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Publication Date

2018-04-01

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ISSUE BRIEF

CALIFORNIA'S STREAM FLOW MONITORING SYSTEM IS ESSENTIAL FOR WATER DECISION MAKING

April 2018

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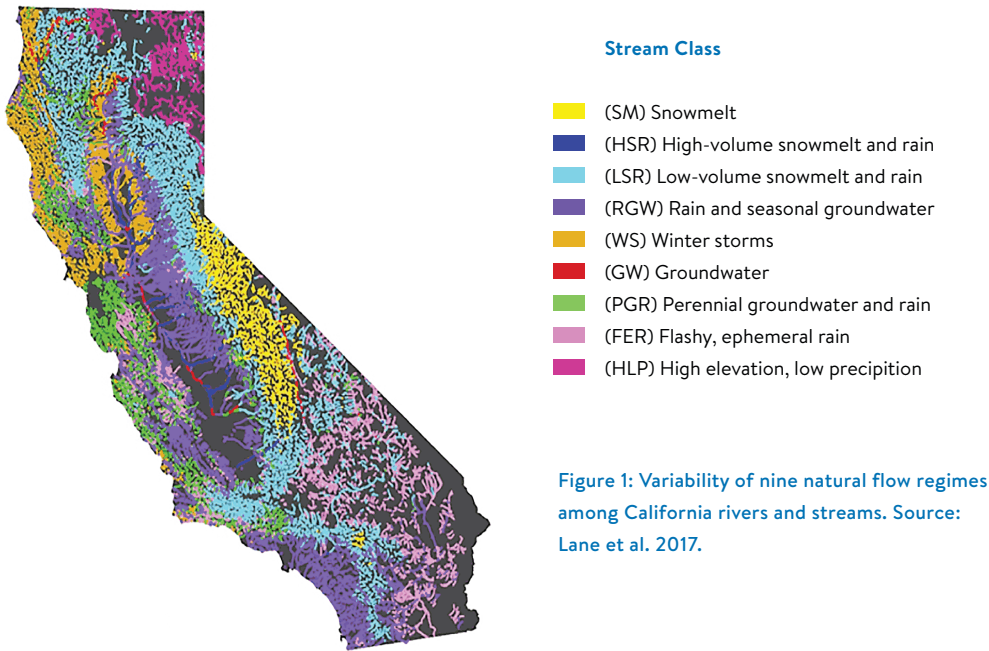
STREAM FLOW DATA TRACK THE PULSE OF CALIFORNIA'S WATERWAYS

With California's drought risk, flood risk, and demand for water all increasing, effective monitoring is more important than ever to water decision making. Stream gages monitor the most basic vital sign of California's waterways—stream flow.¹ Stream flow data support day-to-day decisions about how to manage water and operate water infrastructure. In turn, those decisions have important implications for flood control and the water supplies upon which residential, industrial, agricultural, and environmental water users depend. Stream flow information also provides technical insights into basin hydrology, and those insights aid long-term water planning. As pressures on the state's water systems intensify, the need for accurate and timely stream flow information will continue to grow. Opportunities for better water management created by groundbreaking legislation such as the Sustainable Groundwater Management Act (SGMA), the Open and Transparent Water Data Act, and Proposition 1 will be severely limited without an effective network of continuous stream gaging.

CALIFORNIA'S CURRENT STREAM FLOW MONITORING IS INADEQUATE

California experiences dramatic variations in precipitation and streamflow from stream to stream (Figure 1) and from one year to the next. This variability—and longer-term changes in climate, demand for water, land use, and land cover—makes trends in water availability difficult to predict. Ongoing monitoring is essential.

Today, the vast majority of California's waterways lack adequate monitoring.² Stream flow monitoring generally relies on stream gages. A stream gage typically measures water height, which is used to calculate flow rate. Alarming, the number of stream gages in use continues to decrease as funding dwindles and gages are decommissioned. This is a tremendous loss because water managers need long-term flow records to make accurate forecasts and to understand the likely repercussions of their day-to-day management decisions. Records lasting several decades or longer are especially valuable. Where monitoring is insufficient, scientists and decision makers must rely on crude estimates that do not accurately represent actual hydrological conditions. At best, this results in inefficiencies in an overtaxed water system. At worst, it could lead to inaccurate calculations that lead to poor decisions or otherwise harm human and environmental health.



MONITORING IS ESSENTIAL FOR TODAY'S WATER DECISIONS AND FOR LONG-TERM WATER PLANNING

Water managers at the local, state, and federal levels all rely on stream flow data, whether directly or indirectly, to inform their decision making (see Table). Insufficient stream monitoring hampers these essential functions. Improving the spatial coverage, timeliness, and accuracy of stream gaging data will enable more accurate and effective near-term decisions while empowering more robust long-term water planning. Some of the ways water managers use stream flow information are described below.

Seven Ways Water Managers Use Stream Flow Information

1	Allocating water during drought
2	Predicting floods and managing floodplains
3	Managing dams and reservoirs
4	Protecting California's ecosystems and species
5	Implementing and overseeing water rights
6	Monitoring groundwater-surface water interactions for SGMA compliance
7	Revising water management plans to meet changing conditions

1. Allocating water during drought

Assessing the amounts, locations, and timing of available water requires accurate stream flow data. State decisions related to water rights must be timely, accurate, and transparent. This need is even more acute during droughts. During past droughts, the State Water Resources Control Board (SWRCB) has sometimes notified water users that an upcoming shortage appears likely or that it thinks no water is currently available for their use. However, droughts do not affect every basin the same way, and drought conditions can occur in some parts of the state, while not in others. For maximum efficiency, and to reflect the requirements of water law, water allocation decisions often must be tailored to each area that is affected by these decisions. Accurate stream gage data helps decision makers customize their management decisions to accurately reflect conditions in each particular basin.

2. Predicting floods and managing floodplains

Stream flow data help water managers forecast flood conditions, providing early warnings of increased flows due to rainfall runoff and snow melt. These early warnings can give state and local agencies a critical head start in determining how best to operate flood control infrastructure to avoid disaster, to identify when and where life-saving evacuations of low-lying areas may be needed, and to allocate emergency resources most effectively. On a longer time horizon, insights gleaned from analysis of stream flow data can inform land use and infrastructure decisions that reduce the likelihood of flooding, steer development away from flood-prone areas, and reduce the negative impacts of flooding when it occurs.

3. Managing dams and reservoirs

Dam operators need to track the volume and timing of flows into a reservoir, the quality and volume of stored water, and the volume, timing, and quality of flows downstream of the reservoir. This information feeds into decisions about when to release or store water to serve flood control, water supply, and environmental purposes. Further, stream flow information helps to inform infrastructure design to prevent both costly over- and under-design.³

4. Protecting California's ecosystems and species

Stream flow data may prevent conflicts among water users tasked with meeting instream flow requirements to protect fish and wildlife, while at the same time allow them to utilize their water rights for beneficial purposes. During frost events, for example, growers in the Russian River Valley divert water for frost protection for their valuable crops while keeping an eye on streamflow data for meeting minimum streamflow requirements. Similarly, throughout the Sacramento basin, the California Department of Fish and Wildlife collects fish abundance data and streamflow data. In combination, these data help researchers understand how ecosystem and individual species respond to instream flows.

5. Implementing and overseeing water rights

Using water in California requires a water right (or a contractual relationship with someone who has one), and the SWRCB is responsible for deciding whether to grant permits for new surface water rights. A new surface water right is not available if all the water in a watershed is already spoken for, such that proposed diversion would harm existing water rights or unreasonably impact fish and wildlife. Making those determinations often requires streamflow data. For example, to determine whether it is appropriate to permit a new water right, the SWRCB uses long-term streamflow data to understand whether and under what conditions water will be available to support the proposed use.

Additionally, improved stream flow data would allow state agencies to identify illegal diverters more quickly, and to make a clearer case against them. Illegal diversions, such as unpermitted diversions for marijuana operations or out-of-priority diversions during droughts, can harm those who have and appropriately use their water rights. Illegal diversions can also cause permanent or temporary damage to aquatic ecosystems. With adequate streamflow data, the SWRCB can verify reported water diversions, estimate return flows, and calculate water supply and demand with sufficient accuracy and precision to support successful water right enforcement actions. This has sometimes been a challenge in the past.⁴ Without accurate and timely stream flow data, enforcement becomes difficult, if not impossible.

6. Monitoring groundwater-surface water interactions for SGMA compliance

Calculating the base flow that streams receive from groundwater is critical for water managers whose basins contain extensive groundwater-surface water connections.⁵ SGMA requires that groundwater managers avoid significant and unreasonable impacts to surface water uses.⁶ Improving stream flow data will help managers determine how their actions are impacting or could impact surface water and whether their groundwater sustainability plans will be successful. Additionally, much of the replenishment of California's groundwater basins comes from infiltration of stream water. Without adequate measurements of stream flow, agencies cannot construct the reliable groundwater budgets upon which many water management actions required by SGMA will be based.⁷

7. Revising water management plans to meet changing conditions

Clearer modeling of hydrological systems increases confidence in water management. Data from remote locations that would not have otherwise been reported can be captured and monitored year-round by stream flow measurement devices, filling in important information gaps. This information helps to create a more complete picture of California's waterways, instead of filling in the gaps with less accurate estimates. Over the long term, adequate stream flow data can help decision makers measure the impacts of climate change on the amount and timing of surface water runoff. This allows managers to adjust their water management plans to meet changing conditions in a timely way.

A NOTE ABOUT WATER QUALITY

While this document primarily focuses on monitoring stream flow quantity, it is important to note that gage sites can also often be used to measure water quality. Basic water quality data includes measurements such as water temperature and turbidity. Linking these water quality measurements with water flow allows better understanding of aquatic health. Water quality requirements for human and environmental uses drive many water operations decisions, and understanding stream flows and water quality are both crucial to informing these decisions.

KEY ACTIONS FOR IMPROVING STREAM FLOW MONITORING

California can strategically improve stream flow monitoring to fill critical gaps that impede effective water decision making. This will entail:

1. identifying what stream flow data would be especially useful for water decision making, with the help of decision makers and other stakeholders;
2. analyzing what changes to the current stream flow monitoring system would most cost-effectively address these needs (e.g., reactivating particular inactive stream gages, telemetering existing gages, installing new gages, exploring next-generation techniques and technologies); and
3. creating a viable long-term plan for reliably funding system improvements, system maintenance, and providing real-time public access to flow data.

Acknowledgements:

For further information, including author affiliations and additional material, please see law.berkeley.edu/stream-monitoring or doi.org/10.15779/J2864F. This work is supported by UC Water (www.ucwater.org) through University of California Office of the President (Grant No. 13941).

ENDNOTES

- 1 See Lane, B.A., et al. *Revealing the diversity of natural hydrologic regimes in California for environmental flows applications*. 53 J. American Water Resources Association 411-430 (2017). DOI: 10.1111/1752-1688.12504. Available at http://watermanagement.ucdavis.edu/files/2314/8652/1690/Lane_et_al_2017_Revealing_the_Diversity_of_Natural_Hydro_Regimes_in_CA.pdf, or <http://onlinelibrary.wiley.com/doi/10.1111/1752-1688.12504/abstract>.
- 2 For current gage distribution, status, and funding issues in California see THE NATURE CONSERVANCY, GAGE GAP (2018), available at <https://gagegap.codeformature.org/reports/California.pdf>. See also Matt Weiser, *Funding Woes for Stream Gages Put Crucial Water Data at Risk*, WATER DEEPLY, June 21, 2017, available at <https://www.newsdeeply.com/water/articles/2017/06/21/funding-woes-for-stream-gages-put-crucial-water-data-at-risk>.
- 3 USGS, *Uses of Streamflow Information*, (Feb. 2018), http://www.watereducation.org/sites/main/files/file-attachments/usgs_streamflowuses_gauges.pdf
- 4 See, e.g., SWRCB Order WR 2016-0015 (dismissing complaint alleging that irrigation district illegally diverted water due to prosecution team's failure to meet the appropriate burden of proof). Available at https://www.waterboards.ca.gov/waterrights/board_decisions/adopted_orders/orders/2016/wro2016_0015.pdf. See also Ryan Sabalow, *State moves to drop \$1.5 million fine in water rights case*, THE SACRAMENTO BEE, May 27, 2016, available at <http://www.sacbee.com/news/state/california/water-and-drought/article80413327.html>.
- 5 See A. CANTOR, ET AL., NAVIGATING GROUNDWATER-SURFACE WATER INTERACTIONS UNDER THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT, Center for Law, Energy & the Environment, UC Berkeley School of Law, (Mar. 2018), available at <https://doi.org/10.15779/J23P87> or law.berkeley.edu/gw-sw
- 6 CAL. WATER CODE § 10721(x)(6).
- 7 A water budget is an essential tool for characterizing a hydrologic system. A water budget attempts to account for water inputs (from surface runoff, return flows, and groundwater accretions) and outputs (diversions, losses to groundwater, and evapotranspiration) in a defined area, such as a groundwater basin. Groundwater budgets will be a crucial basis for decisions in many SGMA basins, and stream flow measurements are the lynchpin of these calculations. See A. ESCRIVA-BOU, ET AL., ACCOUNTING FOR CALIFORNIA'S WATER, Public Policy Institute of California (July 2016), available at <http://www.ppic.org/publication/accounting-for-californias-water/>.