The Water Report

Water Rights, Water Quality & Water Solutions in the West

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THE TIJUANA TRANSBOUNDARY POLLUTION PROBLEM

AN OVERVIEW AND RECOMMENDED DIPLOMATIC STRATEGY FOR A LASTING SOLUTION

by Brian McNeece, Co-Chair International Boundary Water Commission Citizen's Forum (San Diego, CA)

Brian McNeece was raised in El Centro in southeastern California along the Mexican border. As a young boy, he didn't realize that he lived in a desert, so thorough was the landscape around him transformed by water brought from the Colorado River. After a running a recycling center and a solar water heating business, he taught English at Imperial Valley College. Based on his studies of water he has produced two documentaries: "The Early History of Water in the Imperial Valley" and "Phil Swing and the Path to Hoover Dam." He is a co-chair of the International Boundary and Water Commission Citizen's Forum in San Diego and volunteers as a Trail Guide at Mission Trails Regional Park. Brian lives in La Mesa, California, with his wife Angela. They have three sons.

Summary

The ongoing problem in South Bay San Diego relating to cross-border pollution of the Tijuana River originating from Tijuana, Mexico, has a long and vexing history extending back to the 1930s. Over the decades, the issue has repeatedly risen and fallen in prominence. Complaints from the United States would lead to responses from Mexico that would create improvements, but efforts would soon be overwhelmed by the effects of rapid growth in Tijuana.

In 2024, the problem came to a head after 1,000 days in a row of beach closures and persistent, sickening odors. A groundswell of complaints and lobbying from the community and local politicians resulted in increased funding for the repair of infrastructure in the United States. Local, county, and national organizations also increased their efforts to monitor the health effects of the pollution coming from Tijuana. Moreover, community members clamored for the State of California and the United States to declare a state of emergency. Others sued Veolia, Inc., the operator of the International Wastewater Treatment Plant.

At the same time, diplomacy efforts between the US Environmental Protection Agency (EPA), the International Boundary and Water Commission (IBWC), and the government of Mexico resulted in continued progress on the projects listed in Minute 328 of the 1944 Water Treaty. IBWC's International Wastewater Treatment Plant (IWTP) is now in compliance with its permit. Funding for the repairs and expansion of the IWTP have been secured and a design/build plan is underway. Mexico's new wastewater treatment plant at San Antonio de los Buenos, 10 kilometers south of the border, is finished and undergoing testing.

Despite this good news, household sewage and industrial waste continue to flow across the border in the Tijuana River during dry weather, ranging from 5 million to 20

Forest Fires

MEGAFIRE RESILIENCE

BRIDGING FORESTS, WATER, AND UTILITIES

by Brandon Jirō Hayashi, Kirsten Hodgson, Tessa Maurer, and Phil Saksa, Blue Forest

Key Insights

- CATALYZING: Direct utility investment in cost-sharing partnerships with government agencies and private companies accelerates needed ecosystem restoration, secures sustained funding, and improves forest resilience and watershed health.
- ALIGNING: Landscape-scale forest treatments are one of the most cost-effective ways for utilities to reduce risk to assets, lower liability, and protect the provision of services to their customers, while also generating numerous co-benefits that can be leveraged for collaborative cost-sharing.
- BRIDGING: Strategic investments from utilities and private companies bridge critical funding gaps, enabling blended finance that can ease project cash flows, accelerate long-term funding commitments, and catalyze the scale of investment required for effective landscape-scale restoration projects.
- SCALING: The involvement of utilities is key to fostering the collaboration needed among project partners to achieve long-term, sustainably managed forests and landscapes at watershed scale (100,000+ acres).

Introduction

Challenges

Water is a cornerstone of healthy societies and ecosystems, yet it is under increasing threat from land degradation, population growth, and the growing frequency of extreme weather events. Shifts in precipitation patterns, reductions in natural water storage, and rising water demands from humans and vegetation underscore the urgency of strategic water resource management.[1] At the same time, the risk of catastrophic wildfire is increasing, necessitating investment in protections for communities and utility infrastructure.[2] Addressing these challenges requires a holistic approach that recognizes the interconnectedness of forests, water supplies, and utility operations.

THE ROLE OF FORESTS IN WATER SUPPLY

Water & Forests

Forests play a vital role in regulating water availability and quality. In the conterminous United States, half of all surface water originates in forested areas, and 89% of public water suppliers rely on these forests for at least part of their supply. In the Western US, federally managed forests contribute 52% of the surface water supply.[3] These figures highlight the need for effective forest management to sustain water resources locally and downstream of where they originate.

Natural Infrastructure

Forests act as natural infrastructure for water systems. Vegetation facilitates water infiltration into the soil and mediates runoff, replenishing groundwater and stabilizing surface water flows.[4,5] These processes help limit the need to release water from reservoirs during high-flow events such as winter storms and spring snowmelt and help utilities ensure that water is available to customers when required. In the Western US, snowpack in forested areas serves as a natural reservoir, storing water during winter and gradually releasing it during the dry season.[1,6] This process extends the availability of water for human use, reducing the strain on utility systems and supporting the continued provision of water to customers. This gradual melting also reduces vegetation moisture stress, thus lowering wildfire risk.[7] Healthy forests also filter pollutants, reducing the nutrient load in streams and rivers and lowering water treatment costs for water utilities.[8]

Fire Impacts

Catastrophic fires decimate vegetation and degrade soil, creating long-term effects that cascade through the water cycle to utilities and customers.[9] For example, the loss of vegetation exposes snowpack to wind and solar radiation, accelerating melt rates and reducing water availability during the dry season, exacerbating drought, and increasing the strain on water and hydropower utilities.[7,10,11,12] Regrowth of shrubs and young trees—which typically require more water than mature trees—can also depress water availability for years to decades.[13,14] These impacts can threaten the ability of water utilities to provide uninterrupted water supply to customers.

Other water quality impacts following major fires can be equally or more difficult to manage. Contaminants such as black carbon, organic matter, and toxic debris from burned structures enter waterways, affecting utility infrastructure, public health, and aquatic ecosystems.[15] Utilities bear significant costs to mitigate these impacts and maintain continuity of service for communities.

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Healthy Soil

Erosion

Management

Human Impacts

Utility Risk

Infrastructure Hardening

THE ROLE OF FORESTS IN INFRASTRUCTURE PROTECTION

Forests also impact the reliability and function of utility infrastructure, since reservoirs, hydropower generation stations, and transmission lines in the Western US are often located near or within forests. In healthy forests, extensive interconnected networks of plant roots and fungal species help stabilize the soil and reduce erosion, preventing particulates and other debris from entering waterways and reservoirs.[4,16] Thus, the soil stabilization effect can help utilities avoid the costs associated with dredging, debris removal, and water treatment.

In the absence of healthy vegetation—for example, after a catastrophic wildfire—the sudden loss of living roots exposes and destabilizes soil, leading to excessive erosion that can damage utility infrastructure, reduce reservoir capacity, and increase nutrient load in the water supply.[17] Post-fire rain events can be especially harmful, triggering large-scale erosion events and landslides, which can cause significant damage to infrastructure and communities, including degrading water quality and increasing sedimentation behind dams.[18] These events strain the ability of utilities to provide reliable water and hydroelectric power to customers.

Forest conditions can also directly influence if and how utilities are impacted by wildfires, which pose a direct threat to built infrastructure such as transmission lines and buildings. A resilient forest will experience wildfires that are generally smaller, less intense, and easier to control.[19] This more moderate fire behavior gives firefighting crews the opportunity to protect vulnerable and important locations such as utility infrastructure, homes, and recreation sites. Without management, wildfires are more likely to be catastrophic and to damage locations of importance before firefighters can safely and effectively intervene.

The Growing Threat of Catastrophic Wildfires and The Utility Perspective

Despite their critical importance, forest ecosystems are increasingly vulnerable. Fire suppression policies over the past century, coupled with warming temperatures and severe droughts, have left forests overly dense and prone to severe wildfires.[20] Damaging fire patterns are also present in other Western US ecosystems such as shrublands and chaparral, where the frequency of wildfire has increased due to accidental ignitions through human activity and the prevalence of flammable, volatile, non-native species over drought- and fire-resilient native vegetation.[21] The risk of severe fire threatens these ecosystems and the plants and animals within them, as well as nearby human communities and the stability of critical resources such as water and energy.

Utilities face unique challenges associated with these elevated wildfire risks. The increasing size, frequency, and severity of wildfires poses an immediate danger to utility infrastructure, threatening service delivery. For example, in 2021 in Southern Oregon the lightning-caused Bootleg Fire damaged a critical Bonneville Power Administration (BPA) transmission line that transports hydroelectric power from the Pacific Northwest to California and the Southwest (https://www.opb.org/article/2021/07/11/southern-oregon-bootleg-fire-continues-to-grow/). BPA was forced to cut transmissions to 10% of normal capacity, leaving many of its customers without power and reducing BPA's income.

Utilities will also encounter significant financial and reputational risks if utility-ignited wildfires resist containment and impact communities, property, and water supply. Following the 2018 Camp Fire, the 2023 Lahaina Fire on Maui, and 2025's Hurst and Eaton Fires, utilities faced lawsuits. In the first two cases, the utilities were found responsible for damages from the fires.[22,23,24] For investor-owned utilities, such events can undermine the trust of regulators and shareholders, complicating efforts to secure rate approvals and attract equity and debt financing.

Common measures to protect utility infrastructure from wildfire and prevent ignitions—including infrastructure hardening and clearing vegetation from rights of way—are important tools for utilities managing wildfire risk, but they are also increasingly insufficient, as critical fire conditions occur more frequently and fire behaves more erratically (https://www.livescience.com/planet-earth/wildfires/wildfires-can-create-their-own-weather-including-tornado-like-fire-whirls-an-atmospheric-scientist-explains-how). The transmission lines affected by the Bootleg Fire, for instance, were themselves relatively well protected; however, smoke particles from the fire caused the lines to arc, prompting the shutdown. Similarly, no infrastructure hardening methods are 100% effective—not even the highly expensive process of burying electric lines. A holistic approach including infrastructure hardening as well as proactive forest management on the surrounding landscape can better reduce fire risk for utilities, communities, and natural resources. While completely eliminating the risk of ignition would be impossible, a holistic approach can decrease the size, rate of spread, and severity of fires that do ignite, significantly reducing the risks for utility infrastructure and communities.

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The Benefits of Proactive Management

Wildfires in the Western US are increasingly threatening water supply and infrastructure and, thus, financial stability, necessitating a search for more systemic approaches to wildfire management. Large-scale, proactive forest management can make a crucial difference to the behavior of fires by creating a landscape in which wildfires are more easily managed. In so doing, the social, economic, and ecological risks associated with uncontrolled wildfires are reduced.

Reducing Vegetation

Management plans are tailored to the specific ecology, natural history, and needs of a landscape. In the Western US, these plans frequently include a reduction in vegetation cover. Reduced vegetation cover decreases the fuel load within a landscape, which can often be hazardously high due to past fire suppression policies. Mechanical thinning and prescribed fire are both methods for reducing fire fuel. Proactive management can also include reconnecting upstream floodplains to degraded meadows that can act as fuel breaks, serve as habitat, and provide sanctuary to wildlife during fire events.[25,26] These practices create a mosaic of open spaces and dense tree stands, thus reducing the intensities of fires that do occur and restoring ecological balance. When forest density is lower and more varied, fires that do occur—whatever the cause—will typically spread more slowly and burn less intensely.[26]

Example

The Bootleg Fire exemplifies this behavior. Areas in the fire footprint that had previously been thinned and subjected to prescribed burns were notably less impacted than surrounding, untreated areas (*see* Figure 1). Tree mortality decreased when the wildfire encountered a patch previously treated with thinning and prescribed fire. This change in fire dynamics provides firefighting crews with critical opportunities to control these fires, which can in turn preserve equipment and personnel resources and minimize damage to lives, properties, and ecosystems.

Figure 1. Bootleg Fire on the Fremont-Winema National Forest. Photo credit: Steve Rondeau, Natural Resources Director of the Klamath Tribes. (https://www.deschutesriver.org/in-the-media/lessons-from-disaster-what-the-bootleg-fire-reveals-about-forest-management)

Benefits

The benefits of enhanced resilience through management extend to communities, ecosystems, utilities, and beyond. For communities, management may mean fewer disruptions from wildfires and enhanced water security. For ecosystems, it preserves biodiversity and reduces the stress on aquatic species that depend on cool, clean water. For utilities, it reduces the costs associated with sediment removal, water treatment, and infrastructure repairs, while also stabilizing financial and operational risks.

Costs

The costs for utilities to implement forest restoration are typically lower than the costs of hardening infrastructure to protect it from wildfire and extreme weather, and forest restoration reduces fire risk across the landscape, not just within the treatment footprint. One study of the Lake Tahoe Basin found that investing approximately $8.5 million in landscape-scale fuel reduction and prescribed fire treatments could deliver a benefit-to-cost ratio of more than 500:1. Using conservative estimates of property value, these treatments would reduce total property assets at risk from extreme wildfire by 78%—from $5.568 billion to $1.196 billion.[27] Another study within California's Sierra Nevada mountain range showed that

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treating 20% of a landscape could reduce burn probability in the event of a fire by 50% across the entire landscape and by up to 76% within the treatment areas.[28] With a conservative treatment cost estimate of $2,700 per hectare (ha)[27], an investment of approximately $20 million to treat about 40,000ha can halve the 30-year burn probability in the event of a fire from 31% to 16.5%. By comparison, public estimates given by Pacific Gas & Electric Company (PG&E) suggest that this investment would be equivalent to the cost of burying ten miles of distribution lines, which is only about 0.01% of all PG&E's network (https://www.instituteforenergyresearch.org/the-grid/pge-to-bury-transmission-lines-at-cost-of-2-million-per-mile/). Therefore, investments in forest management, and the corresponding reductions in the intensity and frequency of wildfires, can translate into real avoided costs for utilities and downstream communities.

Restoration

However, forest restoration treatments yield multiple benefits over time that extend beyond the reduction of wildfire risk. Seeking these benefits helps to mitigate the severest of consequences for utilities, ecosystems, and communities, and it highlights the need to look beyond ignition risk alone. While preventing ignition is essential, utilities also gain significant value from efforts that reduce consequence risk—such as enhancing landscape resilience and protecting critical infrastructure—ensuring that when wildfires do occur, their impacts are less destructive, less costly, and less disruptive.[29] The various benefits arising from such enhancements—for example, water quality protection, public health benefits of reduced exposure to smoke, and protection of recreation areas, combined with the ecological benefits of healthy forests—provide good incentives for many entities to contribute to restoration projects. Wider participation will yield significant value while reducing the amount paid per entity.

Collaborative Solutions: The Forest Resilience Bond

Finance Model

Recognizing the complexity of these challenges, organizations such as Blue Forest (the authors of this article) have developed innovative financial mechanisms, for example, the Forest Resilience Bond (FRB)) (https://www.blueforest.org/finance/forest-resilience-bond/). The FRB is a conservation finance model specifically designed to add new revenue streams to fund forest restoration, increase cost-sharing, and finance upfront project costs. The FRB views the entirety of a watershed, and the critical services that it provides, as natural infrastructure. Using an adapted infrastructure finance model that can be extended to natural areas, watersheds can accelerate climate resilience and economically benefit ratepayers and communities. This is akin to how finance models have enabled communities to thrive with built infrastructure.

Private Capital

The FRB works by attracting private capital to finance forest management activities. By bringing together public and private stakeholders, the FRB aligns resources and expertise to address wildfire risks and protect water supplies. Utilities, which benefit directly from reduced wildfire risk and improved water quality, play a critical role as stakeholders in these projects.

MOVING FORWARD TOGETHER

Resource Managers

The complexity of wildfire and water resource management requires a collaborative approach. Utilities, governments, land managers, and communities must work together to implement scalable solutions. The FRB exemplifies how such collaboration can empower utilities and communities to become active stewards of their natural infrastructure, by aligning diverse interests to achieve common goals. By investing in forest restoration, utilities are not only protecting their infrastructure, operations, and customers but they are also contributing to broader societal and environmental resilience. Structures like the FRB also enable utilities and other private entities to more easily contribute to the management and resilience of land that they do not own or manage but that is critical to their operations and the well-being of their communities.

Policymakers

Policymakers have a role to play in creating supportive frameworks that enable utilities to engage in proactive forest management, including revising regulations that limit the ability of utilities to invest in natural infrastructure as capital expenditures and fostering partnerships between the private and public sectors.

Public

Public awareness is also critical. Educating communities about the role that forests play in water and wildfire management can build support for restoration projects and create momentum for change. Transparent communications from utilities about their efforts and challenges can foster trust and strengthen relationships with customers and stakeholders.

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BLUE FOREST AND THE FOREST RESILIENCE BOND TOOL

Blue Forest is a conservation finance nonprofit that advances ecosystem restoration through scientific research, financial innovation, and collaborative partnerships. In the ten years since its founding in 2015, Blue Forest has been building and deploying innovative financial tools to address issues of ecological and climate resilience in the Western US.

Diverse Funding Sources

A major focus of Blue Forest's work is bringing together partners in the public and private sectors to make up funding shortfalls in forest restoration work. From the federal government side, the 2022 Wildfire Crisis Strategy—developed by the US Department of Agriculture Forest Service—set out a goal of treating 50 million acres across federal and non-federal lands within a decade (https://www.fs.usda.gov/sites/default/files/fs_media/fs_document/Confronting-the-Wildfire-Crisis.pdf). However, in a nation where the National Forest System alone contains more than 63 million acres of land at high or very high risk of wildfire, even recent historic government investment in forest restoration and fire management efforts does not meet the need (https://www.energy.senate.gov/services/files/AAF7DF40-2A47-4951-ADA4-4B124AD3894F). Diverse funding sources are necessary to accomplish the needed scale of restoration.

Valuing Ecosystem Benefits

Upfront Payments

Blue Forest's flagship financial tool—the FRB—was created to address these challenges and support forest restoration for ecological resilience and fire risk reduction. The FRB is a public-private partnership that uses private capital to ease cash flow constraints. The model leverages the valuation of ecosystem service benefits to enable multiple groups to share the costs of forest restoration. Blue Forest works with impact-oriented investors to provide the full cost of a forest restoration project up front to partners who are implementing the work on the ground. This enables these partners to work more efficiently—for example, by completing all necessary treatments in a given location in one season—and have the confidence that they can repay contractors on shorter timelines rather than waiting for reimbursement through traditional grants. Ultimately, this means that work can be completed more quickly and at lower overall costs. Simultaneously, Blue Forest works with other organizations who benefit from the forest restoration work being completed, such as private companies, local governments, and utilities. These organizations agree to repay some of the cost of the restoration work over time, contributing additional funds to projects and making possible the upfront financing of investor capital. By securing commitments from many sources to share in the cost, funding gaps can be closed and financing can be secured to implement landscape-scale restoration.

The First Forest Resilience Bond: Yuba I FRB

Blue Forest's first Forest Resilience Bond, the Yuba I FRB, is located in the North Yuba River watershed northwest of Lake Tahoe, in California's Sierra Nevada. The North Yuba River watershed is a 313,000-acre area encompassing the stretch of river from the Sierra crest downhill to New Bullards Bar Reservoir (https://www.yubaforest.org/). Approximately two-thirds of the watershed comprises National Forest System land. The ecosystems of the North Yuba River watershed are highly biodiverse and ecologically significant, providing both habitat for plant and animal species and downstream benefits to communities. The area is an important source of water in California, and it is also popular for recreation and home to several communities.

Large Fires

As in many parts of the Western US, the ecosystems of the Yuba River watershed are densely vegetated, and they lack fuel breaks. Consequently, they are at risk of severe impacts from disturbance such as drought, insect infestation, and fire. In recent years, nearby watersheds have experienced catastrophic wildfires resulting from the same conditions present in the North Yuba River watershed. The 2014 King Fire in the American River Basin just south of the North Yuba River watershed burned nearly 100,000 acres (https://www.fire.ca.gov/incidents/2014/9/13/king-fire). In 2020, the North Complex Fire, the deadliest California wildfire that year, burned within five miles of the Yuba I FRB treatment area to the north. It burned 318,935 acres—an area slightly larger than the entire North Yuba River watershed. It is now the eighth-largest wildfire in California's history. The following year, the Caldor Fire burned more than 220,000 acres in the Eldorado National Forest, just one forest unit south of the Tahoe National Forest, which covers the North Yuba River watershed (https://www.fs.usda.gov/about-agency/features/caldor-fire-defending-lake-tahoe-basin). Although it was only the third-largest wildfire of the 2021 season, the Caldor fire nevertheless damaged a large swath of forest in addition to threatening communities, causing the evacuation of more than 53,000 people, destroying more than 1,000 structures, and negatively impacting crucial tourism revenue.

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BUILDING THE YUBA I FRB

Given the condition of the forest and the elevated fire risk, the North Yuba River watershed was a fitting location for the first-ever FRB. The Yuba I FRB was launched in 2018. It financed work across a 15,000-acre footprint on the Tahoe National Forest. Located in the upper headwaters of the watershed, the work covered by Yuba I FRB consisted of a variety of ecological resilience treatments. In addition to reducing the fire risk, the project generated benefits such as enhanced water supply, protected water quality, and improved biodiversity.

Pilot FRB

Blue Forest worked with the Sierra Nevada Conservancy and the Forest Service to determine potential locations to pilot and test the FRB mechanism. Those discussions led, ultimately, to the Tahoe National Forest and the Yuba Project, an already planned and permitted forest restoration project. The project included fuel reduction to reduce wildfire risk, invasive plant removal, meadow restoration, and aspen regeneration—but it had not yet secured a source of funding to implement the work. The Tahoe National Forest was working with the National Forest Foundation (NFF) to secure partial funding for the project through a CalFire grant, and both organizations quickly joined as development partners for this FRB. The Tahoe National Forest was already working with the NFF to secure partial funding for the project through a CalFire grant. Both organizations quickly joined Blue Forest and World Resources Institute to form the development team for this FRB. The project's location within the footprint of the North Yuba River watershed meant that the landscapes to be treated by the project were part of the primary source of water for the New Bullards Bar Reservoir. The reservoir has a water storage capacity of 969,000 acre-feet and the capacity to produce 417 MW of hydropower annually. It is owned by Yuba Water, a utility that manages flood protection for downstream communities and provides agricultural water supply to the California Central Valley (https://www.yubawater.org/152/Hydropower-Facilities).

Priorities

Blue Forest worked closely with Yuba Water to understand the risks of wildfire in the utility's source watershed and the potential environmental, economic, and social benefits that would result from forest restoration work. Yuba Water expressed concern about the pattern of severe wildfires adjacent to their watershed and the threat that a similar wildfire within their watershed would pose for the safety and security of their communities and the natural resources they relied on. The FRB development team was invited by a board member of Yuba Water to present to the utility's board. The board approved a motion in 2017 to have their staff explore the feasibility of implementing a Forest Resilience Bond.

Risks

During conversations with Yuba Water staff, operations personnel, and hydrology technical experts, the team discussed the risks that wildfire posed to Yuba Water and the opportunities to secure a more resilient water supply. Concurrently, Yuba Water staff were also managing a Federal Energy Regulatory Commission (FERC) relicensing application. This concurrence galvanized conversations around utility systems and operations that were well timed with respect to FRB exploration, but they limited Yuba Water staff's time, compelling the partners to work efficiently and productively.

The development partners spent months learning about Yuba Water's system, working together with Yuba Water's staff, the Sierra Nevada Research Institute at University of California Merced, the Natural Capital Project at Stanford University, and the World Resources Institute to estimate plausible wildfire, water quality, and streamflow impacts, as well as the associated economic costs resulting from likely wildfire events. Prior to the collaboration, Blue Forest and its partners had assumed that post-fire sedimentation would be the primary concern for Yuba Water. However, the bigger concern—representing the more significant potential cost—was woody debris interfering with reservoir operations and potentially clogging up the spillway. Ten-year storm events carry woody debris into the reservoir in volumes that can require millions of dollars to clear. The development team considered how this cost would increase if a large fire were to precede such a storm and how the risk of such a scenario could be reduced by leveraging forest treatment to reduce the probability of a severe fire. In addition to the protection of the forest to retain snowpack and protect the water supply, avoiding the possibility of flooding after a severe fire was a key motivation for Yuba Water to support the partners' environmental and economic valuation efforts. The open dialogue between partners was critical for quickly identifying the risks of greatest importance to Yuba Water, highlighting the fact that a project is strengthened by a truly collaborative approach to the valuation of benefits.

Economic Valuation

The restoration work planned for the Yuba Project cost $4.5 million, but by working collaboratively with utility staff, the development team arrived at a total economic benefit of $8.7 million from reduced wildfire risk and a more secure water supply. This estimate did not include explicit modeling of woody debris, public health exposure to wildfire smoke, or other impacts to infrastructure such as housing and roads; therefore, it represents a conservative estimate of the economic benefits of forest restoration in the watershed. The partners presented these findings with a funding request to the Project Operation & Development sub-committee of the Yuba Water board, who approved a presentation to the full utility

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board for a decision. Yuba Water's board approved a 5-year $1.5 million commitment to match a $3 million California Department of Forestry and Fire Protection commitment to finance the project. Blue Forest worked closely with FRB development partners at the National Forest Foundation, who would oversee the implementation of the project.

With the board's approval, the first financed project—Yuba I FRB—was launched in October 2018. In 2023, the project was completed after just five years—in half the time projected by Forest Service partners absent an FRB.

The Yuba I FRB supported nearly 3,000 acres of treatments, protecting more than 8,000 acres within the 15,000-acre planning area. Work on this project also protected 27,601 acre-feet of source water supply and sustained 72 jobs, among other benefits. This pilot FRB would not have been successful without the dedication and commitment of many partners in the development process. It helped bring together a group of organizations committed to expanding the scale of restoration work in the North Yuba River watershed, and its successful completion highlights the accomplishments that are possible through strategic partnerships focused on a shared goal of landscape-scale restoration for environmental resilience.

IMPACTS OF THE YUBA I FRB

The launch of the Yuba I FRB demonstrated that partnerships between distinct but interconnected organizations to achieve the mutual goal of forest restoration and resilience can lead to achievable outcomes and opportunities for scale. Galvanized by their success, the group of partners involved in the Yuba I FRB launched the North Yuba Forest Partnership (NYFP) in 2019 (https://www.yubaforest.org/). The NYFP is an ongoing, formal partnership of nine federal, Tribal, state, and local government agencies and nonprofits focused on forest restoration across public and private lands in the entire watershed. Through ecologically based thinning, prescribed fire, and other forest treatments, the NYFP aims to protect communities in Yuba and Sierra counties from wildfires and safeguard wildlife as well as the waterways that nourish the North Yuba River and fill the New Bullards Bar Reservoir. The NYFP takes a holistic, science-based approach to forest restoration, following the modeled impacts of restoration for fire risk reduction, water supply protection, and community safety to guide treatments. The NYFP also aims to achieve economic sustainability by creating a local economy centered around removing and utilizing the wood and biomass that is created by forest treatment but left on the landscape after restoration without a viable plan for removal. The agencies and organizations involved are developing sawmills capable of processing small-dimension logs and a biomass facility that generates renewable electricity using wood chips. The proposed facility, the Camptonville Biomass Plant, will have the capacity to process 40,000 tons of woody material per year and will be fueled by the electricity produced from forest biowaste (https://www.yubawater.org/257/Camptonville-Biomass-Plant). There are also plans to include workforce development programs to teach students forestry-related skills, thus using the goal of achieving wildfire resilience to generate jobs in one of California's poorest regions.

In 2021, the NYFP launched the Yuba II FRB, a scaled-up FRB that finances more than 28,000 acres of treatment to protect nearly 48,000 acres of forest within the watershed (https://youtu.be/Gx7kbhjwMxY?si=nLhHeqPrCP7g8YQ8). The Yuba II FRB represents the next phase in landscape-scale work on the Yuba River watershed. It supports treatment activities such as thinning, prescribed burning, hardwood regeneration, invasive species removal, and other forms of ecological restoration. The Yuba II treatment areas have been incorporated as a subset of the North Yuba Landscape Resilience Project (NYLRP)) (https://www.fs.usda.gov/project/?project=59693). The NYLRP is spread over nine strategically prioritized areas and will focus on wildfire risk reduction to protect communities and infrastructure. Additional benefits include enhanced water supply, protected water quality, protected habitat for sensitive species, and protection of New Bullards Bar Reservoir (providing flood protection and security of hydropower generation and water supply to eight agricultural irrigation districts).

Conclusion

The challenges posed by population growth, land degradation, and extreme weather demand innovative and collaborative solutions. Forests, or natural infrastructure, are central to addressing these challenges, because they provide critical services for water availability, wildfire mitigation, and ecosystem health. Utilities, with their unique role in society, are key partners in forest restoration efforts.

By investing in mechanisms such as the FRB and adopting a collaborative approach, utilities, governments, and communities can build a more resilient future. The path forward requires the breaking down of silos, aligning incentives, and recognizing the mutual interests of our forests, water resources, and communities. Together, stakeholders can protect vital resources, ensure sustainable water supplies, and mitigate the risks of catastrophic wildfires for generations to come.

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For Additional Information

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Brandon Jirõ Hayashi is the Director of Beneficiary Partnerships at Blue Forest. He works with utilities and other stakeholders to connect their needs with large-scale restoration projects and helps show how conservation finance can strategically address operational and regulatory challenges. Brandon brings cross-functional team members together to create practical solutions, secure lasting stewardship agreements, and improve partnership approaches that benefit utilities, ecosystems, and communities.

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WATER BRIEFS

VERTICLE LAND MOTION CA

NASA TRACKS SEA LEVEL

Tracking and predicting sea level rise involves more than measuring the height of our oceans: Land along coastlines also inches up and down in elevation. Using California as a case study, a NASA-led team has shown how seemingly modest vertical land motion could significantly impact local sea levels in coming decades.

By 2050, sea levels in California are expected to increase between 6 and 14.5 inches (15 and 37 centimeters) higher than year 2000 levels. Melting glaciers and ice sheets, as well as warming ocean water, are primarily driving the rise. As coastal communities develop adaptation strategies, they can also benefit from a better understanding of the land's role. The findings are being used in updated guidance for the state.

"In many parts of the world, like the reclaimed ground beneath San Francisco, the land is moving down faster than the sea itself is going up," said lead author Marin Govorcin, a remote sensing scientist at NASA's Jet Propulsion Laboratory (JPL) in Southern California. The new study illustrates how vertical land motion can be unpredictable in scale and speed; it results from both human-caused factors such as groundwater pumping and wastewater injection, as well as from natural ones like tectonic activity. The researchers showed how direct satellite observations can improve estimates of vertical land motion and relative sea level rise. Current models, which are based on tide gauge measurements, cannot cover every location and all the dynamic land motion at work within a given region.

Researchers from JPL and the National Oceanic and Atmospheric Administration (NOAA) used satellite radar to track more than a thousand miles of California coast rising and sinking in new detail. They pinpointed hot spots—including cities, beaches, and aquifers—at greater exposure to rising seas now and in coming decades.

To capture localized motion inch by inch from space, the team analyzed radar measurements made by ESA's (the European Space Agency's) Sentinel-1 satellites, as well as motion velocity data from ground-based receiving stations in the Global Navigation Satellite System. Researchers compared multiple observations of the same locations made between 2015 to 2023 using a processing technique called interferometric synthetic aperture radar.

Homing in on the San Francisco Bay Area—specifically, San Rafael, Corte Madera, Foster City, and Bay Farm Island—the team found the land subsiding at a steady rate of more than 0.4 inches (10 millimeters) per year due largely to sediment compaction. Accounting for this subsidence in the lowest-lying parts of these areas, local sea levels could rise more than 17 inches (45 centimeters) by 2050. That's more than double the regional estimate of 7.4 inches (19 centimeters) based solely on tide gauge projections.