

# Fire Potential Modeling and its Impact in New Mexico

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## Introduction

Anticipated high-severity wildfires in northern New Mexico and southern Colorado, and subsequent post-fire flooding, pose enormous threats to the region's watersheds and downstream communities that depend on them for water supply.<sup>1</sup>

Throughout the past century, forest management has worked within the suppression paradigm, with the goal to extinguish a fire as quickly as possible. New Mexico's forests are well adapted to fire and many of their ecosystems are considered fire-dependent. Normal forest conditions would see frequent low-severity fires throughout the landscape that would burn and clear the understory brush of a forest but allow older growth trees to survive. With active fire suppression, the forests have grown denser with many layers that create ladder fuels. These ladder fuels result in a larger high-severity fires that cause more damage to the forests and watersheds than would low-severity fires.<sup>2</sup>

Forest thinning provides a benefit to water supply through a reduction in forest canopy coverage. Watershed resiliency will increase as the water supply and sedimentation rate increase and mitigating drought and flooding impacts occur.<sup>3</sup>

Fire-potential modeling developed by The Nature Conservancy's (TNC) New Mexico Chapter has guided forest and watershed treatments throughout the state, including in the Bureau of Reclamation's San Juan – Chama Project region in northern New Mexico and southern Colorado. This extended abstract discusses the modeling techniques utilized for this risk assessment, the implementation practices it has initiated, and the collaborative approach taken by agencies and partners to accomplish this work. This fire-potential modeling takes fuels data, topography, weather data and soil type into account when assessing fire risk. This modeling has helped TNC and their subsidiary project, the Rio Grande Water Fund (RGWF), establish four upland headwater priority areas that are critical to New Mexico's water supply. One of these priority areas is the Bureau of Reclamation's San Juan – Project's headwaters region. These four priority areas have been the subject of substantial forest and watershed restoration treatments

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<sup>1</sup> "Navajo Blanco Watersheds Resilience Strategy for the San Juan Chama Project Source Watersheds," Navajo-Blanco Working Group, [https://static1.squarespace.com/static/5a6d11100100277c343e6176/t/5b8580734fa51aaa9a33bb90/1535475901562/SJCP\\_Strategy\\_2017\\_03\\_13.pdf](https://static1.squarespace.com/static/5a6d11100100277c343e6176/t/5b8580734fa51aaa9a33bb90/1535475901562/SJCP_Strategy_2017_03_13.pdf), (March 2017).

<sup>2</sup> The Rio Grande Water Fund, <https://www.nature.org/en-us/about-us/where-we-work/united-states/new-mexico/stories-in-new-mexico/new-mexico-rio-grande-water-fund/>, (February 2019).

<sup>3</sup> Fire Learning Network, <https://www.conservationgateway.org/conservationpractices/firelandscapes/firelearningnetwork/pages/fire-learning-network.aspx>, (February 2019).

by various agencies and entities over the last four years, including tree thinning, mastication, prescribed fire, and riparian restoration. These techniques are utilized to offset the potential for catastrophic fire and its effects, a serious threat to New Mexico's water supply. Impressive collaborative effort has been involved in this work. The Rio Grande Water Fund has brought together almost 100 partners from federal, state, tribal and municipal agencies, non-governmental organizations, and businesses to collaborate on how to secure New Mexico's water future. As the major water management agency in the state, the Bureau of Reclamation is just one of many organizations involved in this effort. This abstract outlines the partnership between federal agencies and local initiatives, a relationship that has great potential benefit to increase the effectiveness of hydrological modeling and forecasting.

## **Background**

In New Mexico the forests in the San Juan River and Rio Chama Watersheds are the primary source of water for the state where snow is retained within the canopy until the spring melt. A forest's ability to adequately perform these storage functions depends on its overall health. High-severity fires greatly hinder this process, as they cause extensive watershed damage and create hydrophobic soils. Heavy rainfall after a fire can be severe and the resulting debris flows can be a dangerous and detrimental after-effect from high-intensity burns.

The San Juan – Chama Project and other watersheds impacted by these dangerous forest conditions are the key drivers for Reclamation's engagement with TNC's Rio Grande Water Fund. These watersheds are critical to Reclamation's mission of water delivery and TNC is pioneering the effort to protect them.

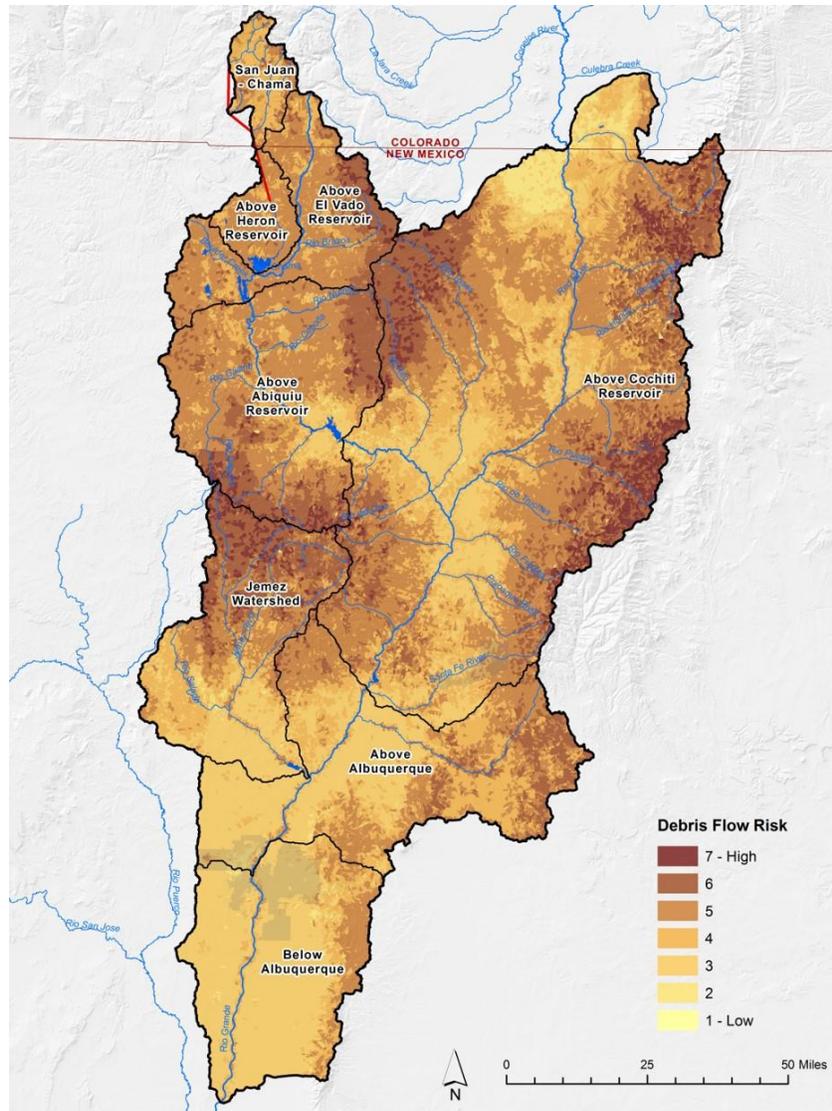
## **Modeling Techniques**

TNC worked with experts from the US Geological Society (USGS), USDA Forest Service (USFS), Rocky Mountain Research Station (RMRS) and RGWF Advisory Board members to develop a model that would aid in the identification of forested watersheds most at risk of catastrophic damage from high severity wildfire. Models including the FlamMap model from the USGS, the FSIM model from RMRS, and a debris flow model developed by the USGS Landslide Hazards Program. These models together estimated spatial variation in burn probability, fire severity, and debris flow hazard across the state of New Mexico and collectively present the debris flow threat in unburned, forested watersheds within the RGWF boundary.

Important layers incorporated in the models used include: topography (slope, aspect, elevation) from LANDFIRE, fuels data such as canopy cover, vegetation type and density from LANDFIRE, weather data from Remote Automatic Weather Stations (RAWS) and burn severity data from the Monitoring Trends in Burn Severity (MTBS) program. The FlamMap model produces outputs describing the spatial probability of crown fire. The USGS' post-fire debris flow model estimates the probability and volume of material resulting from post-fire debris flows. Finally, the FSIM model provides estimates of annual burn probability of the landscape. Combined outputs from these models depict areas at greatest risk of high severity wildfire and significant post-fire debris flow potential.

Figure 1 depicts a rapid assessment of burn probability coupled with probability of debris flow after a wildfire in the Rio Grande Water Fund region. This modeling was developed by TNC as

part of the Southwest Forest Assessment Project. Using layers of percent slope, burn severity, soil type and percent rainfall expected, the assessment classifies the overall fire risk within the RGWF footprint and allows for comparisons between landscapes and identification of focal areas like the San Juan-Chama Headwaters region.



**Figure 1.** Results of a rapid assessment of burn probability coupled with probability of debris flow after a wildfire in the Rio Grande Water Fund region. (RGWF).

## Implementation Practices

### Overview

Various forest treatments, including thinning, mastication, and prescribed fire, have been completed throughout the RGWF’s four focus areas in New Mexico and more are planned. Recent work in the San Juan – Chama Project region has included thinning and forest treatments in critical, yet accessible, terrain. RGWF funding has allowed for more than 300

acres of treatments on private land in southern Colorado and northern New Mexico. Attention was paid to areas that were deemed accessible and in critical need of treatment, with further emphasis given to access roads where critical infrastructure lies.

## Treatment Types

There are a variety of treatment practices happening all over New Mexico that have been guided by the RGWF's wildfire and debris flow potential modeling. Below is an overview of some (but not all) of the methods used. Treatment can be an effective tool to protect critical water supplies and ensure water quality.<sup>4</sup>

**Thinning:** Thinning reduces stand density and remove fuels from the forest. Generally, forest thinning involves strategically zeroing out smaller diameter woods from forests to clear the understory of forests and allow for regrowth of grasses. Larger trees can be removed as well.<sup>5</sup>

**Mastication:** Like thinning, mastication removes fuels from the forest. This technique essentially mulches the forest. Vegetation is reduced into small chunks either mechanically or manually. Small trees, brush, and slash is ground, chipped, and broken apart to reduce ladder fuels to prevent crown fire spread in the event of a fire.<sup>6</sup>

**Prescribed Fires:** Across the American West, historic natural fire regimes have been disturbed in the past century due to active fire suppression. Many western forested ecosystems, including the Pecos River Basin headwaters region, are considered to be “fire-dependent,” meaning they rely on fire as an agent to keep them healthy. Trees are stressed by overcrowding. Historically, fire has been the natural tool to reduce the spread of insect pests and disease, remove non-native species, recycle nutrients back to the soil, and to provide forage for game.

According to the US Forest Service, “Prescribed fire is a planned fire used to meet management objectives.” Prescribed fires are planned and administered by fire-management specialists in order to reintroduce fire onto the landscape. Burn plans are written with extreme caution and awareness of climate, weather, and forest type. Often, prescribed fires will be executed on lands that have already undergone thinning or mastication treatment as fuel reduction has already taken place.<sup>7</sup>

**Managed Fire:** Managed fires are similar to prescribed fires and are used to clear the forest's overgrown understory while allowing older growth trees to remain. This increasingly-used tactic starts when a fire occurs naturally. Rather than suppressing the fire, the response agency (usually Forest Service or BLM) allows the fire to burn with active and attentive management. These types of fires are done with extreme sensitivity to the current climate, weather, and forest conditions. They are also well staffed with firefighter response teams to properly manage the fire. However, because managed fires are by nature more unpredictable than a prescribed fire, a range of fire severity can be seen in a managed fire footprint.<sup>8</sup>

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<sup>4</sup> Silvio Simonit, “The Impact of Forest Thinning on the Reliability of Water Supply in Central Arizona” PLoS ONE, (April 2015).

<sup>5</sup> Donna Childress, “Tree Thinning 101,” Woodland Magazine, Forest Foundation, (Fall 2014).

<sup>6</sup> “What is Forest Mastication?” Diversified Resources Inc. <https://www.driforest.com/what-is-forest-mastication/> (February 2019).

<sup>7</sup> “Wildland Fire: What is a Prescribed Fire?” National Park Service, <https://www.nps.gov/articles/what-is-a-prescribed-fire.htm>, (February 2017).

<sup>8</sup> Fire Use for Resource Benefit, United States Department of Agriculture Forest Service, [https://www.fs.usda.gov/detail/sequoia/home/?cid=fsbdev3\\_059508](https://www.fs.usda.gov/detail/sequoia/home/?cid=fsbdev3_059508), (February 2019).

## **Collaborative Approach**

Collaboration and coordination between stakeholder groups are critical for continued effective water supply protection projects in New Mexico. Below are two examples of innovative groups that are pioneering the effort in the state.

### **The Rio Grande Water Fund**

Founded in 2014, the Rio Grande Water Fund has established itself as a leader in forest and watershed protection in the state. The RGWF works by gathering key stakeholders throughout the state to raise and distribute money for forest and watershed treatment efforts in its four focus areas, including the San Juan – Chama Watershed area.<sup>9</sup>

This innovative approach to fundraising and project development engages stakeholders across the state in planning and implementing watershed protection measures. The Water Fund has more than 70 member organizations that have signed its charter document and is actively working to engage even more agencies and businesses.

Using this collaborative approach, the RGWF has treated 108,000 acres with thinning, controlled burns, and managed natural fires. There are currently 300,000 acres of land that are currently being planned for treatments. The RGWF is working progressively towards a goal of restoring 600,000 acres over a 30-year period. The Fund has accumulated \$4.55 million in private funding and has leveraged \$40 million in public funding.

The RGWF has been incredibly effective at engaging partners and honing in on critical regions within the upper Rio Grande watershed to help ensure that New Mexico's water future is secure.

### **The San Juan – Chama Watershed Partnership**

Also founded in 2014, the San Juan – Chama Watershed Partnership is a partnership of local, county, state, tribal, and federal agencies, non-government organizations, and local individuals that come together to support a watershed for a healthy ecosystem, a vibrant economy, and sustainable communities for the people who live and depend on this watershed. The Partnership's region is made up of the three sub-watershed basins that make up the San Juan - Chama Project: the Rio Blanco, the Navajo River, and the Little Navajo River in southern Colorado, and the entire Rio Chama watershed basin in northern New Mexico.<sup>10</sup>

The Partnership's members engage with the Water Fund and other entities in the area to further watershed protection efforts and to encourage collaboration to enable effective local cooperative decision-making. The Partnership's flagship event hosted every Spring, the Rio Chama Congreso, gathers stakeholders in the region for a day long forum that connects individuals, non-government organizations, and agencies with one another to discuss resource management challenges and solutions. In 2018, over 80 individuals attended the Rio Chama Congreso to discuss the nexus between wildfire and water in the region.

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<sup>9</sup> Rio Grande Water Fund, The Nature Conservancy, <https://www.nature.org/en-us/about-us/where-we-work/united-states/new-mexico/stories-in-new-mexico/new-mexico-rio-grande-water-fund/>, (February 2019).

<sup>10</sup> San Juan – Chama Watershed Partnership, <https://www.sanjuanchama.org/>, (February 2019).

## **Next Steps**

As outlined above, agencies and non-government entities alike have begun extensive work in New Mexico's critical watersheds. The RGWF is on track to have 100 signatories by 2020, the San Juan – Chama Watershed Partnership is becoming more active in their region, and there appears to be more fire mitigation collaboration efforts happening throughout the state.

Notably, 2019 New Mexico State Legislature passed the Forest and Watershed Restoration Act into law in March 2019. This act establishes a board that provides criteria to evaluate forest and watershed restoration projects and provides approved projects with funding from the New Mexico Irrigation Works Construction Fund and the Improvement of the Rio Grande Fund. This indicates that state leadership understands the challenges New Mexico faces with regards to water security and is prioritizing the treatment and restoration its critical watersheds.

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