifth strategic goal, Integrate and Transform California Water Management, is recognized as a theme throughout the report.

Key Takeaways for each Strategic Goal

Goal: Be an Employer of Choice

Through building internal climate and science literacy, embedding and supporting climate experts throughout the organization, and fostering diverse partnerships, DWR strengthens its ability to make informed decisions grounded in the best available science and contributes to the advancement of best available science.

Key Takeaways

- Continuous learning and leadership opportunities build capacity and a climate-resilient workforce.
- Climate experts across organizational divides support aligned science-based decision-making and foster coordinated climate actions and accountability.
- Diverse partnerships advance the usability of emerging technologies and fill knowledge gaps to advance climate-resilient water and environmental management.

Goal: Build Community Capacity

DWR invests in programs that put local communities and voices into leadership positions, thereby reducing institutional barriers, while also providing scientific,

financial, and technical assistance to leaders to help ensure successful water management decisions. Coupled with educating the next generation on the impacts of climate change, DWR's programs, projects, and partnerships are building a resilient California capable of facing future climate challenges with local communities leading the way.

Key Takeaways

- Empowering local communities to lead helps overcome barriers throughout the climate adaptation process including understanding, planning, taking action and managing adaptation.
- Education is a climate adaptation strategy that fosters long-term public awareness, resource conservation, climate literacy, and community engagement.
- Collaborative frameworks coupled with technical and financial assistance support equitable partnerships and adaptative capacity.

Goal: Pursue Innovative Infrastructure Solutions

DWR is partnering to combine data, models, natural systems, and adaptive infrastructure operations to respond to immediate conditions and long-term climate change.

Key Takeaways

- Partnered investments in long-term monitoring, data storage, and data sharing are essential to support science-informed decision-making.
- Innovative nature-based infrastructure provides climate resilience by enhancing water supply, reducing flood risk, and mitigating for sea level rise.
- Science advancements support adaptation actions, such as improved forecasts to inform flexible operations of existing infrastructure.

Goal: Respond to Public Safety Emergencies

Adapting to climate change requires partnership with the climate science research community to advance how weather and hydrologic conditions are forecast to protect life and property from catastrophic events, such as floods and droughts, and to respond to post-wildfire recovery efforts.

Key Takeaways

- Make a friend before you need a friend. Building ongoing relationships in regions and watersheds benefits collaborative planning, preparation, and implementation of resources management actions before, during, and after emergencies.

- Investment in observation and forecast technology increases warning and response time during emergencies.
- Flood and drought emergencies are expected to increase in frequency and severity, and they can even occur at the same time.

Looking Forward

Two major themes emerge as lessons learned from DWR's approach to science and partnership for climate readiness: (1) **sustained investments in science and climate resources, including staff expertise, build organizational and community readiness for climate resilience**, and (2) **partnerships drive innovation and collective preparedness**.

This report offers an example of one State agency's approach to build capacity for climate resilience and science-driven decision-making as a culture, practice, and resource for partners. With the flexibility and expectation of continuous change, DWR's collective investments in scientific advancements, community partnerships, and collaboration across sectors aim to strengthen climate readiness and a shared capacity to adapt to challenges and changes.

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1 Introduction

Pathways for solutions in the 21st century require better understanding of how our landscapes, communities, and systems connect and shape the future. Preparing for and addressing rising risks driven by climate extremes is the new normal. Water managers are confronted with complex decisions that demand increasing creativity, integration, and innovation to meet multi-benefit goals.

For more than 35 years, the California Department of Water Resources (DWR) has progressively integrated climate science into its decision-making, driving progress through strong partnerships with researchers, resource managers, and communities. In 2009, DWR established its Climate Change Program to enable climate-informed decision-making by integrating science and risk assessment into DWR's policies and planning (Figure 1.1). This team has developed and is implementing all aspects of the department's internal-facing Climate Action Plan (see sidebar), with the support of other staff throughout DWR. Across program areas, DWR provides local water managers with technical assistance and engages in partnerships to build resiliency in water management by mitigating, preparing for, and adapting to climate change. Together, organizational investments and partnerships are advancing innovative, practical solutions to build more climate-resilient approaches to managing water resources.

DWR'S Climate Change Program

DWR's climate leadership has grown since the 1980s and has been recognized with the Climate Leadership Awards Hall of Fame Recognition and the American Water Resources Association Sandor C. Csallany Institutional Award for exemplary contributions to water resources management. In 2009, DWR formally established a Climate Change Program with a team of full-time engineers and scientists working on regional support, statewide mitigation and adaptation, and Tribal support.

The Climate Change Program team's work is underpinned by four core values:

- Resiliency
- Science-Based Services
- Collaboration and Outreach
- Authenticity

Diverse partnerships remain essential to the program's work to improve science-practitioner collaboration, foster the use of best available science in water management, and create unique public outreach on the impacts of climate change on California.

DWR'S Climate Action Plan

"A comprehensive climate action plan can meet and exceed legal requirements, reduce risk, achieve business process efficiencies, apply best available science, and demonstrate social responsibility" (Arnold et al. 2022). DWR's Climate Action Plan guides how climate change is integrated into programs, projects and activities. The plan is divided into three phases:

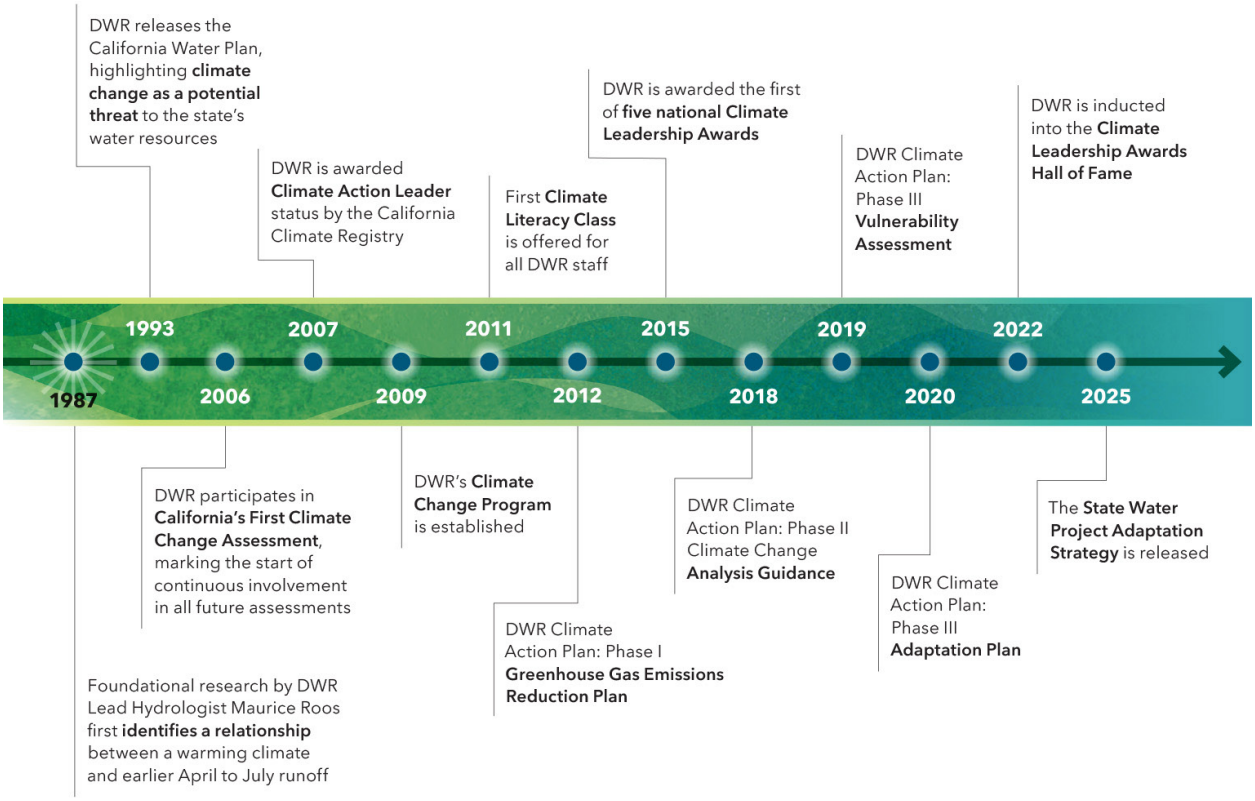
- Phase I: Greenhouse Gas Emissions Reduction Plan, Update 2023
- Phase II: Climate Change Analysis Guidance
- Phase III: Climate Change Vulnerability Assessment and Adaptation Plan

The companion State Water Project Adaptation Strategy provides State Water Project (SWP)-specific climate adaptation strategies and analysis. A Climate Action Plan for the California Department of Water Resources (Arnold et al. 2022) recounts the significant drivers, lessons learned, and the road ahead for DWR's Climate Action Plan.

1.1 Commitment to Science and Partnerships

Two of DWR's five core values inform how climate science is developed and used at DWR. One of these values, "**Science Drives Decision-Making**," shows how DWR is dedicated to using and advancing the best available science to make informed management decisions. This commitment includes supporting staff-driven scientific inquiry and publication, scientific community engagement, and promotion and adoption of forefront technologies. DWR uses science as a basis for planning and project development actions while sharing expertise gained through this work with the national and international water community. A second DWR core value, "**Partnership Development & Transparency**," spotlights how DWR strives to educate the public on the importance of water, California's unique water challenges and opportunities, and its role in managing and protecting a sustainable water supply for communities and ecosystems. DWR's work affects every Californian and extends to neighboring states as it drives national and international directions in climate-related water science and policy. DWR values its relationships with federal, State, and local governments, Tribes, academia, and non-governmental organizations. Science investments are amplified by sustained investments by partners like the Delta Science Program and its research investments to fill critical knowledge gaps and facilitation of independent scientific peer review. Through partnerships, California can achieve its water management goals, plan for emergencies, minimize risks, and develop best available science and engineering tools.

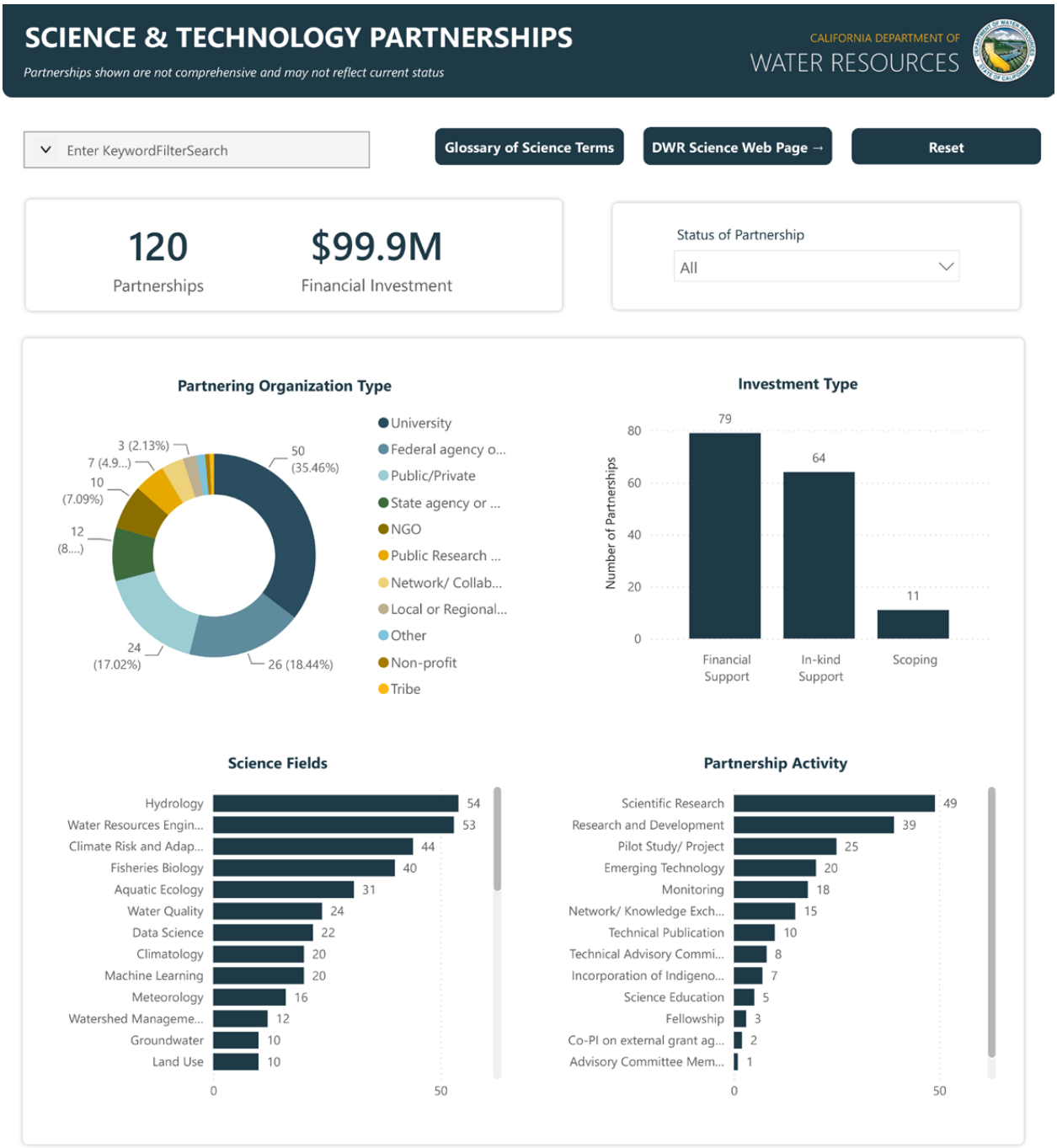
Figure 1.1.



DWR's climate milestones over the years

DWR's commitment to science and technology partnerships continues to move solutions forward (Figure 1.2). **More than 120 partnerships and tracked investments of nearly $100 million**, in addition to in-kind support from DWR technical staff to serve in technical and advisory roles, have furthered research, emerging technologies, pilot projects, data collection and monitoring, incorporation of indigenous knowledge, science education, and participation in technical advisory committees. DWR's partnership activities span over 30 science fields, including climate, hydrology, ecology, fisheries, land use, environmental policy, risk and adaptation, data science, and machine learning. DWR's investments in climate resiliency are part of the State's broader portfolio of investments.

Figure 1.2.



Public dashboard highlights DWR's Science and Technology Partnerships
*Source: **Dashboard** accessed 9/10/2026*

1.1.1 Highlighting Science Partnerships in Action

DWR's climate resilience efforts are grounded in collaboration across disciplines, agencies, sectors, and communities. These partnerships (detailed throughout this report), ensure that climate information, policy, and planning are informed by the best available science and are responsive to the needs of those managing and affected by water resources across California. Some examples of science partnerships in action include use of Environmental DNA (eDNA) for environmental monitoring (discussed in Chapter 2), Project WET (Water Education Today) empowering educators to include climate science in their curriculums (discussed in Chapter 3), Forecast Informed Reservoir Operations (FIRO) and managed aquifer recharge (MAR) (discussed in Chapter 4), and improving emergency response with better observations (e.g., airborne snow surveys) and improved forecasts (discussed in Chapter 5).

1.1.2 DWR Partnership in State Climate Change Assessments

DWR's nearly 40-year commitment to climate science is demonstrated through contributions to *The Impacts of Global Warming on California (1989)* and continuing with every California Climate Change Assessment. DWR's long-standing partnership with the Climate Assessments encompasses scoping research needs, reviewing proposals, providing technical support to funded research projects, conducting and submitting original research as well as providing support for project management, peer review, editing, and publication.

This report is DWR's State Agency report for California's Fifth Climate Change Assessment. State Agency Reports are new and voluntary Assessment contributions that are intended to complement the Assessment's suite of products. Note that State Agency reports are reviewed by the contributing agency and are not included in the Assessment's expert review or Editorial Board approval process.

1.2 Report Organization

Aligned with the goals of California's Climate Change Assessments to advance action-based science and offer communities and decision-makers the tools to take climate action, this report provides on-the-ground examples of how an organization can be science-driven in its decision-making, support advancements in action-based science, and support community and cross-sector actions through partnerships.

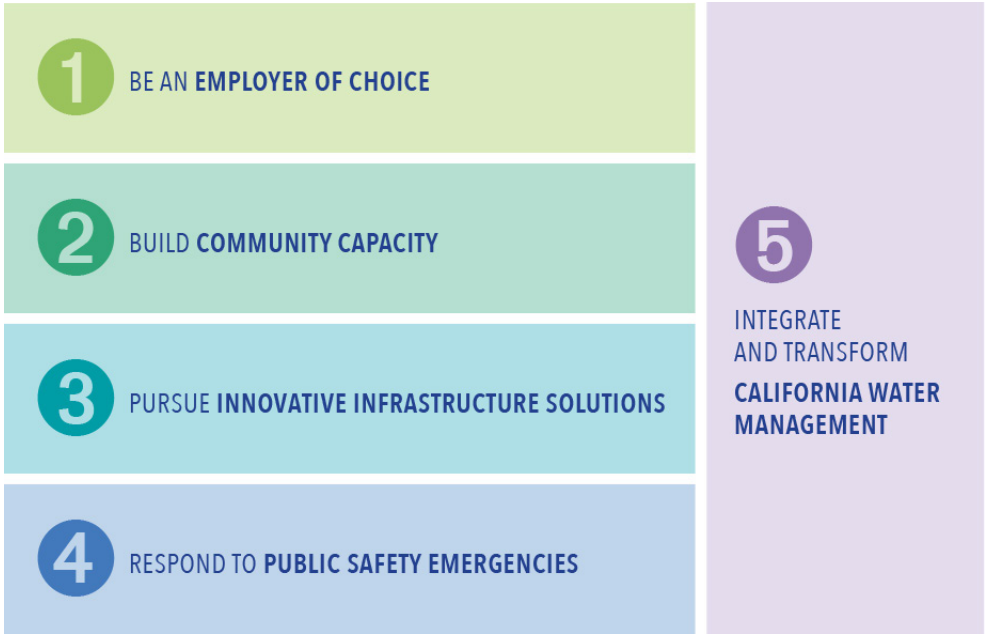
This report builds on the themes of actionable science and partnerships through real-world examples and success stories. To show how climate-resilient water resources management plays a vital role in DWR projects, the spotlighted

partnerships are organized around DWR's Strategic Plan goals (Figure 1.3, DWR 2023):

- Be an Employer of Choice
- Build Community Capacity
- Pursue Innovative Infrastructure Solutions
- Respond to Public Safety Emergencies

The fifth strategic goal, Integrate and Transform California Water Management, is recognized as a theme throughout the report.

Figure 1.3.



California Department of Water Resources Strategic Goals

Each chapter starts with a brief overview of the strategic goal that is that chapter's theme. Examples from DWR's activities and partnerships that advance both that specific strategic goal and science-driven decision-making for climate resilience are the core content of each chapter. Each chapter then concludes with a "Challenges and Opportunities" section. Although examples presented in this report are related to water resources, it is DWR's belief that this report can serve as an inspiration to others also working toward a more climate-resilient future.

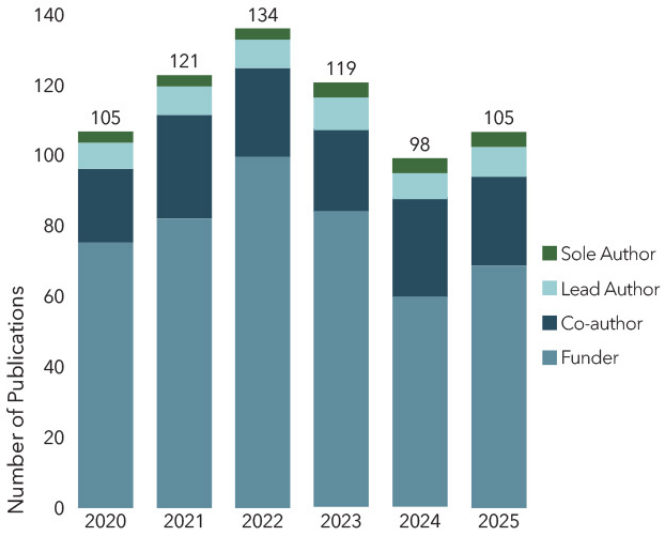
2 Goal: Be an Employer of Choice

2.1 Goal Overview

DWR's ability to lead California toward cross-sector resilience by mitigating, preparing for, and adapting to climate change in water resources management relies on the strength of its workforce. **Creating an environment that attracts and retains highly qualified, talented, and motivated employees is essential to building the expertise and capacity needed to address the State's climate challenges.** By dedicating resources to support employee development and by promoting collaboration with experts across the water management sector, DWR is better positioned to implement effective climate resilience actions in support of California's climate goals.

DWR brings scale and expertise in shaping California's climate resilience solutions. Its workforce of roughly 3,500 demonstrates a strong foundation in technical disciplines, with more than a third of staff specializing in science and engineering roles. For decades, DWR has advanced applied science by sponsoring research, conducting science-based monitoring, and piloting emerging technologies that inform water management. **DWR funds, supports, or directly authors approximately 100 scientific peer-reviewed publications each year** across a range of disciplines (Figure 2.1, see DWR Peer Reviewed Publication Inventory). This commitment to science-based decision-making attracts and empowers skilled professionals and enables DWR to lead science-driven climate resilience actions with partners.

Figure 2.1.



Annual Peer-Reviewed Scientific Publications with DWR Authorship or Funding
Source: Publications Inventory accessed 4/24/2026

2.2 Science-Driven Decision-Making and Partnerships

Science plays a central role in shaping effective, equitable, and forward-looking climate resilience strategies across DWR. By building internal climate and science literacy, embedding and supporting climate experts throughout the organization, and fostering diverse partnerships, DWR strengthens its ability to advance best available science and connect it with decision processes and decision-makers. These actions support integrated planning, improve collaboration across programs, and build the internal capacity needed to respond to complex climate challenges. This approach aligns with leading practices recognized by the Water Utility Climate Alliance, such as integrating climate adaptation through communities of practice and mainstreaming climate considerations throughout its organizational activities. Through these approaches, DWR builds its capacity as a science-driven organization while also enhancing its appeal as an employer of choice for scientists and engineers. The following case studies highlight how science-driven approaches are used to advance DWR's climate resilience objectives.

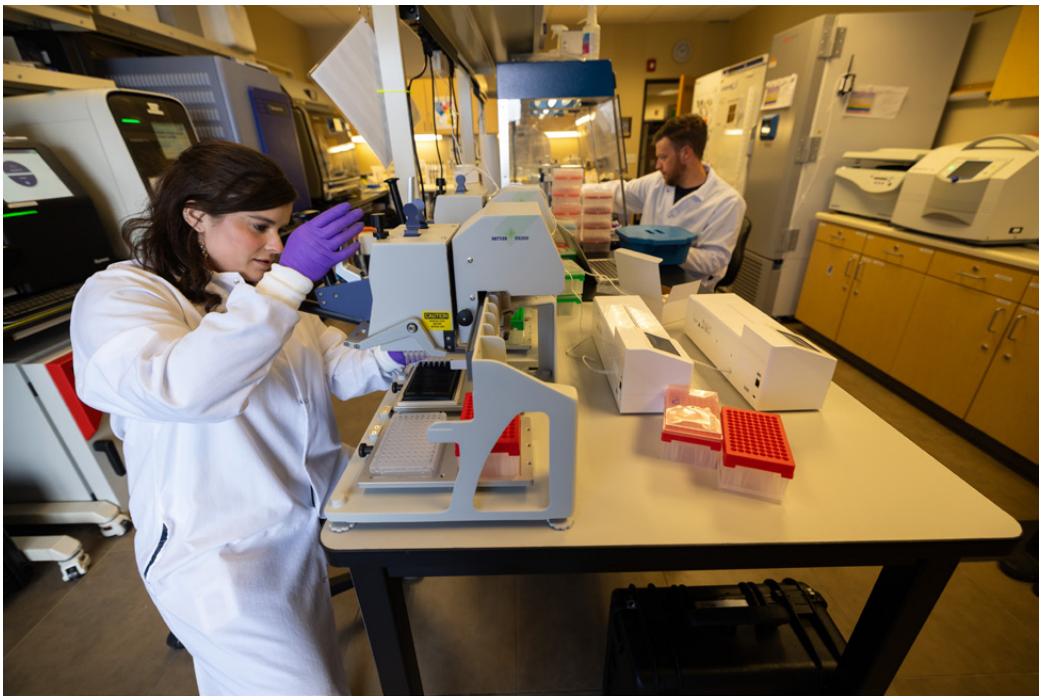
2.2.1 Partnering to Advance Emerging Technology

In 2024, DWR published an Environmental DNA (eDNA) Strategy to apply emerging genetic tools for biological monitoring. By analyzing water samples, scientists can identify traces of DNA left behind by nearly any species recently present, introducing a powerful economy of scale for biological sampling (Figure 2.2). Environmental DNA monitoring offers promising applications for ecosystem management as well as water project operations, enabling scientists to detect changes in biodiversity and presence of special species of interest (e.g., protected or nuisance species) in response to climate change. In 2024, DWR staff presented this strategy at the 3rd National Workshop on Marine eDNA in Washington, D.C. and collaborated with federal agencies and other partners to support the development of the National Aquatic Environmental DNA Strategy. These efforts set the stage for coordination among scientists and water resources decision-makers nationwide and positioned DWR as a leader in advancing eDNA applications to support natural resource decision-making. This work reflects not only science-driven innovation but also DWR's commitment to dispatch emerging thought leaders to national and international forums, in alignment with DWR's Strategic Plan (Goal 1, Objective 2, Action 9).

This initiative directly supports California's Climate Adaptation Strategy (Priority: Accelerate Nature-Based Climate Solutions and Strengthen Climate Resilience of Natural Systems, Goal A, Action 11), which identifies the application of eDNA monitoring as a success metric for increasing the scale of nature-based climate solutions. This recognition underscores DWR's role in advancing applied science and reflects the strength of its science partnerships and the influence of its science leaders. By aligning emerging technologies like eDNA with statewide adaptation

priorities, DWR demonstrates how strategic science leadership and collaboration can accelerate the integration of innovative solutions into climate resilience planning and decision-making.

Figure 2.2.



Scientists in the eDNA (environmental DNA) laboratory look for the presence of golden mussels, an invasive species. eDNA is the cellular material shed by organisms such as skin cells, excrement, etc. in aquatic or terrestrial environments. DWR's Genetic Monitoring Laboratory (GeM Lab) leverages state-of-the-art equipment for both eDNA and organismal genetic monitoring techniques to inform State Water Project operations, conduct surveillance for invasive species, and monitor aquatic biodiversity for DWR programs. Photo taken March 13, 2025.

Photo credit: Andrew Nixon / California Department of Water Resources

2.2.2 Investing in a Climate Literate Workforce

Creating a climate-minded culture starts with informed and engaged employees. DWR has invested in growing internal climate and science literacy by providing accessible and relevant learning opportunities for staff at all levels (Figure 2.3). In doing so, it helps ensure water management decisions are grounded in current science and aligned with DWR's long-term climate resilience goals.

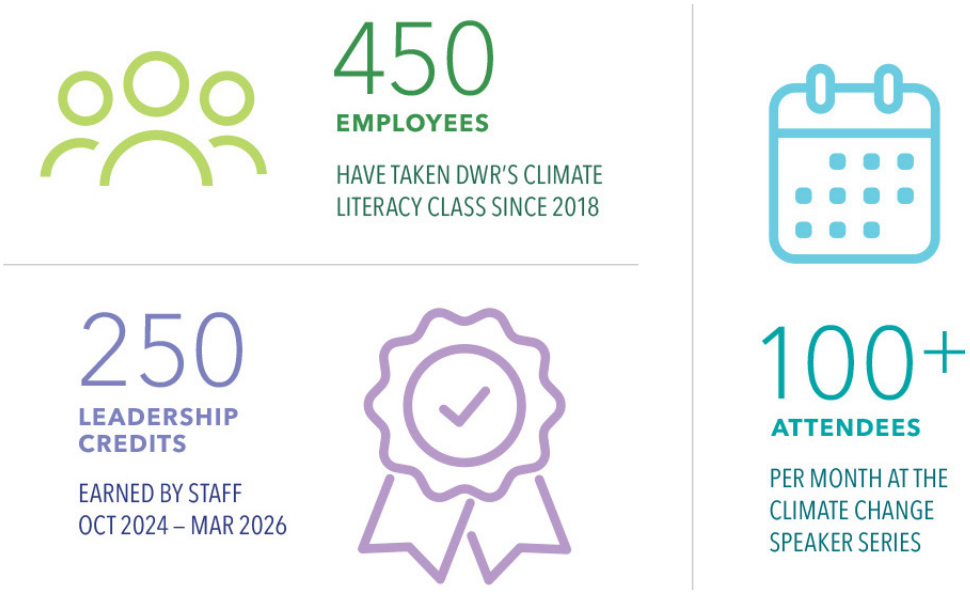
One cornerstone of this effort is DWR's Climate Literacy Training which introduces foundational concepts in climate science and connects them directly to water

management and policy in California. Topics include hydrologic change, greenhouse gas emissions, statewide climate policies, climate change adaptation and mitigation, and DWR's Climate Action Plan. The training serves as both a primer for new employees and a professional development opportunity for existing staff, ensuring that DWR's workforce remains aligned with the latest climate science and policy developments.

To build on this foundation and encourage continuous learning, DWR also hosts a **Climate Change Speaker Series**. This monthly seminar is open to staff across DWR and features a **pair of complementary presentations**: first, a longer presentation from **external experts on emerging research, innovative strategies, and interdisciplinary approaches to climate-resilient water management**, followed by a shorter presentation from DWR staff **connecting these topics to specific activities within DWR**. In addition to advancing climate knowledge, the series promotes discussion to deepen understanding of relevant science and further develop a community of practice. It also adds value as a professional development opportunity by offering leadership development credits to attendees.

Together, these initiatives illustrate how advancing climate literacy and cultivating science leadership throughout DWR empowers both staff and the next generation of scientists, engineers, and planners to understand and respond to climate challenges. By prioritizing partnerships, education, and innovation, DWR can advance California's climate resilience goals, help build a climate-ready workforce, and reinforce its position as a leader and employer of choice in the water sector.

Figure 2.3.



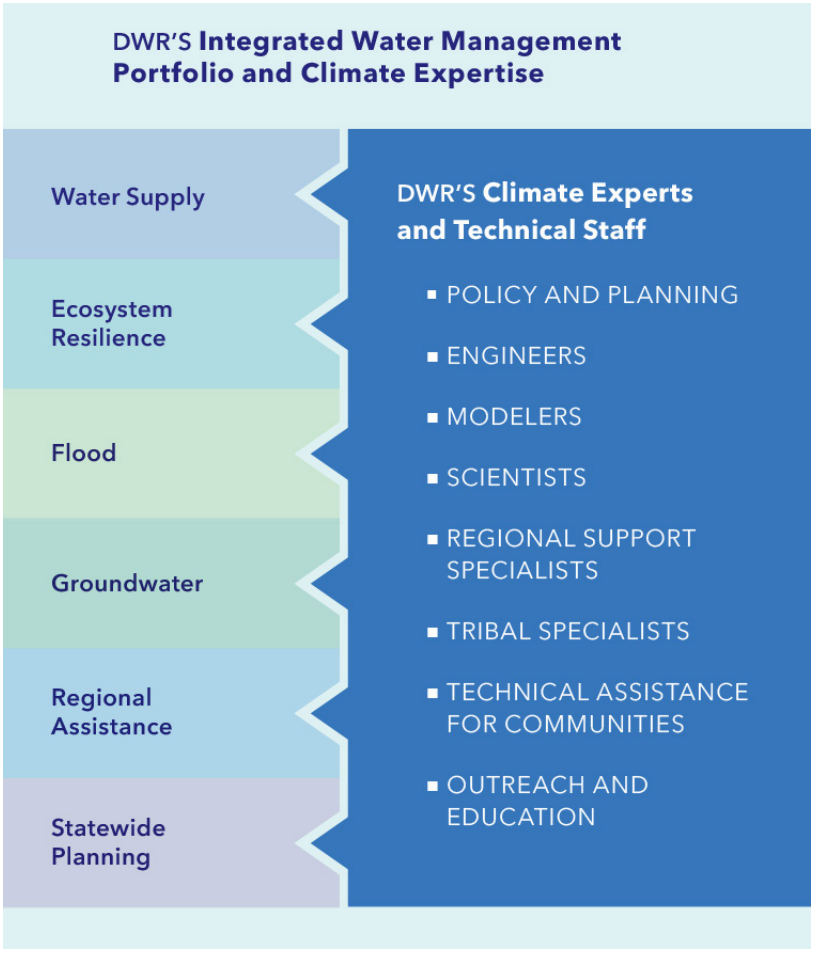
Climate learning venues and engagement

2.2.3 Embedding Climate Change Experts throughout DWR

DWR uses a portfolio approach to advance its climate resilience strategies. It relies on coordinated, multi-ownership policies, programs, initiatives, and teams across divisions and program areas. This portfolio delivers a wide range of science-based services and products for both internal and external water managers. **Within DWR, climate change is not treated as a standalone initiative but rather as a core element of DWR's culture, informing planning, design, operations, and investment decisions across all program areas** (Figure 2.4). This integration directly supports DWR's climate resilience mission and its strategic goal to be an employer of choice by fostering a culture of excellence grounded in expertise, innovation, and shared accountability.

Consistent with DWR's Strategic Plan (Goal 1, Objective 2, Action 5), which calls for embedding climate change experts in each division, DWR's climate governance structures have expanded to include increased leadership support. This includes executive leadership, climate coordinators and managers, and climate leads within major planning and program implementation divisions (e.g., State Water Project; Sustainable Water Management; Dam Safety and Flood Management; Statewide Planning; and Natural Infrastructure and Ecosystem Resilience). These experts bring a set of key competencies adapted from scientific literature on actionable science (Goolsby et al. 2023), building connections across boundaries (Goodrich et al. 2020; Neal et al. 2022), and integrating climate considerations into organizational culture (Runhaar et al. 2018). These key competencies enable climate experts to develop and translate science usable for decision-making and advance integrated climate resilience policies and programs throughout DWR. Collectively, these competencies encompass systems-level thinking, strategic relationship management, effective cross-organizational coordination, and facilitation of climate literacy and professional capacity. This evolving governance adds expertise, accountability, and leadership capacity within DWR to integrate climate resilience across DWR's core activities and ready California's water sector for a changing climate.

Figure 2.4.



Integrating climate science and expertise throughout DWR.

2.3 Challenges and Opportunities

Investments in climate and science literacy have enhanced staff knowledge and awareness, while embedding climate experts has improved coordination, increased technical capability, and supported integrated planning across divisions and regions. Strategic partnerships have extended DWR's reach, strengthened cross-sector collaboration, and expanded access to and capacity for best available science. As workforces evolve, knowledge-sharing across disciplines and areas of responsibilities will be important to sustain and leverage climate expertise and instigate integrative solutions. Commitments to matrixed approaches and cross-cutting considerations require greater coordination than single sector or divisional responsibilities. Sustaining and prioritizing time and space for interdivisional teams and learning venues are challenged by competing priorities. These efforts not only support effective water management at DWR but also contribute to the State's broader

resilience goals across natural resources, energy, public health, emergency response, and community development. They have established DWR as a center of excellence for advancing climate science and cultivating a science-based organizational culture. Moving forward, DWR has opportunities to deepen internal alignment, expand regional and community partnerships, and further embed climate considerations across policies, investments, and operations.

In a nutshell

- Continuous learning and leadership opportunities build capacity and a climate-resilient workforce.
- Climate experts across organizational divides support aligned science-based decision-making and foster coordinated climate actions and accountability.
- Diverse partnerships advance the usability of emerging technologies and fill knowledge gaps to advance climate-resilient water and environmental management.

3 Goal: Building Community Capacity

3.1 Goal Overview

DWR is committed to investing in solutions to protect and address the needs of all Californians by building community capacity (DWR Strategic Plan, Goal 2) through equitable outreach and engagement and by expanding technical and financial assistance. DWR acknowledges historical water management inequities in water management decisions. Some of these decisions limited the benefits available to communities and/or caused some communities to carry a larger burden of impacts ranging from flood risks to water shortages. DWR addresses these inequities through several actions, including expanding outreach and engagement with domestic well users on groundwater, supporting climate science-driven regional planning, and advancing water and climate education.

DWR is committed to investing in solutions to protect and address the needs of all Californians by building community capacity. California Water Plan 2023, the State's strategic plan for sustainably and equitably managing, developing, and stewarding water resources, took an in-depth look at issues and opportunities to advance equitable outcomes in water management (DWR 2024a).

3.2 Science-Driven Decision-Making and Partnerships

Inadequate community engagement and limited technical or financial capacity are common barriers to effective community-based water management decisions and climate adaptation planning (DWR 2024a; Moser and Ekstrom 2010). DWR invests in programs, such as DWR's Watershed Resiliency Program, that put local communities into leadership positions, thereby reducing institutional barriers, while also providing scientific, financial, and technical assistance to community leaders to help ensure successful water management decisions. These holistic investments in social, built, and nature-based infrastructure are important to community well-being and effective public climate mitigation and adaptation (National Academies of Sciences, Engineering, and Medicine 2024).

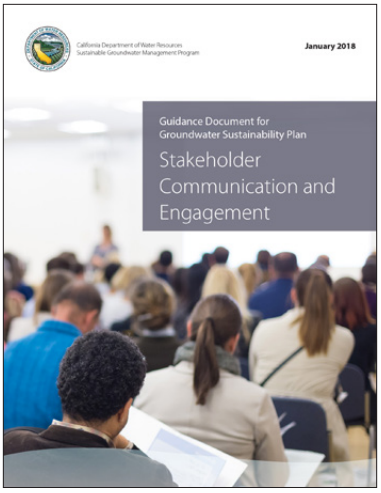
DWR's commitment to building community capacity and climate resilience are demonstrated by examples that highlight the importance of science-based technical capacity building and partnership in decision-making. These examples include resources for groundwater planning, drought coordination, watershed-scale network investments, and public climate literacy education. These initiatives uplift local communities in leading others, addressing historical inequities through collaborative frameworks, and using education as a climate change adaptation tool. They also advance key priorities of California's Climate Adaptation Strategy to strengthen

protections for climate-vulnerable communities and bolster public health and safety to protect against increasing climate risks.

3.2.1 Sustainable Groundwater Management Act Resources

The Sustainable Groundwater Management Act (SGMA), passed by the California Legislature in 2014, was created to ensure that California's groundwater resources are managed in a way that supports long-term sustainability and the health of local communities. SGMA recognizes that local communities, through their respective groundwater sustainability agencies (GSAs), are best equipped to lead this effort. GSAs are expected to consider a wide range of voices, including farmers, domestic well owners, local governments, Tribes, environmental groups, and underserved communities. Each group plays a vital role in California's water landscape and may be affected by groundwater decisions. **DWR produces several resources to help GSAs engage diverse voices and develop groundwater plans** that are mindful and adaptable to the growing challenges of climate change and protection of water resources for future generations. The SGMA Data Viewer is a map-based web tool for viewing and downloading SGMA related datasets. Examples of other resources include:

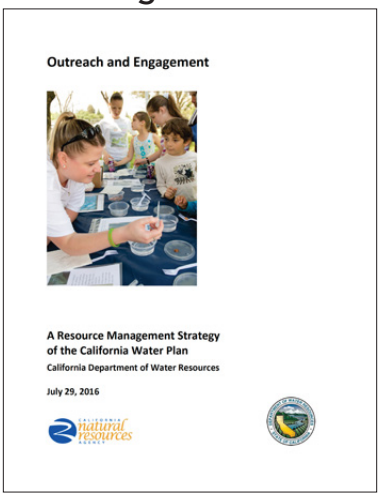
Figure 3.1.



Stakeholder Communication and Engagement Guidance helps GSAs communicate and engage effectively. This guidance offers practical methods to encourage ongoing, two-way communication by highlighting the importance of inclusive participation and offering tools, examples, and resources to support meaningful engagement.

DWR's Stakeholder Communication and Engagement guidance was developed for GSAs to guide stakeholder communication and engagement.

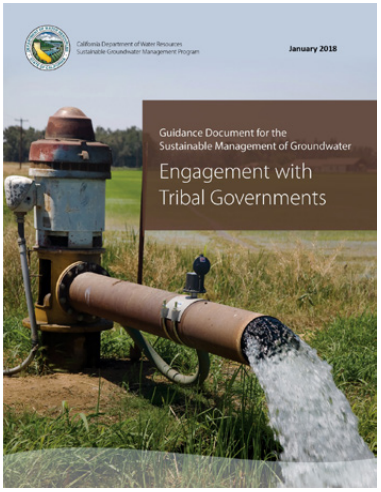
Figure 3.2.



Outreach and Engagement offers a resource management strategy for culturally appropriate communication and inclusive engagement practices that strengthen collaboration across California's water management landscape. It also highlights the value of educating youth about water resources to promote long-term awareness and behavior change, as well as the importance of understanding local impacts and community-driven responses to climate change.

DWR's Outreach and Engagement guidance outlines the principles and best practices for effective public outreach and engagement in water management.

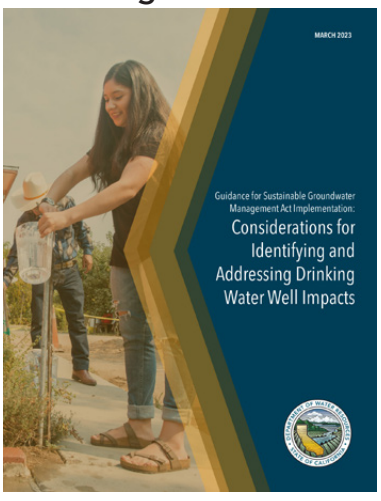
Figure 3.3.



Guidance Document for the Sustainable Management of Groundwater: Engagement with Tribal Governments outlines effective outreach and consultation strategies that support sustainable groundwater management while respecting Tribal sovereignty and promoting government-to-government relationships.

DWR's guidance document for local agencies and GSAs to engage and communicate with Tribal governments throughout the formation, development, review, and implementation of Sustainable Groundwater Management Plans.

Figure 3.4.



Guidance for Considerations for Identifying and Addressing Drinking Water Well Impacts provides approaches to address impacts to drinking water supplies that result from management strategies to reach sustainable groundwater conditions.

DWR's guidance for GSAs to identify and address impacts to drinking water well users.

3.2.2 DRIP Collaborative – Task Force on Planning, Preparing, Responding, and Recovering from Droughts and Water Shortages

Acknowledging a changing climate and the need to prepare for drought and water shortage conditions, Governor Newsom signed Senate Bill 552 in September 2021 to require DWR, in coordination with other State agencies, to establish a standing interagency drought and water shortage task force. The task force, known as the **Drought Resilience Interagency and Partners (DRIP) Collaborative, is charged with facilitating proactive planning and coordination for predrought planning and post-drought emergency response.** The DRIP Collaborative includes 18 voluntary non-State entities representing local governments, State agencies, community-based organizations, nonprofit technical assistance providers, the public, and experts in land use planning, water resiliency, and water infrastructure. The diverse representation of the DRIP Collaborative brings a wider range of perspectives and needs. These observations and experiences improve resilience to drought and water shortages that are forecasted to increase in severity and frequency.

The DRIP Collaborative adopted a group of recommendations centered on three focus areas: Drought-Relevant Data; Drought Preparedness for Domestic Wells; and Drought Definition and Narrative (DWR 2025a). The recommendations were informed by subject matter experts who used the latest data on past and current communities that have struggled because of water supply shortages and droughts (e.g., State Water Resources Control Board's SAFER Drinking Water program and 2024 Safer Drinking Water Needs Assessment and DWR's Water Shortage Vulnerability Tool). The DRIP Collaborative's recommendations address state needs to prepare and plan for droughts and water shortages that can affect various communities vulnerable to different severities of impact (Figure 3.5).

Figure 3.5.



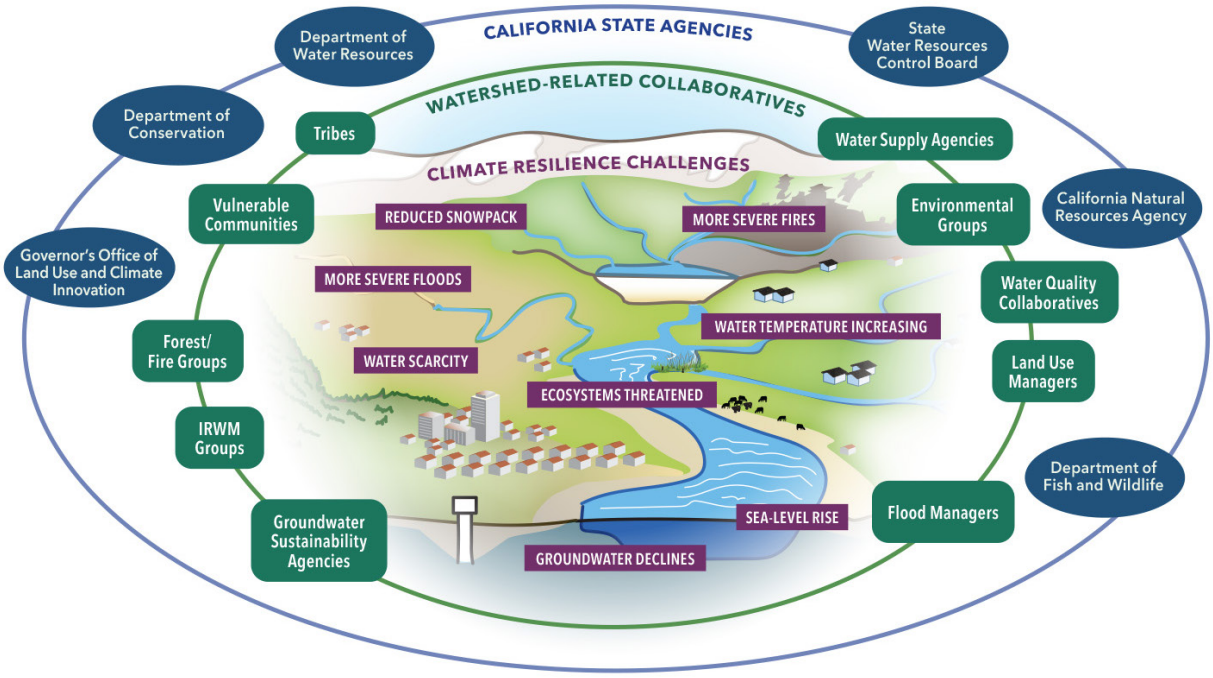
Drought Resilience Interagency & Partners (DRIP) Collaborative members first gathering of 2026 to discuss strategies to attain drought resilience in an uncertain climate future for millions across California. Photo taken April 17, 2026.

Photo Credit: Sara Nevis / California Department of Water Resources

3.2.3 Watershed Resiliency Program Investments

California watersheds are increasingly adversely affected by climate change, with increasing wildfires, floods, droughts and rising sea levels putting unprecedented stress on natural and human systems (DWR 2024a). Watershed-scale planning offers a comprehensive and integrated approach to building climate resilience locally, throughout the state, and across all water-related sectors (i.e., water supply, flood management, groundwater, ecosystems, forest and fire management, and land use). **DWR is piloting a new integrated water management framework centered on the formation of watershed-based networks to collaboratively evaluate climate change vulnerabilities and identify adaptation strategies at the watershed scale.** The development of watershed networks is the foundation of DWR's Watershed Resilience Program, which emphasizes authentic and mindful engagement to foster climate resilience. Watershed networks are encouraged to seek solutions and involve traditionally underrepresented interests and groups, including vulnerable communities and California Native American Tribes (Figure 3.6).

Figure 3.6.



Watershed Networks for Equitable Multi-Sector Collaboration

Currently, the program is being piloted within five diverse watersheds around the state: Ventura River, Pajaro River, Russian River, Calaveras River, and American River watersheds. DWR provides these local communities with technical and scientific expertise that is often identified as a barrier to adaptation planning. DWR has provided outreach support, particularly with Tribes, by providing guidance, letters of support, and Tribal-focused webinars. Technical assistance for pilot watershed networks has included water budgeting support, identifying and quantifying watershed climate vulnerabilities, and assistance with adaptation planning. Additionally, each of the five pilot watersheds have been awarded $2 million to develop their watershed networks and complete watershed resilience plans. As a result, communities are equipped to make science-driven decisions for climate resilience in their watersheds.

Figure 3.7.



DWR's Watershed Resilience Program awarded $2 million to 5 pilot watersheds to develop watershed networks and watershed resilience plans.

Climate Conversations

California's Tribal communities are leading the way in helping our state adapt to our new climate reality. Climate Conversations is a powerful documentary that captures the perspectives and experiences of Tribal members as they adapt to the effects of climate change. These stories, told by multiple generations, provide a legacy and discussion about climate vulnerabilities.

Figure 3.8.



Tribal members share perspectives and experiences in the Climate Conversations documentary

3.2.4 Sustained Attention to Building Community Capacity: Partnership with Project WET

DWR is committed to raising awareness of climate change and its impact on the water supply by empowering educators to include climate science in their curriculums. For more than 10 years, DWR has partnered with the Water Education Foundation to offer workshops featuring Project WET curriculum on climate change and the state's water resources to teachers and environmental education professionals. DWR plays a vital role in supporting Project WET through technical expertise and financial investments.

Up to four workshops are convened annually throughout the state with at least one location hosted by a Tribe and/or in an underserved community. Locations are identified based on need, request, and accessibility by region. Participating educators increase their knowledge of California's water resources, as well as local and statewide mitigation and adaptation efforts to build climate resiliency. They return to their classrooms prepared to share these science-based lessons with students through hands-on, engaging activities.

In the first decade of hosting these workshops, **DWR trained nearly 1,000 teachers, reaching more than 250,000 students** (DWR Teacher Workshops Increase Access to Water Education). As a result, educators are equipped with the tools, skills, and knowledge to help their students build climate literacy, encourage problem solving, and promote community engagement, climate justice, and water-efficient behaviors.

Figure 3.9.



DWR's Regional Climate Change Specialist Jordi Vasquez teaches at a "Climate Change and California's Water" Project WET educational event in Stockton on February 1, 2025.

3.3 Challenges and Opportunities

The programs and partnerships detailed in this section empower local agencies and communities with technical assistance, financial support, and collaborative frameworks needed to build climate resilience solutions. Moreover, developing educational partnerships creates the next generation capable of leading climate resilience actions in their communities. Although these initiatives represent significant progress, sustaining momentum will require continued investment. Studies to evaluate the impacts of climate change outreach and technical assistance in community engagement processes are emerging practices and an area for future research. Sustained, multi-year investments, consistent and continual engagement, and shared leadership with community partners are important to building and sustaining trust. By creating frameworks that allow local voices to lead, empower communities with technical and financial assistance, and educate the next generation on the impacts of climate change, these programs, projects, and partnerships aim to build a resilient California capable of facing climate challenges with local communities leading the way.

In a nutshell

- Empowering local communities to lead helps overcome barriers throughout the climate adaptation process including understanding, planning, taking action, and managing adaptation.
- Education is a climate adaptation strategy that fosters long-term public awareness, resource conservation, climate literacy, and community engagement.
- Collaborative frameworks coupled with technical and financial assistance support equitable partnerships and adaptative capacity.

4 Goal: Pursue Innovative Infrastructure Solutions

4.1 Goal Overview

Innovative infrastructure solutions are a central goal of DWR's Strategic Plan. Although "infrastructure" often suggests traditional engineered systems, such as reservoirs and levees, DWR takes a broader view that also includes data, natural, and social infrastructure (discussed in Chapter 3). This chapter highlights how DWR is rethinking built and natural infrastructure across California's water systems, from the headwaters to the ocean. Whether through field monitoring, data-driven planning tools, multibenefit landscape restoration, or Forecast-Informed Reservoir Operations (FIRO), DWR is proactively managing infrastructure to be adaptable, integrated, and flexible for climate change.

4.2 Science-Driven Decision-Making and Partnerships

Management of California's data, natural, and built water system infrastructure is becoming more flexible and climate resilient through collaboration with local, federal, university, and other partners.

4.2.1 Data Infrastructure: Data and Models Support Better Decision-Making

Data ranging from field observations to model output are the backbone of science to inform decision-making and track trends. This section highlights partnerships to collect, store, share, and generate data.

Continued availability of observed data depends on a dedicated group of IT professionals in DWR's California Data Exchange Technological Services (CDETS) to maintain and modernize the California Data Exchange Center (CDEC). Currently, DWR and more than 140 agencies provide data to CDEC, including the National Weather Service, U.S. Bureau of Reclamation, U.S. Geological Survey, U.S. Army Corps of Engineers, Pacific Gas & Electric, and Sacramento Utility District. **Many agencies, researchers, and the public obtain data from CDEC, and this data is essential to inform water management decisions and actions** (Figure 4.1). **Investment in sustaining and enhancing CDEC is essential**, especially as federal databases are becoming less publicly available.

A partnership with the Western Region Climate Center hosts the California Climate Tracker which produces maps and time series of observed precipitation and temperature data for counties, regions, and the entire state. This freely available

online tool provides both historical and modern climate data, with some records dating back to 1895. Users can generate high-resolution, publication-quality visualizations for use in reports and presentations.

Figure 4.1.



CDEC California Data Exchange Center **CDETS** California Data Exchange Technological Services **CIMIS** California Irrigation Management Information System **CNRFC** California Nevada River Forecast Center **GOES** Geostationary Operational Environmental Satellite **NWS** National Weather Service **SMNU** Statewide Monitoring Network Unit

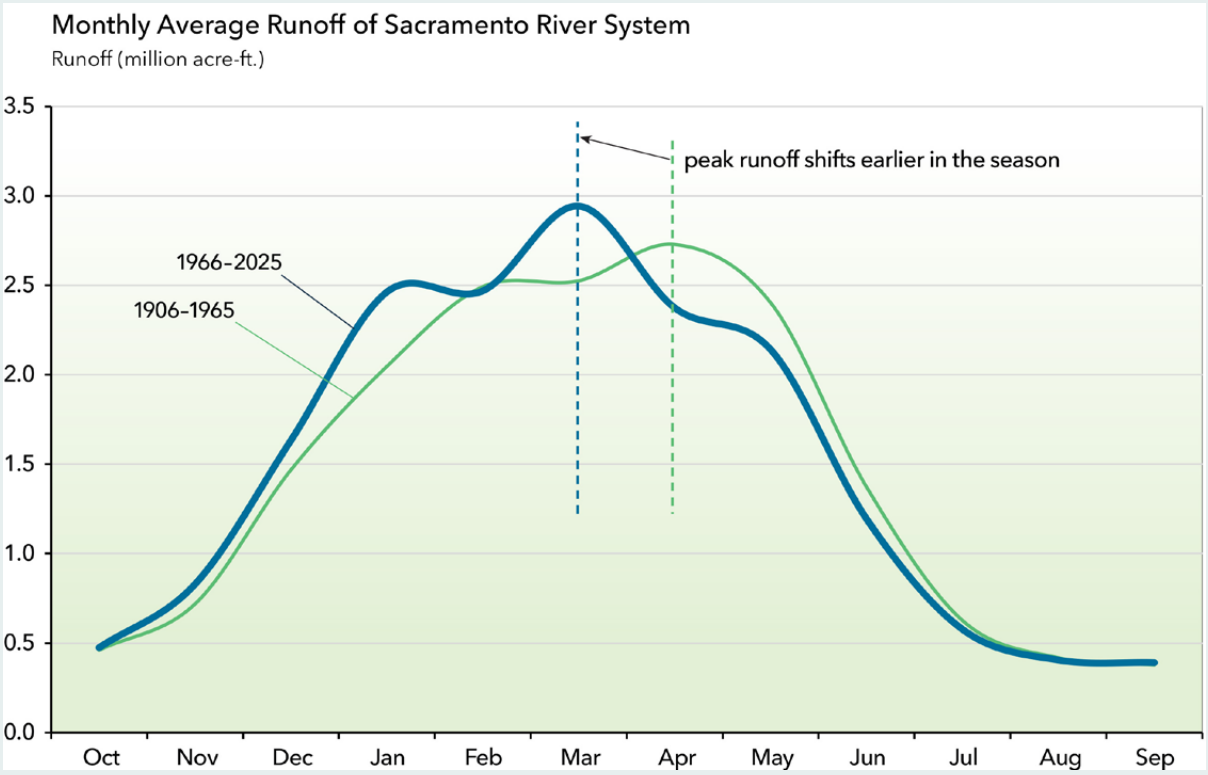
*Statewide Monitoring Network Unit (SMNU) maintains 145 observation stations with multiple instruments and sensors on each.

California Data Exchange Technological Services (CDETS) are central to data driven integrated water management exemplifying the benefits of partnership, observations, and improved forecasts.

Runoff Is Shifting Earlier–Water Management Indicators Must Change Too

Observations show that spring runoff has shifted about 3 weeks earlier for the Sacramento River System. Many water management practices are tied to an April 1 benchmark which historically reflected when snowpack was the highest. Observing the peak snowpack is essential for water supply forecasters to calculate how much snowmelt runoff will eventually make its way into California's rivers and reservoirs. This information is critical for reservoir managers, who must balance flood control and water supply goals. Historically defined rules and regulatory triggers are now often out of alignment with observed precipitation and runoff patterns highlighting a need to update regulatory triggers and management practices. DWR partners with the Office of Environmental Health Hazard Assessment (OEHHA) to update scientifically based measurements that track trends in various aspects of climate change. The latest report on Indicators of Climate Change in California, Fifth Edition will be released in fall 2026.

Figure 4.2.



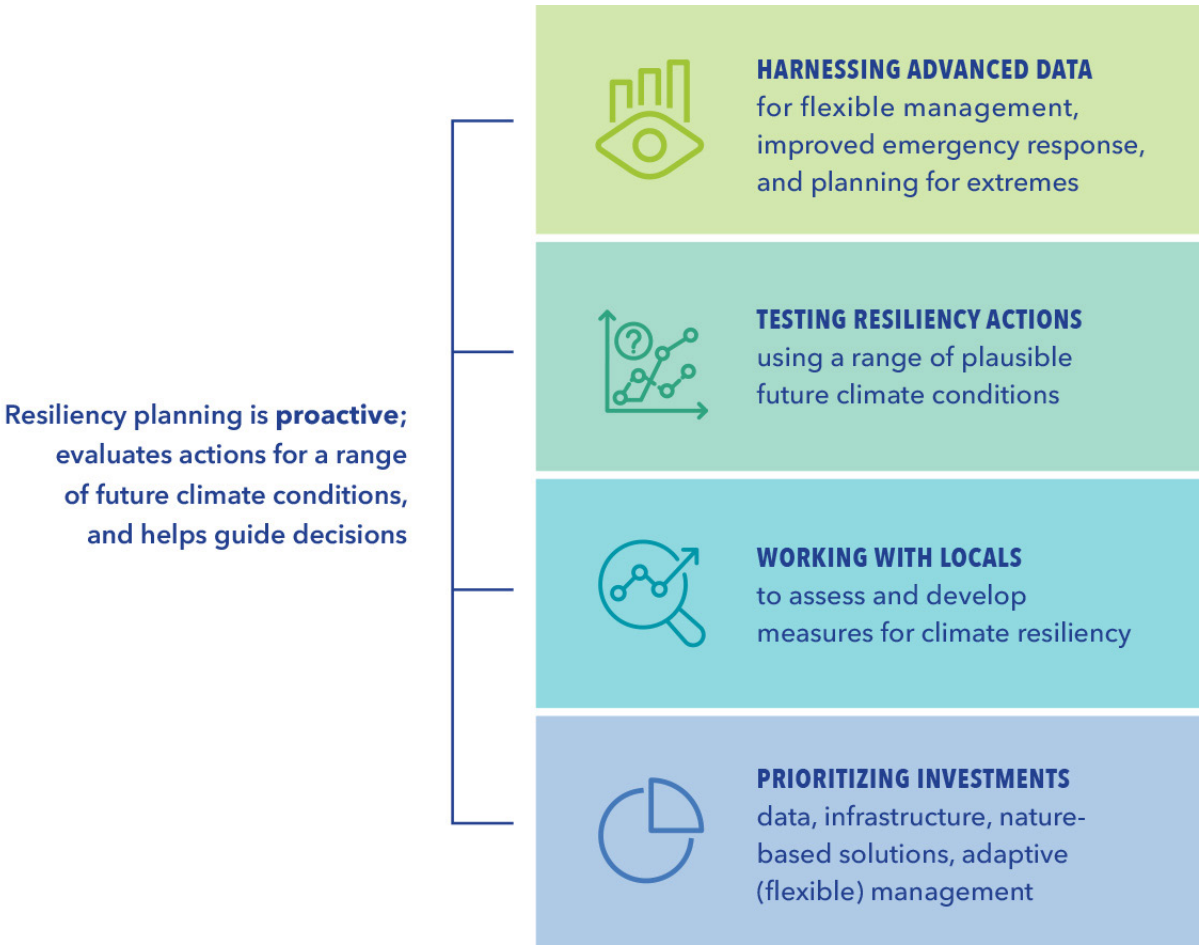
Monthly Average Runoff of the Sacramento River System

Advances in data management and modeling capabilities provide rich datasets beyond the observed records. DWR's **Climate Change Data Management Workgroup** is a central team working to improve how data supports large-scale

planning. DWR is developing advanced database storage and design to make it easier for users to access high quality planning data and associated metadata. DWR and external partners benefit from advanced data delivery methods. An example of creating planning data is a DWR partnership with university researchers to develop a stochastic Weather Generator tool (Najibi & Steinschneider 2023) that produces a wide range of plausible future precipitation and temperature scenarios (Najibi et al. 2024). An analysis method to explore uncertainty called "decision scaling" (Brown et al. 2012) is used to evaluate performance of water systems across multiple future scenarios and to determine the likelihood of potential outcomes relative to projection data.

Decision scaling is a proactive approach to climate resilience planning to evaluate stress tests for water conveyance and flood systems under a wide range of future climate conditions. These uncertainty analyses help identify thresholds where water system adaptation is needed, inform planning efforts and guide investment priorities for infrastructure improvements (Figure 4.3.). The Delta Stewardship Council conducted an Independent Scientific Peer Review of the use of this climate analysis approach in the State Water Project Delivery Capability Report (2023), which led to additional transparency, credibility, and meaningful improvements. Decision scaling has also been used in the California Water Plan 2023, State Water Project Adaptation Strategy (2025), Federal Emergency Management Agency (FEMA) Cooperating Technical Partner Climate Risk-Informed Flood Inundation Mapping Project report, and the upcoming Central Valley Flood Protection Plan (2027) and California Water Plan 2028.

Figure 4.3.



Elements of Proactive Climate Resilience Planning

DWR's commitment to observational science is reflected in the professionals building and maintaining the instrumentation associated with the Statewide Monitoring Network (SMNU) to provide reliable, accurate, and timely data that is foundational to forecasting. DWR expands scientific understanding through longstanding partnerships like the one with the University of California, Berkeley Central Sierra Snow Lab (DWR 2022a) since 1956. In addition to daily monitoring of snow conditions in the Sierra Nevada, work at the lab has made significant contributions to the fields of snow physics, meteorology, climatology, and hydrology. Other examples include DWR's support implementing Senate Bill 19's Stream Gaging Plan; funding federal science partners, such as the U.S. Geological Survey (USGS) for soil moisture probes used for Feather River watershed research; and partnership with airborne snow observation snow hydrology professionals on remote sensing of snow including the expansion of aerial LiDAR and on-the-ground snow survey instrumentation proposed in the Roadmap for Climate Resilient Forecast Framework discussed further in Chapter 5.

Figure 4.4.



UC Berkeley's Central Sierra Snow Lab Lead Scientist Dr. Andrew Schwartz (right) and DWR Electrical Engineers Bryan Prestel (center) and Nick Ellis (left) discuss maintaining and upgrading the Statewide Monitoring Network next to an instrumentation tower. Photo taken January 26, 2022.

Photo credit: Florence Low / California Department of Water Resources

4.2.2 Nature-Based Infrastructure

Nature-based infrastructure supports resilient watersheds and ecosystems and helps sustain water supplies and manage floods.

Using Natural Features to Slow and Store Water

The anticipated loss of seasonal snowpack in mountain watersheds will affect flooding and water supply. Because less precipitation will fall as snow and more will fall as rain, rain-dominated flood events are more likely. Water supply scarcity in a warmer future climate is expected given that spring and summer domestic and agricultural water systems depend on historically snow melt-driven reservoir releases. Transitory storage and meadow restoration projects, such as the Thompson Meadow Restoration Project, are designed to play a role in helping California's headwaters hold more water and release it slowly, which increases baseflows in rivers and streams and improves water quality and habitat.

Reconnecting Floodplains and Recharging Aquifers

Floodplains and groundwater aquifers are integral natural infrastructure for California's water management. When floodplains are covered in water, the water seeps into the ground and replenishes groundwater supplies and provides critical habitat for both aquatic and avian species.

In response to intensifying climate extremes including longer droughts and more severe floods, **DWR introduced flood-managed aquifer recharge (Flood-MAR)** (DWR 2018) **as a voluntary, integrated water management strategy that diverts high flows, typically from winter storms or snowmelt, onto working lands for groundwater recharge, reducing flood peaks and restoring depleted aquifers.** Additional benefits include subsidence mitigation, water quality improvements, and ecosystem enhancements.

Harnessing high flows for recharge has evolved from a concept to becoming reality in California. The Central Valley Flood-MAR Dashboard is a data-driven decision-support tool developed by DWR that assists water managers across the San Joaquin and Sacramento Valleys in identifying and diverting floodwater flows for groundwater recharge. The dashboard integrates State forecasting capabilities with local flood thresholds to better forecast and manage available flood waters to facilitate floodwater diversions for groundwater recharge.

To improve the understanding of the natural storage capacity of groundwater basins and support the implementation of SGMA, DWR launched the Basin Characterization Program which uses partner-developed, state-of-the-art data such as airborne electromagnetic (AEM) surveys to create basin-specific and cross-basin geophysical

data, tools, and analyses. These tools, along with California's Groundwater Bulletin 118, assist federal, State, local, and groundwater sustainability agencies to integrate management of groundwater basins and surface water systems. These tools also provide data to water resource managers, interested parties, and the public.

To enhance floodplain connectivity and ecosystem function, DWR uses the Ecological Floodplain Inundation Potential (EcoFIP) analysis approach to prioritize floodplain restoration including setback levee construction. EcoFIP initiatives, such as the Cosumnes River Multibenefit Floodplain Restoration Pilot Study Summary (DWR 2025b), illustrate green infrastructure solutions that work with natural processes to buffer floods and support biodiversity.

Tidal Restoration for Resilience to Sea Level Rise

DWR invests in tidal wetland restoration in the Sacramento-San Joaquin Delta (Delta) and larger San Francisco Estuary to achieve benefits of ecosystem resilience, flood protection, carbon sequestration, and to counteract sea level rise. In this region, historical wetlands have been reclaimed and reduced by more than 95% (Beagle et al. 2015); as a result, the region is heavily subsided and vulnerable to flooding because of an increasingly fragile levee system. In addition, wetland ecosystem support of increased productivity and refuge has flat-lined. Investing in tidal wetlands increases plant growth and accumulates sediments, which helps the land stay above rising sea levels, improves water quality, traps carbon and reduces greenhouse gases. The projects presented here align with DWR's Climate Action Plan requirements to utilize science-based analysis of climate change impacts to adapt to changes in salinity, future flood risk, and provide inland migration space for wetland plant species to adapt to sea-level rise.

Tidal marsh and floodplain habitat restoration in the Delta (see Map of Delta Restoration Projects), such as the Tide's End Multibenefit Restoration Project and the Dutch Slough Tidal Wetland Restoration Project, provide flood protection, carbon sequestration, and water quality protection. Other major tidal wetland restoration projects, such as the 3,000-acre Lookout Slough Tidal Habitat Restoration and Flood Improvement Project completed in 2024, simultaneously support flood capacity by connecting to the major floodway of Yolo Bypass and support the ecosystem through enhanced food web productivity.

On Sherman and Twitchell islands, DWR wetland restoration projects were implemented to halt severe land subsidence caused by drainage of Delta peat soils. Subsidence threatens levee stability and increases saltwater intrusion risk driven by sea level rise, thereby directly threatening California's water supply. Through multiple research partnerships, DWR funds detailed long-term studies of the impacts of wetland restoration on subsidence, carbon cycling, and greenhouse gas dynamics (Hemes et al. 2019; Anthony and Silver 2021). Data from these experiments

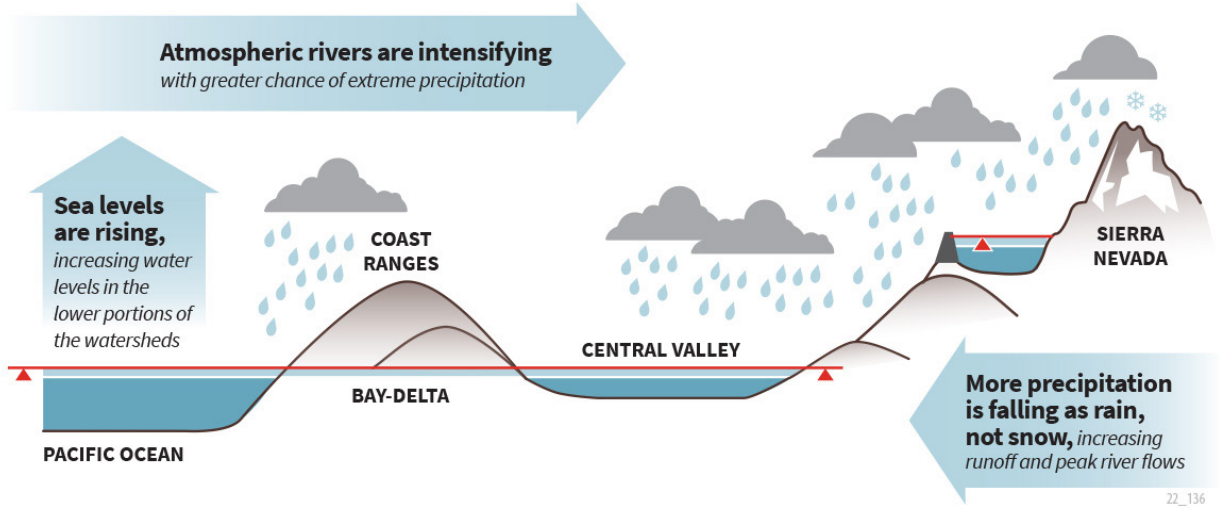
provides clear, science-based evidence that these **wetlands not only halt but actually reverse subsidence and result in substantial carbon sequestration and greenhouse gas reductions**.

These research efforts directly influence DWR's Agriculture and Land Stewardship Program, which facilitates knowledge-sharing across land managers, continuous scientific research and monitoring, and ongoing adaptive management to ensure that DWR remains at the forefront of best practices for ecosystem management in the face of a changing climate and rising sea levels.

4.2.3 Built Infrastructure: Finding Flexibility using Existing Infrastructure

Traditionally, California's reservoirs have operated for flood control in the winter and water supply in the summer. Reservoir inflows are expected to shift earlier in the year with more precipitation falling as rain than as snow, resulting in less spring snowmelt. Atmospheric River storms, which provide much of California's water supply, are expected to become more intense, increasing the chances for extreme precipitation (Figure 4.5.). Thus, to use California's scarce water resources efficiently and increase climate resilience, water management is evolving to more flexible operations that manage flood control and water supply together.

Figure 4.5.



Extreme precipitation and flooding are expected to intensify.

Credit: Central Valley Flood Protection Plan, 2022

Forecast-Informed Reservoir Operations (FIRO) is a strategy that uses weather forecasts and observations to inform decisions to release water from a reservoir before a storm to reduce flood risk or to store the water after a storm for later use. **The three key components of FIRO are partnership, observations, and improved forecasts.**

FIRO partnerships include:

- the U.S. Army Corps of Engineers (USACE) (responsible for flood control),
- a local sponsor (typically a water agency responsible for water supply),
- DWR (issuing forecasts, facilitating partnerships, technical support, and funding to improve observations and forecasts), and
- researchers (identifying observation and forecast needs for FIRO implementation).

Investments in weather observations to enhance forecasts include six Atmospheric River (AR) Observatories (four along the coast, one in the Delta, and one in Oroville), Atmospheric River Reconnaissance (see Chapter 5), balloons with measurement devices that are released during storms (augmented radiosondes) and vertically pointing radar for determining freezing levels and snowlines. The research and operations partnership with the Scripps Institution of Oceanography's Center for Western Weather and Water Extremes (CW3E) work to innovate observations and improve forecast accuracy at longer lead times (i.e., knowing what will happen sooner to provide more time to prepare).

Early efforts to evaluate forecasts and joint operations include the Yuba-Feather Forecast Coordinated Operations (FCO) and the Folsom Dam Joint Federal Project (JFP). The Yuba Feather FCO partnership built analytical tools and secure data exchange networks that are foundational to a decision support system to evaluate forecast uncertainty under current reservoir release regulations. As early as 2012, Federal, State and local partnerships on the Folsom JFP and associated Water Control Manual update facilitated the use of forecast technology to reevaluate reservoir operations.

The first FIRO research and operations partnership started in 2014 when Sonoma Water explored a FIRO pilot project in the Russian River watershed at Lake Mendocino. In both 2019 (a wet year) and 2020 (the third driest year on record), **using flexible forecast-informed operations at Lake Mendocino increased water storage by nearly 20%, which is enough water for approximately 22,000 households** (Jasperse et.al., 2020). The USACE adopted FIRO in the official reservoir operation guidelines for the updated Coyote Valley Dam and Lake Mendocino Water Control Manual signed in October 2025. (Figure 4.6.).

Figure 4.6.



Leaders from the U.S. Army Corps of Engineers (USACE), Sonoma County Water Agency (Sonoma Water), UC San Diego's Scripps Institution of Oceanography Center of Western Weather and Water Extremes (CW3E) and California Department of Water Resources (DWR) commemorate updates to the water control manual for Coyote Valley Dam and Lake Mendocino to include Forecast-Informed Reservoir Operations (FIRO) to enhance the facility's dual mission of flood risk management and water supply security. October 22, 2025

Photo Credit: Will Bucquoy / Sonoma Water

Caption adapted from SCRIPPS Press Release text by Lauren Fimbres Wood

Currently, California has six FIRO pilot projects conducting initial and final viability assessments; Lake Mendocino and Lake Sonoma in the Russian River watershed, Prado Dam and Seven Oaks Dam in the Santa Ana watershed, New Bullards Bar in the Yuba watershed, and Lake Oroville in the Feather watershed. The FIRO Final Viability Assessment (CW3E 2025) for the Yuba-Feather pilot projects is presented here as an example. A working group of more than 80 members from 14 different organizations concluded that **FIRO is viable for both New Bullards Bar, managed by Yuba Water Agency, and Lake Oroville, managed by DWR**. Findings from this assessment will help inform efforts by USACE to add FIRO concepts to water control manual revisions at these facilities.

Alongside the growing adoption of FIRO into practice, the concept is being integrated into long-term planning processes. Integrating other adaptation strategies with FIRO enhances strategic planning efforts. For example, the State Water Project Adaptation Strategy presents a forward-looking roadmap for adapting to the challenges of climate change that explores various adaptation strategies

individually and combined in adaption portfolios. The report recommends that FIRO be implemented at Oroville Dam in partnership with USACE because it is a low-cost adaptation strategy for reducing flood risk and storing more water safely with little to no downside. The report concluded that **a portfolio of strategies, including FIRO, would provide greater adaptation to climate change than individual strategies alone**. Implementing a portfolio of climate resilience strategies contributes to the long-term sustainability of California's water supplies.

Additional planning efforts across the San Joaquin Basin, such as the Merced River Watershed Flood-MAR Reconnaissance Study (DWR 2024b) and the San Joaquin Basin Flood-MAR Watershed Studies (DWR 2025), explore flexible water management practices to enhance groundwater recharge. These watershed-scale assessments span the Calaveras, Stanislaus, Tuolumne, Merced, and Upper San Joaquin watersheds. Each assessment quantifies how climate change is altering basin hydrology and evaluates two groundwater recharge focused adaptation strategies. The strategies range from existing permittable Flood-MAR high flow diversion actions (MAR 90/20) to innovative proposed use of flood waters based on reservoir reoperations optimized by current forecast capabilities (I-FIRM) which combines FIRO and MAR. The existing high flow diversion scenario can reduce the additional climate-driven groundwater overdraft by roughly 30%, while the scenario that implements the FIRO-MAR concept delivers more than four times the recharge. The FIRO-MAR concept also reduces peak flood flows by up to 54%, fully recovers the climate-driven groundwater overdraft, and produces measurable ecosystem gains including enhanced habitat. Watershed-scale partnerships, pilot projects, and full-scale coordinated actions are essential for climate resilient groundwater management in the San Joaquin Valley.

Building Resilience: Reducing Flood Risk, Enhancing Habitat, and Supporting Agriculture

The Lower Elkhorn Basin Levee Setback Project exemplifies climate-ready, multi-benefit design, and it is the first multi-benefit project implemented from the Central Valley Flood Protection Plan. This project expands Yolo and Sacramento Bypass by moving the levee further away (setback) to increase the flood capacity of the bypass system and to create an additional one thousand acres of floodplain habitat that will be inundated seasonally to provide nutrient-rich fish rearing and migratory bird habitat. The project also enhances riparian and native grassland habitats, including leaving parts of the old levee intact for higher elevation habitat. Local agriculture improvements are supported by a new pump station and new interior drainage facilities. The climate-smart design allows for raising the levee height in the future if needed. This is DWR's first design project to include an additional 1-foot freeboard factor of safety for climate uncertainty.

4.3 Challenges and Opportunities

From snow-fed headwaters to the Delta's tidal channels, DWR is demonstrating that flexibility is a guiding principle for infrastructure investment and management. The projects and strategies described in this report illustrate how data, models, natural systems, and adaptive infrastructure operations can be combined to respond to both immediate conditions and long-term climate change. Whether by modernizing monitoring networks and data systems, restoring meadows and floodplains, recharging groundwater, designing climate-resilient tidal wetlands, or reoperating reservoirs, each effort contributes to systems and partnerships that are better able to adjust as the future diverges from historical norms.

This vision of resilience depends on integrating three forms of infrastructure:

- **Data infrastructure** that securely delivers timely, reliable, and relevant information for science-based decisions.
- **Nature-based infrastructure** that restores natural functions to retain water, improve habitat, and buffer climate extremes.
- **Built infrastructure** that is designed and operated adaptively to deliver benefits and manage risk.

Together, these investments enable DWR to pivot quickly, coordinate across watersheds and sectors, and link local projects to statewide goals. They also position DWR to take advantage of emerging opportunities, such as advances in forecasting, machine learning, and ecosystem restoration science, that will improve climate change mitigation and adaptation work.

By ensuring that the SWP and the broader water system and aquatic ecosystems are climate-ready, DWR is building a future where data is a shared resource; natural and engineered systems work in concert; and California's waterways, aquifers, and infrastructure can sustain California's communities, ecosystems, and economy under a changing climate.

Local, State, federal and science collaborations are essential to achieving California's sustainability goals. Federal spending cuts and disruption to scientific research and essential services threaten the short-term and long-term success of DWR's plans to increase California's climate resilience in water management.

In a nutshell

- Partnered investments in long-term monitoring, secure data storage, and data sharing are essential to support science-informed decision-making.
- Scientific monitoring and modeling of watersheds enhances water and habitat management through improved forecasting of water availability and excess runoff.
- Innovative nature-based infrastructure provides climate resilience by enhancing water supply, reducing flood risk, and mitigating for sea level rise.
- Collaborative scientific advancements support adaptation actions such as improved forecasts informing flexible operations of existing infrastructure.

5 Goal: Respond to Public Safety Emergencies

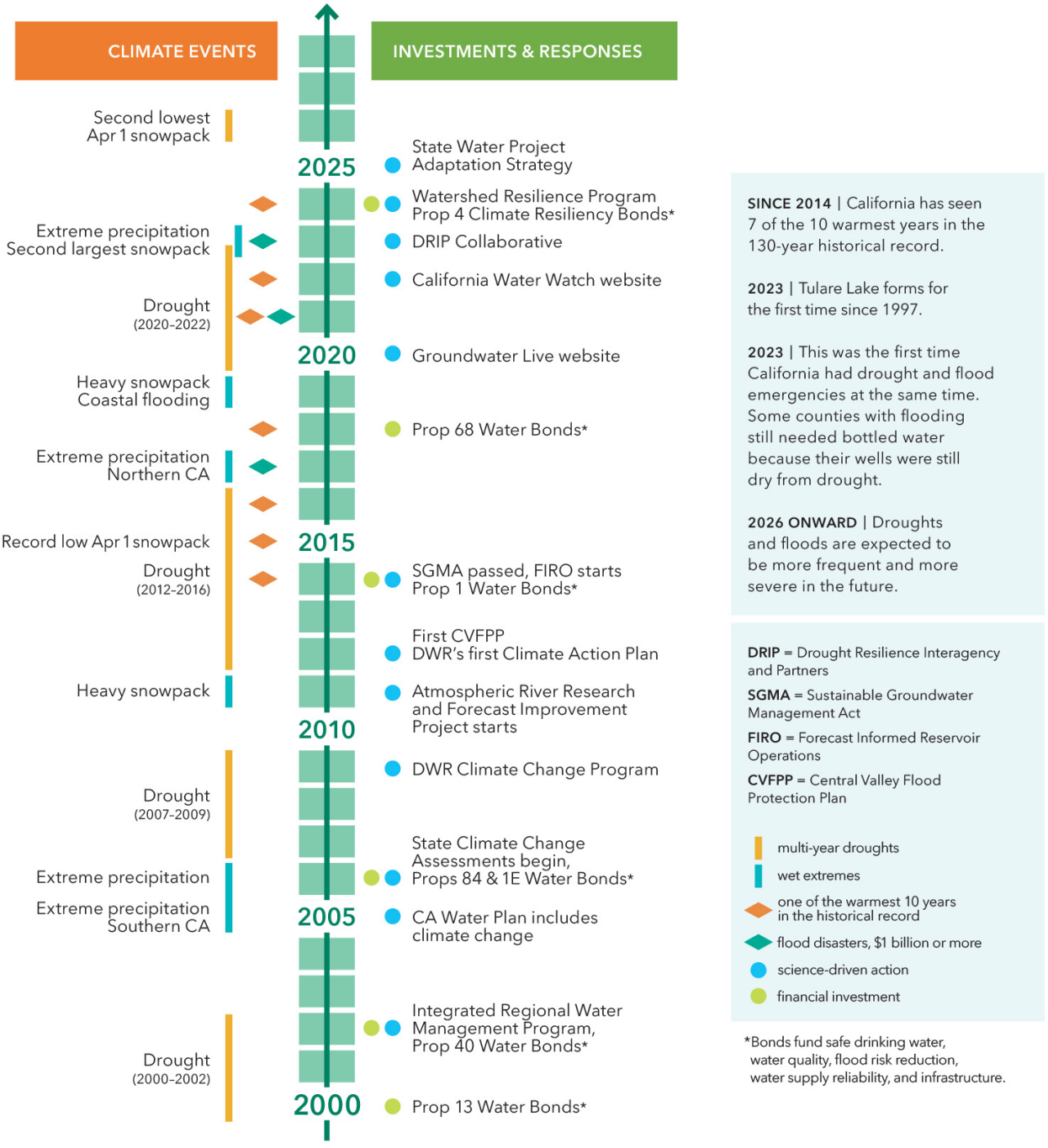
5.1 Goal Overview

DWR is continually improving its response to public safety emergencies. In the Strategic Plan, this commitment is recognized as Goal 4 (Respond to Public Emergencies). DWR is responsible for protecting life and property from catastrophic events, such as floods and droughts, and responding to post-wildfire recovery efforts. Educating the public and providing local assistance strengthens local partnerships (in keeping with Goal 2, Build Community Capacity, see Chapter 3) and builds a responsive and adaptive emergency response network to prepare for, respond to, and attempt to prevent emergencies.

A Tale of Two Low Snowpacks

In California, the April 1 snowpack measurement—historical benchmark for peak snowpack (see Sidebar CH4)—guides key water management decisions, including agricultural water allocations, municipal conservation measures, reservoir operations and storage planning, hydropower generation, and environmental flow management. The two lowest April 1 snowpacks in 2015 (5% of average) and 2026 (19% of average) illustrate different ways extreme conditions can develop in a warming climate. In 2015, the state received very little precipitation, and the few warm storms that occurred produced minimal snow. In contrast, in 2026 both precipitation and snowpack were near normal through mid-February. However, a warm storm at the end of February followed by a record hot and dry March caused rapid early melting, leaving only 19 percent of average snowpack on April 1. Together, these cases underscore the **need for improved forecasting and monitoring, as well as flexible water management strategies that can adapt to the diverse ways that extreme conditions can develop**.

Figure 5.1.



As extreme climate events intensify, sustained funding and science-based decision-making are essential to advance climate preparedness and resilience.

5.2 Science-Driven Decision-Making and Partnerships

Increasingly complex emergency response challenges — stemming from more intense and frequent extreme climate events— require strong partnerships, continuous monitoring of weather and water conditions, robust scientific information, and sustained funding (Figure 5.1). A central component to emergency response is providing sufficient lead time to detect a hazard, identify probable risks, inform local responders, and deploy resources where they are needed. Partnerships and investments in science and technology support evolving needs in emergency response to expected increases in flood, drought, and wildfire frequency and severity.

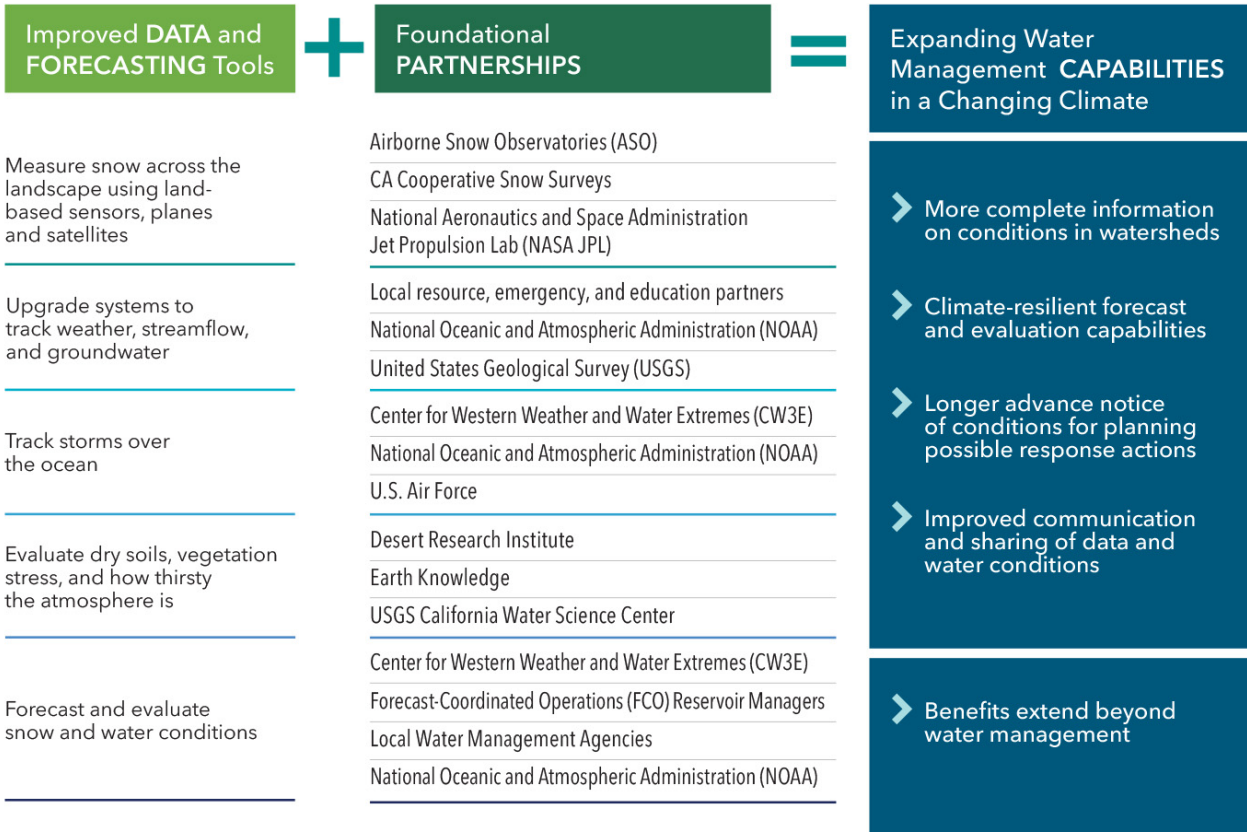
5.2.1 Roadmap for the Climate-Resilient Forecast Framework

Accurate observations and forecasts of weather and hydrologic conditions are essential for preparing for and responding to public emergencies. Collaborating with science research partners, DWR has developed a Roadmap for a Climate Resilient Forecasting Framework to adapt to changing conditions. Key partnerships for data and forecast improvement are shown in Figure 5.2.

The foundation for the Roadmap started with over a decade of partnership building between the DWR-led California Cooperative Snow Surveys program and the research community, including the National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration, National Center for Atmospheric Research, United States Geological Survey, and the University of California (UC). The Roadmap focuses on two goals:

1. Shift from using statistical forecasting tools at individual locations to using advanced tools that provide forecasts over the entire watershed based on climate processes including precipitation, snow accumulation, and snow melt.
2. Create a decision-support dashboard that generates graphics that connect observations and forecasts for a range of time horizons including high-resolution near-term forecasts, standard weather forecasts, two- to six-week subseasonal to seasonal outlooks, and water year outlooks.

Figure 5.2.



Enhancing Water Management Through Strategic Partnerships Focused on Data and Forecast Improvements

Snow accumulation monitoring and seasonal snow melt runoff contribute to forecast uncertainty for managing both floods and water supply. DWR instrument modernization and partnerships with Airborne Snow Observatories, Inc. (ASO) (described in the next section), and the research community, including CW3E at UC San Diego and UC Berkeley's Central Sierra Snow Lab are providing better data and physical process models for forecasting. The DWR Snowtrax website tracks advancements in snowpack monitoring and forecasting.

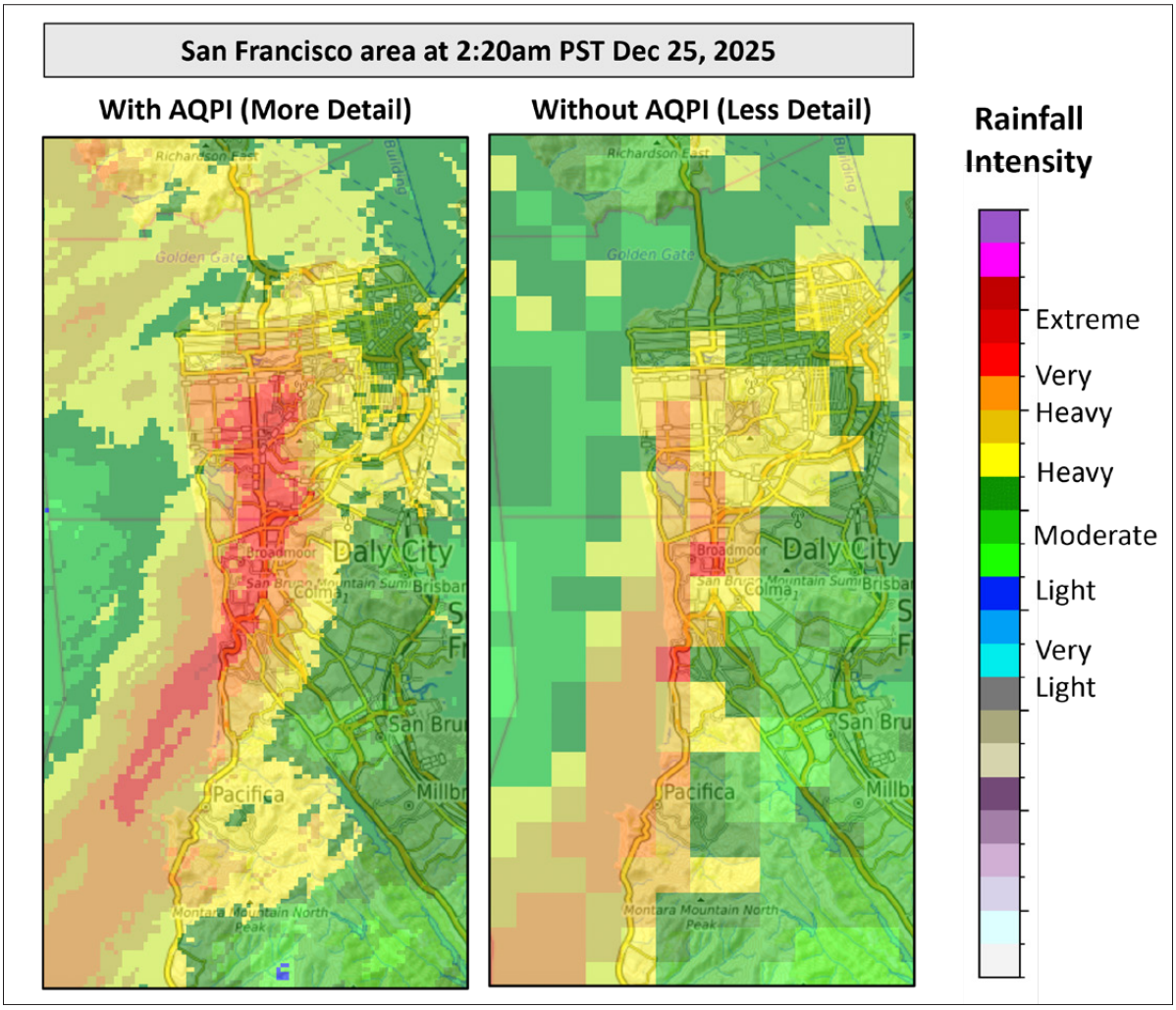
The Advanced Quantitative Precipitation Information (AQPI) project is a real-world pilot application of emerging weather observation technologies built on strong nearly decade long partnerships between:

- Agencies and utility partners from 10 San Francisco Bay Area counties,
- CA Department of Water Resources,
- NOAA's Physical Sciences Laboratory,
- Center for Western Weather and Water Extremes (CW3E) at UC San Diego/ Scripps Institution of Oceanography, and

- Cooperative Institute for Research in the Atmosphere at Colorado State University.

AQPI seeks to provide more detailed real-time precipitation information by augmenting national weather radar information with smaller high-resolution gap-filling radar. The AQPI User Dashboard pairs the high-resolution precipitation observations from AQPI with advanced weather forecasts to **provide local partners with timely and accurate customized precipitation forecasts that support decision-making and response planning with lead times of 1-10 days** (Figure 5.3).

Figure 5.3.



Advanced Quantitative Precipitation Information (AQPI) augments existing radar data. In this example for a storm impacting the Bay Area on December 24-25, 2025, the left panel shows more detailed AQPI mosaic radar while the right panel shows less detailed NEXRAD-only data without AQPI.

Image credit: Center for Western Weather and Water Extremes (CW3E)

DWR helps fund the Atmospheric River Reconnaissance (AR Recon) program, led by CW3E and includes partnerships with multiple government agencies. AR Recon involves aircraft flights over the Pacific Ocean that release weather sensors into storms to capture meteorological data including temperature, relative humidity, and wind. Ocean surface sensors that drift with the currents are also deployed to capture surface conditions in the northern Pacific Ocean. The data collected improves forecasts and advances scientific research. During Water Year 2025, 52 flights from Hawaii, Japan, and California dropped approximately 1,400 weather sensors into AR storms.

DWR has worked with the USGS and more recently a public-private partnership with Earth Knowledge to develop a watershed assessment platform based on the Basin Characterization Model which provides detailed spatial information across California on drought stress to vegetation and associated fire risk, an assessment of how much moisture the atmosphere can pull from the earth's surface, and identifies areas where flood diversion for recharge enhancement can benefit managed aquifer recharge efforts during periods of heavy rain and runoff. The Basin Characterization Model supports DWR's Basin Characterization Program (described in Chapter 4), water supply forecasting, and drought monitoring. The partnership has extended to other State agencies including the Governor's Office of Emergency Services.

5.2.2 Science Advancements and Partnerships Helped Manage the 2023 Storms

After three years of record-setting drought, 2023 pivoted from extremely dry to extremely wet conditions, bringing record flooding and a massive snowpack to the parched state. **For the first time, State of Emergency executive orders for flood and drought were in effect concurrently** (Figure 5.1). Extreme impacts included areas with dry wells caused by drought suddenly experiencing overflowing rivers; snowfall in typically snow-free areas, such as Napa and around Los Angeles; and the reemergence of Tulare Lake for the first time since 1997.

Nine Atmospheric River storms (ARs) produced an estimated 31 trillion gallons of water over a three-week period (December 26, 2022, to January 17, 2023), equivalent to a statewide average of more than 11 inches of rainfall, which led to widespread flooding and mudslides. Mountain snowpack grew, and on February 1, 2023, the amount of water stored in the snowpack was 212% of average, the highest since 1969. Seven additional ARs starting in late February brought significant precipitation to California, especially in the Central Coast and Southern Sierra, with Central California receiving more than 200% of normal levels. Cold temperatures of 9 degrees Fahrenheit below normal in March caused much of the precipitation to fall as snow, accumulating a snowpack similar to record snowpacks in 1952, 1969, and 1983 (Hydrometeorology Report Water Year 2023) (DWR 2024c).

The long-standing partnership between National Weather Service's California Nevada River Forecasting Center and DWR is invaluable to assessing flood risk for communities statewide and for triggering warning systems and emergency response activities. During the flood emergencies, DWR's decade-long Atmospheric River Research and Operations Partnership with CW3E provided new tools to augment National Weather Service forecasts. These include the AR Landfall and AR Scale Forecast tools that provided additional information on the timing, frequency of storms (pace), and intensity and geographic extent (scale) of the storms. **This improved forecast information increased the lead time for emergency response statewide to stage resources earlier and more strategically.** For example, detailed information and increased lead time helped swift water rescue teams plan and position rescue operations, which saved lives.

DWR's partnership with ***Airborne Snow Observatories (ASO)*** provided improved information for forecasting and managing the large spring snowmelt and runoff. Several snow survey flights throughout the spring provided detailed mapping of the snowpack including the amount of water contained in the snow, the spatial coverage and depth of snow, and other snow characteristics (Figure 5.4). The combination of traditional ground-based snow surveys and innovative aerial and remote-sensed survey techniques provided input to advanced tools resulting in improved forecasts of snowmelt and runoff. The runoff forecasts were then used to manage reservoir operations for flood control and water supply.

Figure 5.4.



Airborne snow observations of snowpack support water supply planning and emergency response during flooding and provide important data for tracking effects of climate change.

Photo credit: Airborne Snow Observatories

Because the storms and flooding occurred while California was entrenched in a multi-year drought, emergency response teams managed flood and drought simultaneously by diverting floodwaters onto available lands for groundwater recharge. This diversion reduced the amount of floodwater in rivers and added water to depleted groundwater basins. It is estimated that **4.1-million acre-feet of floodwater diversions** statewide were used to increase water supply through MAR. This achievement serves as an example of flexible water management that will become increasingly important in a warmer climate with more extreme wet and dry weather conditions.

5.2.3 Building Resilience to More Extreme Drought

During the next 20 years, California could lose 10% of its water supplies because of increased temperatures that lead to reduced snowfall, less spring runoff, and a thirstier atmosphere, plants, and soils (California Natural Resources Agency 2022). Adapting to expected increases in drought severity and duration driven by climate change requires planning, tracking of conditions, and providing support when drought conditions develop.

California's Water Supply Strategy: Adapting to a Hotter, Drier Future outlines goals to develop new water supplies, increase surface and groundwater storage, reduce water demand, and improve forecasting and data. The DRIP Collaborative (discussed in Chapter 3) brings water managers and communities together to support proactive pre-drought planning and post-drought emergency response. Several resiliency actions enhance water storage in wetter times for use in drier times including FIRO to manage reservoir storage based on weather forecasts and Flood-MAR to use excess flood flows to recharge groundwater. The State Water Project Adaptation Strategy and the San Joaquin Basin Flood-MAR Watershed Studies (DWR 2025) (both discussed in Chapter 4) indicate that combining both FIRO and MAR could lead to enhanced benefits over implementing the strategies separately.

DWR collects and consolidates hydrologic and atmospheric observations to determine the extent and magnitude of drought. Websites help communicate current conditions to water managers and the public. The California Water Watch has statewide summaries of hydrologic conditions, and Groundwater Live helps visualize current groundwater conditions.

In response to the 2020–2022 drought emergency, additional resources have been allocated to develop more scientific understanding and clearer technical communication of drought science, current conditions, and risks. Informative resources, such as the Water Shortage Vulnerability Tool, were developed for analysis of small water systems, and domestic wells that serve under-resourced, vulnerable, and disadvantaged communities. Dry well reporting is an online resource to track local wells that no longer supply water.

During the height of the 2022 drought, DWR launched the Land*Flex* Program to build climate resilience by pairing technical assistance with financial incentives that compensated farmers for reducing groundwater pumping to protect vulnerable community drinking water wells and permanently reduce unsustainable groundwater use, while supporting transitions to more climate-resilient agricultural practices. The program was implemented in partnership with local Groundwater Sustainability Agencies (GSAs), with technical assistance provided by the California Alliance with

Family Farmers, Self-Help Enterprises, Western United Dairies, the Almond Alliance, and the California Department of Food and Agriculture, helping design the program and provide implementation support to GSAs and participating growers.

5.2.4 Supporting Post-Wildfire Recovery

DWR's experience in flood and drought emergency management can be used to assist and lead in other disaster situations, such as the winter 2025 Los Angeles County post-fire watershed protection effort. DWR worked closely with the California Office of Emergency Services, Caltrans, the California Conservation Corp, Los Angeles County, and other State, local, and federal partners to assist with fire and watershed mitigation work in local communities. DWR managers and staff joined the vast team of volunteers to install hundreds of thousands of feet of protective materials safeguard the downstream storm drainage system from the pending contaminated runoff resulting from 37,000 burned acres and more than 15,000 burned structures (Figure 5.5).

Figure 5.5.



Watershed Protection Specialists Vanessa Velasco (left) and Francisco Pineda (right) aid with determining placement of watershed protection materials where the Eaton Fire burned in Los Angeles County. Photos taken January 28, 2025 (right) and February 7, 2025 (left).

Photo Credit: Ken James / California Department of Water Resources

5.3 Challenges and Opportunities

A warming world is expected to amplify extremes and increase the chance for "weather whiplash": rapid shifts from one weather extreme to the other and potentially longer droughts and more intense floods driven by climate change. These extremes threaten lives, infrastructure, groundwater sustainability, and ecosystems.

Planning, preparation, and practice continually drive advancements in emergency management capacity and capability. Training emergency responders based on both past experiences and scenarios of magnified extremes backed by science (see Incorporating Climate Data into Emergency Planning and Exercises – A Primer for Emergency Management Practitioners and Data Developers) will help emergency managers recognize potential new extremes and be ready for amplified impacts and consequences ready for amplified impacts and consequences utilizing data and tools like the ARkStorm 2.0 Scenario Explorer (Desert Research Institute 2024). Challenges remain in maintaining the communication and coordination needed for success while identifying the resources needed to sustain collaboration. Partnerships enable the opportunity for emergency management to keep pace with the changes created by a warming world. The science and partnership advancements enable stronger relationships across agencies and sectors resulting in benefit to all Californians.

In a nutshell

- Make a friend before you need a friend. Building ongoing relationships in regions and watersheds benefits collaborative planning, preparation, and implementation of resources management actions before, during, and after emergencies.
- Investment in observation and forecast technology buys increased warning and response time during emergencies.
- Flood and drought emergencies are expected to increase in frequency and severity, and they can also occur at the same time.

6 Looking Forward

Expecting and embracing change is foundational to DWR's history and a tenet of its future. Building capacity for integrated climate resilience at DWR has occurred simultaneously with changing physical conditions, ecology, and social expectations. This evolution includes shifting policy priorities and definitions that guide water management. To anticipate and respond to these changes, DWR has drawn on its investments in a climate and science-minded workforce and diverse science partnerships (discussed in Chapter 2).

Evolutions in policy and science have and will continue to warrant greater integration, interconnectedness, and a new frontier of solution spaces (DWR Strategic Plan, Goal 5). As highlighted, SGMA (signed into law in 2014) expanded DWR's responsibilities to include oversight and ongoing assistance to local entities for groundwater sustainability planning (discussed in Chapter 3). Scientific advancement in modeling future climate change conditions and scenarios have driven innovations in integrated water management solutions such as Flood-MAR, watershed resilience networks, and FIRO (discussed in Chapters 4 and 5).

Two themes emerge as lessons learned from DWR's approach to science and partnership, (1) **sustained investments in science and climate resources build organizational and community readiness for climate resilience**, and (2) **partnerships drive innovation and collective preparedness**.

6.1 Sustained Investments Meet Future Needs

Sustained investments in science are essential for science-driven decision-making to capably address future challenges. Investments in climate change professionals with interdisciplinary skill sets and an aptitude for translating science are recognized as foundational for preparing for and adapting to climate change (Andrew 2015). DWR has invested strongly in a diverse science-driven workforce; the department established the Modeling & Analysis group in 1985 (currently the Modeling Support Office), Environmental Services Branch in 1992, and Climate Change Program in 2009. These investments enable ongoing collection and sharing of high-quality water and environmental data, capacity to model climate change impacts on California's water system, and embrace emerging technologies (e.g., machine learning, remote sensing, and eDNA). Integrating technical expertise across DWR's organization supports statewide cross-sector planning for flood management in the Central Valley (Central Valley Flood Protection Plan 2022, DWR 2022b), assessments of water supply reliability from the SWP (Delivery Capability Report for the State Water Project), and informing local actions for Sustainable Management of California's Groundwater.

6.2 Partnerships Drive Innovations

Science advances creatively and innovatively through diverse partnerships. DWR is committed to promoting opportunities for transdisciplinary science partnership and co-production of research (DWR Strategic Plan, Goal 1, Objective 2, Action 2; discussed in Chapter 1). This commitment builds climate readiness and the capacity to anticipate and prepare for change (discussed in Chapter 2). For example, partnerships will continue to drive innovation in water and environmental data collection. Collecting high-quality and continuous data involves substantial investment that enables measuring and quantifying the success of programs and projects. Additional partnerships and innovations will be needed to leverage high-quality, continuous monitoring efforts with modeling, machine learning, and other artificial intelligence technologies that can help cost-effectively and accurately upscale efforts across water management areas.

DWR leverages emerging technologies to turn real-time and historical water data into forward-looking adaptive strategies. By improving data quality and accessibility, feeding it into predictive and scenario-based climate models, and integrating live sensor inputs, DWR can better prepare for droughts, floods, and shifting demands (discussed in Chapters 1, 4, and 5). This approach allows for more adaptive water management operations and the ability to test management decisions before acting, supporting proactive and resilient actions to a changing climate.

6.3 Evolving for the Future

With changes in federal research funding priorities becoming increasingly uncertain, California's government agencies, including DWR, have an urgent responsibility to safeguard the state's future by continuing to invest in climate adaptation and mitigation research. As the world's fourth-largest economy facing increased droughts, wildfires, and sea level rise, California cannot afford delays in developing the data, tools, and strategies needed to effectively protect its communities, infrastructure, and natural resources. Proactive, targeted, and sustained State funding ensures research continuity, fosters innovation, and accelerates the translation of science into actionable policy. Strategic investment today delivers resilience, economic stability, and long-term cost savings for California in the face of mounting climate threats.

Now is the time to ready our institutions, partner across areas of responsibility and elevate opportunities for resilience. This includes embracing new ways of doing science, developing policies, increasing organizational capacity, and thinking about the environment (Norgaard et al. 2021). It includes engagement in open and actionable science collaboratives for science-based decision-making expected in this era of climate change (Colombano et al. 2025). Institutions need the capacity and acumen to contribute and support their partners amid shifts in funding landscapes,

social changes, and accelerations in technology that impact opportunities for science-driven decision-making. This report offers an example of one State agency's approach to build capacity for climate resilience and science-driven decision-making as a culture, practice, and resource for partners.

Sustained investments in science and partnerships are quintessential to DWR's climate readiness, a commitment that continues to evolve to support its partners and the communities it serves. Its capabilities are bolstered through the diversity of its partnerships, and its decisions are strengthened by its investments in partnered scientific advancements. Keeping an astute eye on the horizon, **DWR invites partnership with others to strengthen readiness across communities, sectors, and industries. Anticipating continuous change, shared investments in science, community partnerships, and collaboration across sectors invite a new frontier of climate readiness and collective capacity to adapt into the future**.

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