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Building Climate Resilience through Integrative Community Stewardship and Long-term Hydro-biogeochemical Water Quality Monitoring

SARAH H HIRSCHEY[1], CATHY MUELLER[2], ED MCMURRAY[3], ELENA DELACY[2], TRAVIS BOHANNON[3], TAIXIN DONG[1], TATIANA DORRESTEIN[1], JENA BRASIL[2], SPENCER CORTWRIGHT[2], BRIEGAN AGUILAR[2], MICHELLE E NEWCOMER[4], ERICA R WOODBURN[4] AND JASQUELIN PEÑA[1]

[1]University of California Davis
[2]American River Conservancy
[3]Rancho Murieta Community Services District
[4]Lawrence Berkeley National Laboratory

Watershed monitoring after major disturbances, such as wildfire, presents challenges at each stage of the methodological pipeline. Meaningful insights into post-fire impacts require immediate, watershed-wide sampling followed by sustained monitoring. Campaign recruitment, safety constraints, and delayed funding often prevent rapid deployment. These limitations reduce temporal resolution and spatial coverage of emergency response studies, constraining our ability to characterize disturbance-driven hydro-biogeochemical change. Targeted science education and program development informed by stakeholder needs can build project capacity to navigate these challenges. Here, we present a framework that centers sustained community engagement and cross-disciplinary technical infrastructure as the foundation for dexterous program initiation and long-term campaign management.

Following the 2021 Caldor Fire in the Cosumnes River Watershed (California, USA), we developed a multi-partnership monitoring framework that integrated analytical and intellectual resources from academic (University of California, Davis) and research institutions (Lawrence Berkeley National Laboratory) alongside those from citizen scientist volunteers from the American River Conservancy (ARC) and local water utility operators from the Rancho Murieta Community Services District. Together with the U.S. Forest Service, this collaboration enabled immediate access to the watershed and field infrastructure that supported campaign deployment prior to containment.

Annual needs assessments allow the program to evolve and adapt alongside participant priorities, ensuring program health and longevity. These conversations yielded three course pathways that embedded students in the ARC monitoring campaign, streamflow measurement efforts, and data management protocol development. To date, 26 undergraduates and 114 citizen scientists have participated in the program, benefitting from intergenerational exchange while increasing sample collection capacity.

This multipronged model (1) produced a dataset with high spatiotemporal resolution that would be difficult to build through academic participation alone, (2) strengthened community climate resilience through regular engagement with the recovering watershed, and (3) supported program longevity and scientific career development. By aligning research needs, volunteer stewardship, and undergraduate training within a single framework, we developed a transferable model for sustained geochemical monitoring in disturbance-affected landscapes while strengthening public engagement in science. Such integrative strategies are increasingly critical as wildfire and climate extremes challenge environmental systems and the methodological infrastructure needed to study them.