# Integrating Compounding Hazard Frameworks with Community-Based Approaches to Address Wildfire-Water Risks in the American West

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## Background & Question

- Drinking water systems in fire-prone regions face a growing set of interconnected threats, including wildfire, drought, sedimentation, and treatment infrastructure failure.
- These risks interact across ecological, hydrological, and institutional systems, often **amplifying each other in unexpected ways**.
- Many current approaches to risk assessment continue to **isolate hazards** rather than understand them as **compounding, cascading, and systemic.**
- As wildfire regimes intensify under climate related stressors, there is an urgent need to **reframe how we assess and respond to drinking water vulnerabilities**—moving beyond single-hazard perspectives toward approaches that address multi-scalar, cross-sector complexity.

**How are landscape processes linked to infrastructure vulnerability in rural drinking water utilities in the Pacific Northwest?**

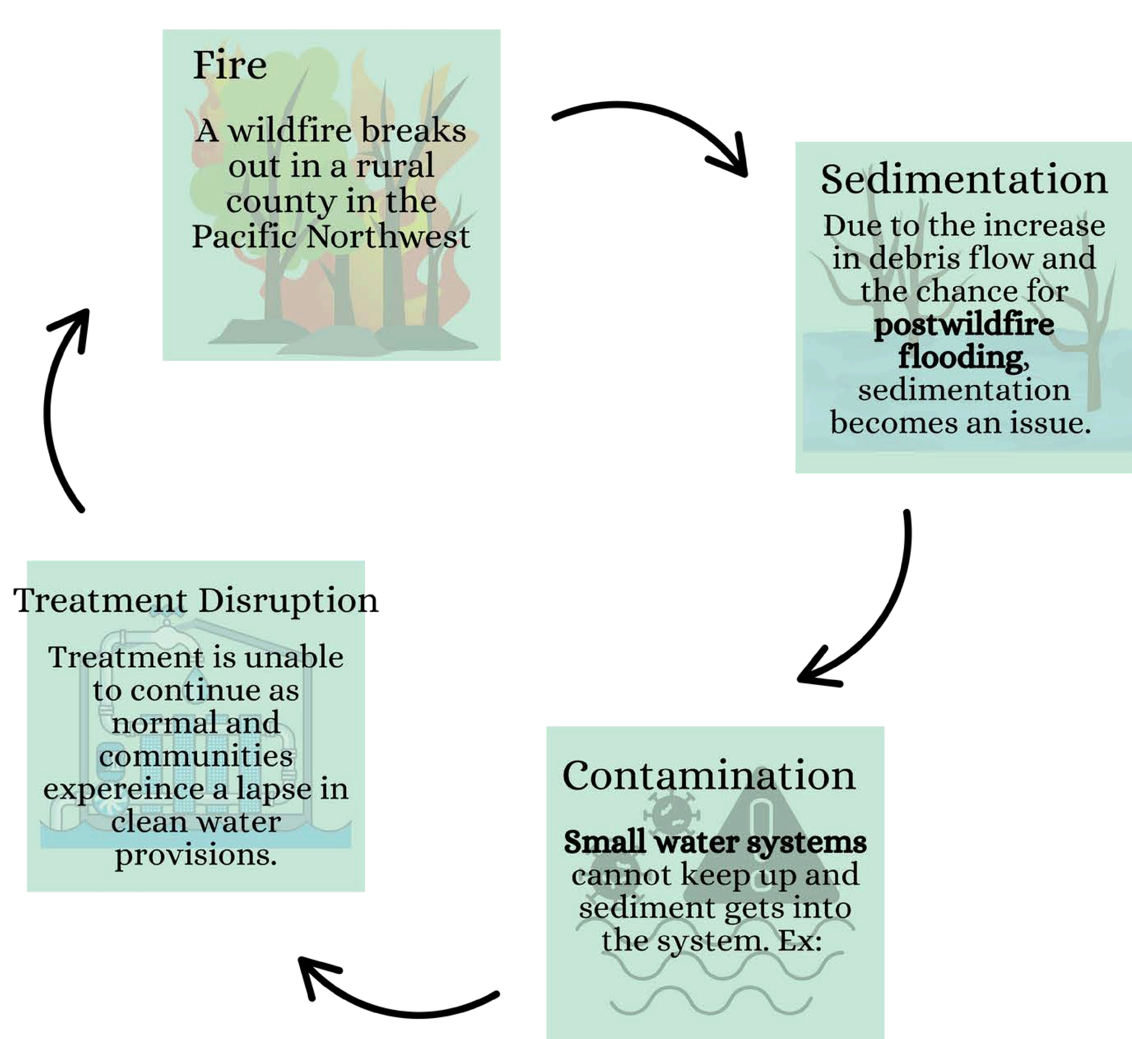
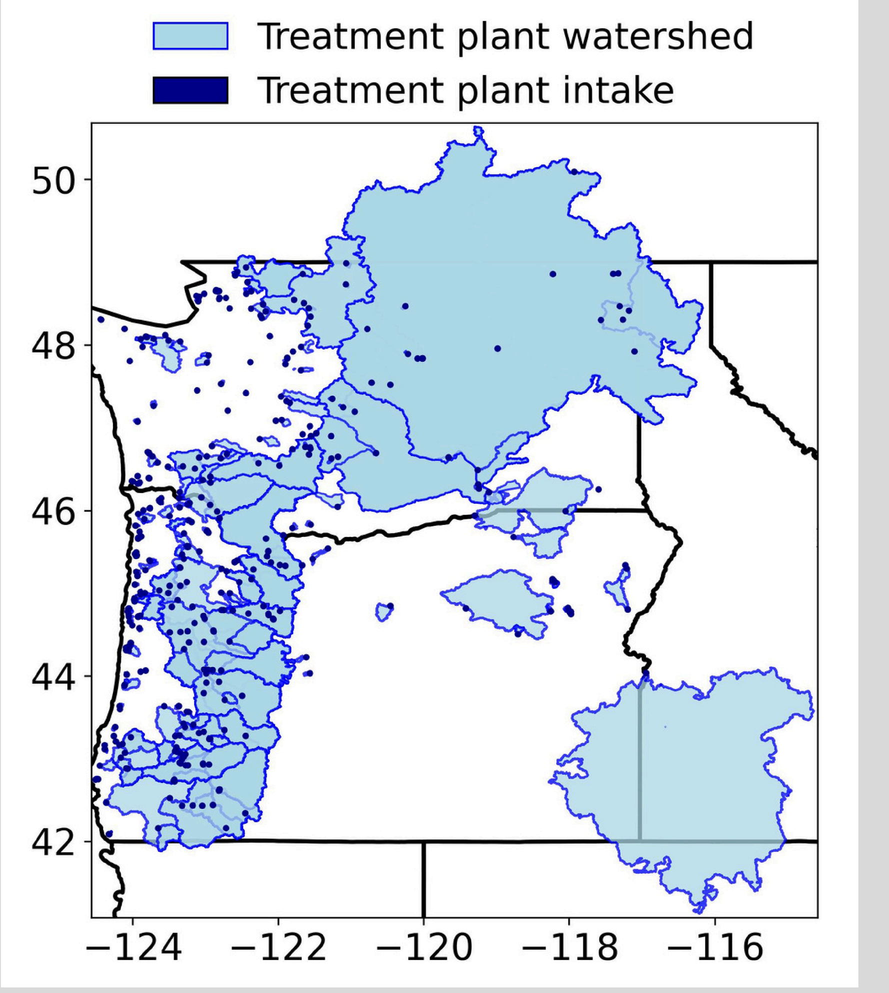


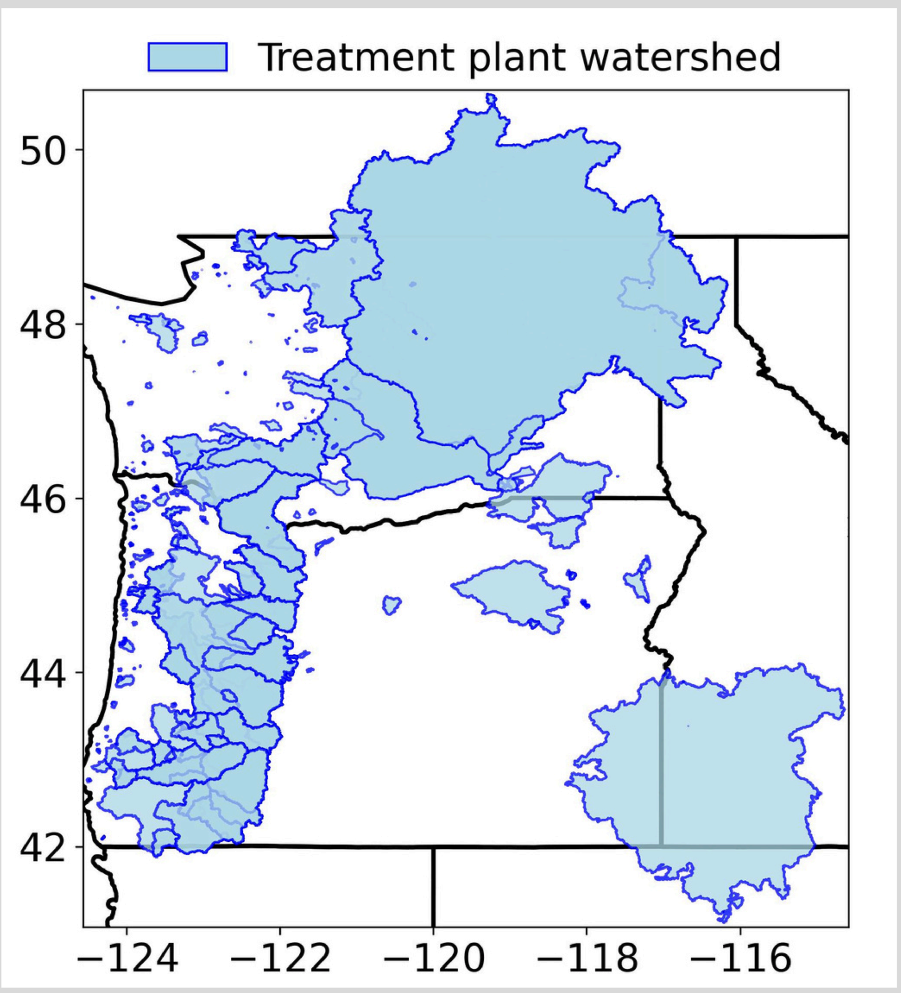

Figure 1. As wildfires become more prevalent in the West, disruptions to water treatment facilities become more common, especially in rural areas. Hazards begin cascading.

## Literature Review

- In the water sector, wildfire has traditionally been treated as a technical risk - addressed through infrastructure upgrades, land-use restrictions and watershed treatments. Framing often centers hydrological or engineering solutions within utilities conversations and overlooks broader socio-ecological contexts.
- Recent literature in disaster studies and environmental science center compounding hazards.
- A growing body of research is experimenting with participatory modeling, scenario planning, and community co-production in disaster risk reduction. These approaches aim to integrate hydrological and ecological expertise with the lived experiences of frontline communities.
- The literature increasingly points toward a need for epistemological inclusivity. Doing so requires methodological innovation and institutional flexibility. Rather than asking only *what is at risk*, scholars and practitioners are beginning to ask *who defines risk*, *who is involved in planning*, and *how justice is enacted through governance*.

## Study Area Map: Treatment Plant Watersheds in Oregon and Washington




## Scenes from the Field

*Clockwise from top left. (1) Falls Fire. (2) EWB Fielf trip with WWS team. (3) Timber Lake Wastewater Treatment Facility being hosed down as the Falls Fire burns. Estacada, OR. (4) Debris flow along the Clackamas River following the Falls Fire.*

## Integrative Research Framework

The evolving integrative research framework we propose is **designed to better address real-world vulnerabilities to environmental hazards** through a convergent science approach. Rather than being a fixed structure, this framework is **intentionally iterative and co-constructed**, drawing on diverse theories and principles from interdisciplinary environmental sciences, community hazards literature, Indigenous studies, and environmental justice scholarship. It weaves together several core elements - *ontological and epistemological grounding, trust building and relational accountability, team science and transidisciplinarity, and action-oriented, community-centered outcomes.* Using wildfire-driven landscape change and infrastructure vulnerability in rural water systems as a focal case, this framework integrates hydrological modeling, engineering analysis, and community-based knowledge in ways that foreground these commitments.

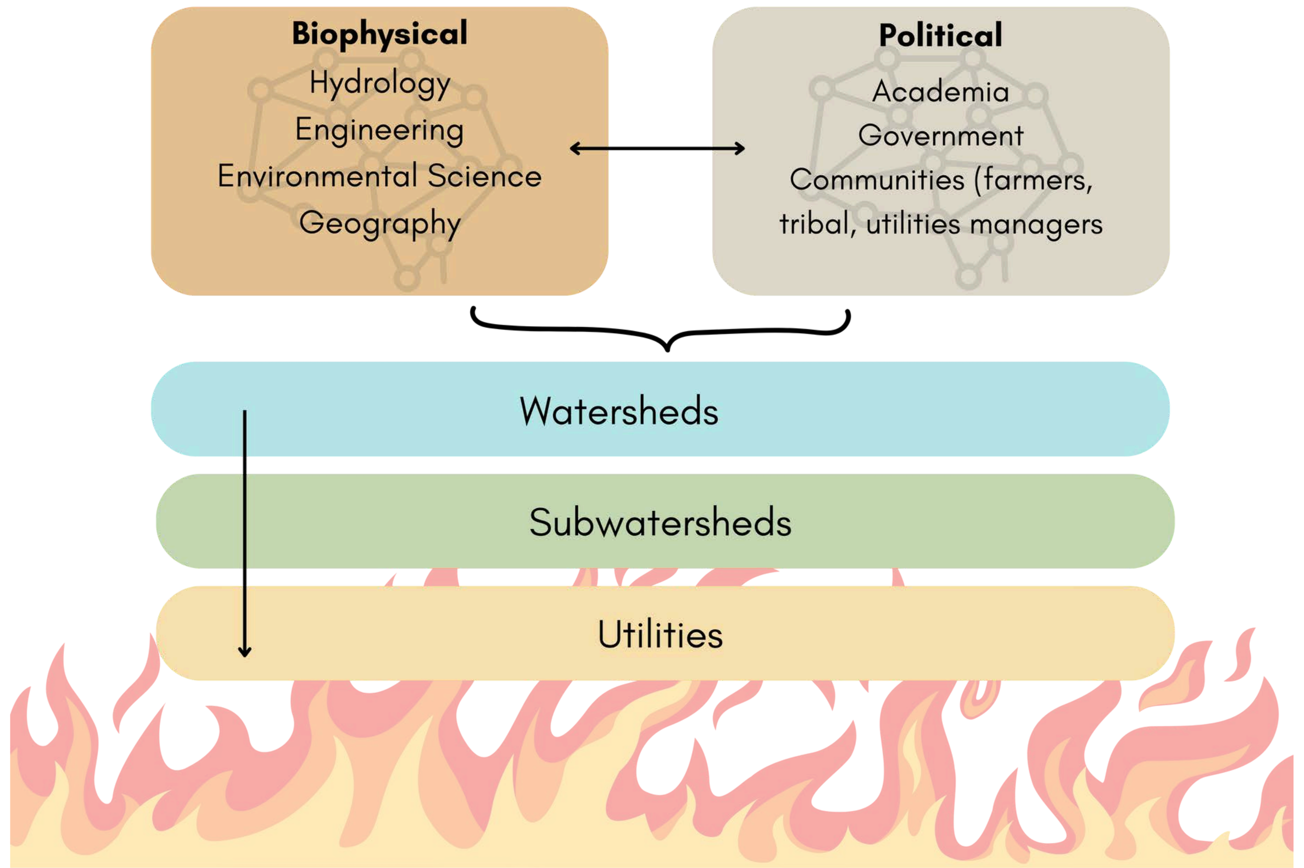



Figure 2. This integrative approach follows several concepts across multiple scales to co-develop actionable tools for wildfire-resilient water systems. The different biophysical components network with each other freely. The different participants interact politically across a variety of scales, whileboth the political and biophysical compenents also intereact with one another. Our watersheds break down all the way to utilites and all these intereaction are happening under the threat of wildfire.

## Preliminary Outcomes & Discussion

Wildfire as a landscape process - We need to think of wildfire not as an isolated hazard but as a landscape-transforming event that alters forest structure, soil chemistry, and watershed hydrology.

Impacts on rural water infrastructure - Rural drinking water utilities are often small, isolated, and rely on a single surface water source—typically a forested watershed. When wildfire impacts that watershed, these systems face: Increased sediment and organic load, Infrastructure exposure to debris flows or landslides and Source water uncertainty, especially if intake points are damaged or unusable. Because many rural utilities lack redundancy, staff, or resources, even moderate disruptions can lead to service failures.

Cascading risk as a major linkage point - The vulnerability of infrastructure is not static—it is activated by changing landscape conditions (e.g., after fire, a normal rain event becomes a flood risk). Utility resilience is tightly linked to what happens far upstream—and often outside the jurisdiction or planning reach of the utility itself.

Benefits of Interdisciplinary Insight -By integrating different fields, we can more readily identify where vulnerabilities exist, and how they might be mitigated through design, early warning, and adaptive management.