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Resources for Postfire Response: Empowering Land Managers with New After Fire Toolkit

Today, land managers and scientists around the southwestern United States are faced with long-term risks following the unexpected movement of fire. While wildfires are a common and important part of natural ecosystem processes, wildfire can change soil and plant characteristics, altering the ability of soils to absorb water and the capacity of watersheds

to handle postfire precipitation. In the Southwest, fire season is often followed by intense summer thunderstorms. After a wildfire—particularly a severe one—heavy precipitation increases risk of severe runoff, flooding, erosion, and debris flows.

It's easy to see why this is a concern: The changes in hydrologic

cycles that accompany large and severe fires can affect water quantity and quality, interfere with reservoirs and infrastructure, threaten wildlife, reduce ecosystem function, destroy natural and cultural resources, and cause dangerous conditions such as flooding and debris flows. According to a 2009 Western Forestry Leadership Coalition report entitled *The True Cost of*



The Rocky Mountain Research Station's After Fire Toolkit contains resources that can be used to avoid debris flows such as occurred after the Schultz Fire in the Coconino National Forest in Arizona. (photo: A. Jaramillo-Scarborough, USDA Forest Service).

SUMMARY

To improve access and understanding of postfire resources, scientists with the Rocky Mountain Research Station and its partners have drawn on years of science/management collaboration to compile an online resource called the After Fire Toolkit and Information site. The After Fire Toolkit, which can be found at www.fs.usda.gov/rmrs/tools/after-fire-toolkit-southwest, came about following a 2014 science and land management workshop to identify and prioritize land managers' research needs for enhancing long-term resilience of ecological systems to wildfire. The Toolkit includes technical reports, assessments, case studies, articles, flow and erosion models, and information on methods for postfire mitigation, treatment effectiveness, rehabilitation, and restoration.

Wildfire in the Western U.S., it's been estimated that the full cost of wildfire—which includes direct fire-related casualties, natural resource and property losses, and longer-term losses due to flooding and erosion—can be 2 to 30 times greater than the cost of suppression alone.

LEARNING FROM LAS CONCHAS

In New Mexico, one fire in particular caused regional managers to look at fire's aftermath differently. The 2011 Las Conchas fire put so much ash, sediment, and other impurities into the Rio Grande that the City of Albuquerque had to shut off its water intake system. Cultural and recreational resources were also affected: Santa Clara Canyon, a spiritual sanctuary to the Native American people of Santa

Clara Pueblo, was so devastated by postfire debris flows that it has been off-limits since 2011. According to Anne Bradley, forest program director for The Nature Conservancy in Santa Fe, New Mexico, "The Las Conchas fire mobilized us to look more carefully at postfire resources, such as past research, evaluation tools—even funding. We realized that there's a greater need for these resources as the climate changes and large fires become more frequent and more severe. It became very clear that more postfire management is needed."

TAKING INVENTORY

Although plenty of resources are available for understanding and dealing with fire's aftermath, it can be difficult for land managers to locate and navigate them. To help user groups to access Federal

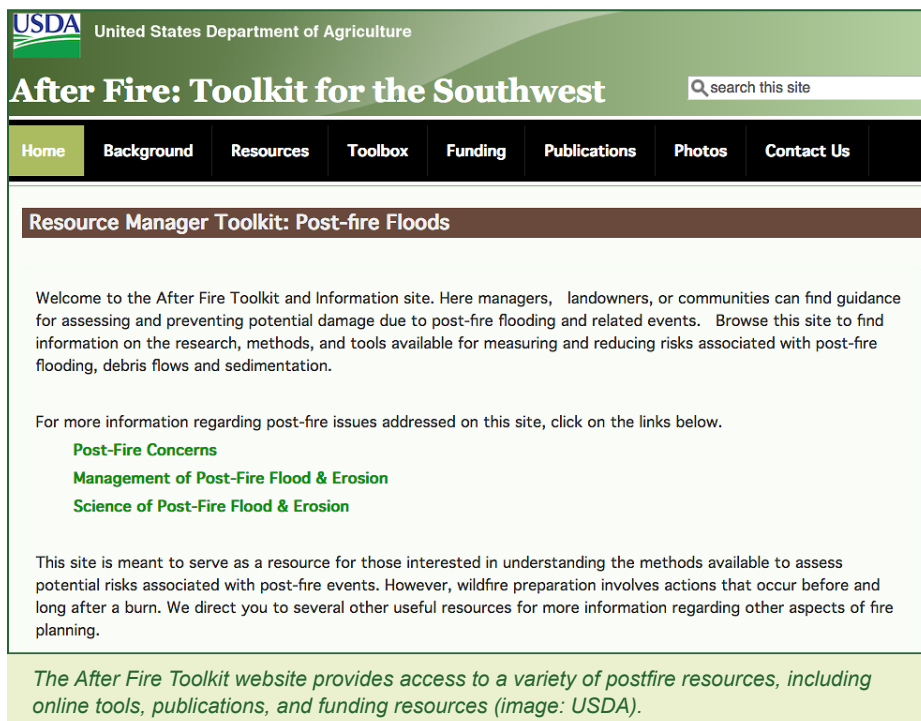
and other resources, scientists with the Rocky Mountain Research Station (RMRS) and its partners worked together to create an online resource called the [After Fire Toolkit and Information site](#).

The Toolkit's resources for managers include criteria for measuring risk, including: mapping "values at risk" such as a road to a remote community; estimates of the probability of a threat occurring with and without treatment; and treatment recommendations and costs. Resources for communities and landowners include links to State soil and water conservation districts, Federal Fire Adapted Communities Learning Network sites, and the Environmental Protection Agency's Surf Your Watershed website. Funding resources include links and descriptions for the EPA-maintained Watershed Protection website, the U.S. Army Corps of Engineers-affiliated Tribal Partnership Program, and the Natural Resources Conservation Service-administered Environmental Quality Incentives Program.

The Toolkit also represents significant collaboration between scientists and resource managers, particularly with case studies and success stories. According to Megan Friggens, a research ecologist for the RMRS and co-lead of the After Fire Toolkit project, the website was envisioned in 2014, at a workshop convened by the University of Arizona to focus on understanding needs related



A postfire debris flow in Santa Clara Canyon was one of several events that mobilized postfire experts to evaluate and gather resources in the After Fire Toolkit (photo: A. DuBrowa, FEMA).



USDA United States Department of Agriculture

After Fire: Toolkit for the Southwest

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Resource Manager Toolkit: Post-fire Floods

Welcome to the After Fire Toolkit and Information site. Here managers, landowners, or communities can find guidance for assessing and preventing potential damage due to post-fire flooding and related events. Browse this site to find information on the research, methods, and tools available for measuring and reducing risks associated with post-fire flooding, debris flows and sedimentation.

For more information regarding post-fire issues addressed on this site, click on the links below.

- Post-Fire Concerns
- Management of Post-Fire Flood & Erosion
- Science of Post-Fire Flood & Erosion

This site is meant to serve as a resource for those interested in understanding the methods available to assess potential risks associated with post-fire events. However, wildfire preparation involves actions that occur before and long after a burn. We direct you to several other useful resources for more information regarding other aspects of fire planning.

The After Fire Toolkit website provides access to a variety of postfire resources, including online tools, publications, and funding resources (image: USDA).

to wildfire, postfire floods, and extreme precipitation. Attendees included floodplain managers, urban planners, fire ecologists, hydrologists, geomorphologists, and climatologists. In order to better align existing research and research gaps with land managers' "wish lists," workshop attendees reviewed case studies, shared lessons learned, and evaluated the state of knowledge regarding headwaters and downstream concerns, hydrology and fire ecology, flood impacts, and perceived threats as they applied to prefire, during fire, and postfire time frames.

COMPILING RESOURCES

"The workshop participants envisioned an online toolkit with information on trainings, research, data, and methods for evaluating burned landscapes," Friggens says,

adding, "With support from the USDA Southwestern Climate Hub and working with other partners including the USFS Southwestern Region, the University of Arizona, and The Nature Conservancy, the RMRS scoured existing resources and cooperated with experts to identify tools appropriate for various audiences. We collected them into a single online location."

Katey Driscoll, RMRS research ecologist and the After Fire Toolkit project co-lead, was responsible for compiling Toolkit resources. According to Driscoll, "Federal land managers have protocols in place but private landowners and local governments need assistance. It's an ongoing effort and we're always looking to add more information."

The Toolkit is a culmination of many years of collaboration and fine-tuning. The project leads described the Toolkit in a 2019 *Natural Areas Journal* piece by Driscoll and Friggens titled, "Assessing Risk in a Postfire Landscape: Are Currently Available Tools Good for the Local Landowner?"

A KEY PARTNER

One early After Fire Toolkit supporter was Emile Elias, a research hydrologist with the USDA Agricultural Research Service in Las Cruces, New Mexico, and director at the USDA Southwest Climate Hub. "Past fire exclusion in fire-prone forests in the western United States has led to dense forests with high flammability and heavy fuel loads," she explains, adding, "A warm and dry climate has increased the area burned over the past 20 years. Continued warm and dry projections under a changing climate in the southern United States increase wildfire likelihood. Several years ago the University of Arizona researchers who convened the 2014 workshop contacted us to discuss developing the online toolkit envisioned by workshop participants."

After funding was obtained through a Climate Hub competitive grant program of the Forest Service, Elias says, "We worked with the Rocky Mountain Research Station and compiled resources and built the Toolkit. It gets quite a few hits during wildfire season by people looking for emergency flood prevention resources,



Three After-Fire Partners

Some wildfires require special efforts to prevent negative postfire effects. For example, loss of vegetation can expose soil to erosion while runoff can increase and cause flooding. As sediment moves downstream, it can damage buildings and infrastructure, fill reservoirs, and put endangered species and community water supplies at risk.

Burned Area Emergency Response Teams (BAER)

The Forest Service's BAER program, which addresses these situations on Forest Service lands, was a resource for developing many of the tools found in the After Fire Toolkit. According to Cara Farr, national BAER program lead, "Our goal is to keep the forest safe and running and to keep the people there safe following a fire, sometimes for many years."

More information on BAER can be found at www.fs.fed.us/naturalresources/watershed/burnedareas.shtml.

The Burned Area Learning Network (BALN)

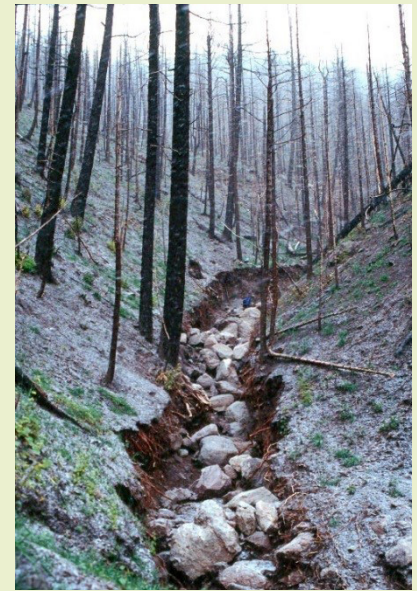
The national nonprofit organization The Nature Conservancy, along with partners such as the Forest Service and the Department of the Interior, provides a cross-disciplinary collaboration framework called BALN that also focuses on long-term management of burned areas. According to Anne Bradley at The Nature Conservancy, "We conduct prefire collaboration and planning that includes postfire response. For example, BALN coordinates workshops and field trips, which have included visits to the site of the 2017 Boundary Fire in Arizona, the 2011 Las Conchas Fire in New Mexico, and the 2002 Hayman Fire in Colorado."

More information on BALN can be found by going to www.conservationgateway.org and searching for "BALN."

Southwest Climate Hub

For land managers and stakeholders interested in impacts of a changing climate—including drought, extreme weather events, changing growing seasons and fire, including postfire resources—the USDA developed a network of regional Climate Hubs. According to Emile Elias, director of the Southwest Climate Hub, "Ten regional climate hubs were established in 2014 to help farmers, ranchers and foresters cope with the regional impacts of climate change and extreme weather, as well as to understand and plan for changes to support things like provisioning of foods and supporting ecosystems. The Hubs are a great example of how USDA divisions like the Forest Service and the Agricultural Research Service work together."

More information on the USDA Climate Hubs can be found at www.climatehubs.usda.gov.



Significant erosion followed New Mexico's Cerro Grande Fire in 2000, but flash flooding was minimized by prompt implementation of a Burned Area Emergency Rehabilitation team rehabilitation plan (photo: After Fire Toolkit photo library).

permanent after-fire solutions, and strengthening tribal partnerships. We find that it's especially useful for smaller communities in the wildland-urban interface and invaluable to local water and forest managers."

WILDFIRE CHALLENGES

Friggens explained that although wildfires are an important and natural disturbance in Southwestern ecosystems,

burned landscapes can present challenges to managers and landowners, especially when they occur in areas that are especially susceptible to postfire flooding and erosion. "The After Fire Toolkit supports needs for enhancing long-term resilience of ecological systems to wildfire and the human populations which depend on them," Friggens says, explaining, "The tools themselves can be used

for improving science, policy and management practices."

Visitors to the website can find a wealth of wildfire resources, including:

- a technical report focused on the state of knowledge related to secondary fire events,
- research, assessments, and case studies of postfire activities,
- a searchable publication library of more than 150 articles,



The After Fire Toolkit provides information on alert systems such as precipitation gauges that provide flash-flooding or debris flow alerts (photo: K. Lemoine, Natural Resources Conservation Service).

- information on methods for postfire mitigation, treatment effectiveness, rehabilitation, and restoration, and
- a journal article addressing the accessibility of currently available tools for different user groups.

Friggens also noted that wildfires burn across property lines and that secondary fire events such as flooding and erosion cross administrative boundaries. Because of this, Friggens says, “It was critical that the After Fire Toolkit include information for the diverse user groups that may be affected by a burned landscape. To help these groups make decisions about how and where to apply treatments that reduce risk, we’ve provided information on State and Federal programs that provide funding to communities and private landowners to respond to postfire threats, built a searchable publication library of more than

150 articles, and compiled computer models, technical guides, and web resources that contain specific information for each type of user.”

The Toolkit also provides access to a wide range of tools, including flow and erosion models. According to Friggens, “It’s meant to be a comprehensive summary of all the relevant after-fire tools that people can use, although some are easier to use than others. There are more than 40 tools, including guides, web-based applications, analysis tools, alert systems, and more.”

For example, the Toolkit provides information on alert systems that can provide communities with advance warning about flash flooding or debris flows. Warnings are based on peak storm rainfall thresholds that are developed for recently burned areas.

A WEALTH OF RESOURCES

With new content added regularly, the Toolkit has become a leading

regional information resource for postfire land management and a model for other parts of the country. According to Driscoll, “It’s an ongoing effort and we’re always looking to add more information. We aim to include resources for many different potential users, such as links to conservation districts within southwestern states. These groups can be great partners for communities and private landowners looking to plan for and mitigate postfire flooding and erosion. There are also links to case studies of successful postfire mitigation that I think are useful.”

One such case study is the 2013 Silver Fire in southern New Mexico. Following a period of intense drought, the fire burned more than 130,000 acres and left several communities, private properties, and infrastructure at risk from flooding, erosion, and debris flows. Based on postfire assessments, straw and seed were

MANAGEMENT IMPLICATIONS

- The After Fire Toolkit provides managers, landowners, and communities with online guidance for assessing and preventing potential damage due to postfire flooding and related events.
- The Toolkit includes links to emergency response resources, cooperative extension documents, funding resources, and guidance on developing and implementing postfire restoration activities.
- Computer modeling tools highlighted on the site include erosion estimation, prediction and reporting software, watershed assessment models, and precipitation runoff simulators.
- The Toolkit’s extensive library includes more than 150 book chapters, white papers, conference proceedings, journal articles, General Technical Reports and more.
- Additional information can be found at www.fs.usda.gov/rmrs/tools/after-fire-toolkit-southwest or at <https://postfiresw.info>.

applied aerially to high-severity burn areas. In the year after the fire, monitoring of treated and untreated sites found that seeding and mulching reduced erosion by more than 100 percent compared to untreated sites. For land managers uncertain about how to rehabilitate postfire landscapes, it's a welcome success story.

The 2013 Silver Fire in New Mexico put several communities, private properties, and infrastructure at risk from flooding, erosion and debris flows (photo: DanEverett45, <https://creativecommons.org/licenses/by-sa/4.0/legalcode>).

KEY FINDINGS

- The After Fire Toolkit includes guidance for risk assessment and treatment selection, analysis tools, alert systems, and web resources.
- Specific tools include computer models, alert systems, technical papers, guides and methodologies, online resources, and funding programs.
- These resources can help individuals, communities, private landowners, and resource managers to learn about, plan for, and implement postfire management actions to reduce risks associated with postfire erosion and flooding.
- Many State and Federal programs provide funding to communities and private landowners to respond to postfire threats. Some of these require partnerships with conservation districts or local governments. The After Fire Toolkit website provides links to conservation districts in the Southwest.



Postfire Researchers at Rocky Mountain Research Station

PAULA FORNWALT is a research ecologist based in Fort Collins, Colorado. Paula's research examines vegetation recovery following wildfire and how recovery relates to factors such as fire severity, time since fire, and biophysical characteristics in dry conifer forests of the Interior West. For more information, go to www.fs.usda.gov/rmrs/people/pfornwalt.

SHARON HOOD is a research ecologist based in Missoula, Montana. Sharon studies how fire affects trees and ultimately forest dynamics. For more information, go to www.fs.usda.gov/rmrs/people/shood.

JOSE INIGUEZ is a research ecologist based in Flagstaff, Arizona. Jose studies prefire and postfire forest conditions across burned landscapes in the sky islands of southeastern Arizona. For more information, go to www.fs.usda.gov/research/people/jiniguez.

CHARLES LUCE is a research hydrologist based in Boise, Idaho. Charlie measures the effects of climate change and wildfire on stream flows and forest and aquatic ecology. For more information, go to www.fs.usda.gov/rmrs/people/cluce.

CHARLES RHOADES is a research biogeochemist based in Fort Collins, Colorado. Chuck evaluates the effects of ecological disturbances such as severe wildfire on forest ecosystem dynamics, soils, water quality and streamwater chemistry. For more information, go to www.fs.usda.gov/rmrs/people/crhoades.

PETE ROBICHAUD is a research engineer based in Moscow, Idaho. Pete has developed a web-based probabilistic erosion risk management tool for postfire assessments and investigating the use of remote sensing imagery for postfire burn severity classification, water-repellent soil identification, and erosion control treatment effectiveness. For more information, go to www.fs.usda.gov/rmrs/people/probichaud.

VICTORIA SAAB is a research wildlife biologist based in Bozeman, Montana. Vicki studies the ecological consequences of fire and other landscape stressors for avian communities in dry coniferous forests of the Interior West. For more information, go to www.fs.usda.gov/rmrs/people/vsaab.

Photo: K. Greer, USDA Forest Service

FURTHER READING

Driscoll, K.P.; Friggens, M. 2019. Assessing risk in a postfire landscape: Are currently available tools good for the local landowner? *Natural Areas Journal*. 39(4): 472-481. www.fs.usda.gov/treearch/pubs/59368.

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WRITER'S PROFILE



BRIAN COOKE is a science and environmental writer based in Fort Collins, Colorado.

SCIENTIST AND MANAGER PROFILES

The following scientists and team members were instrumental in the creation of this Bulletin.



MEGAN FRIGGENS is a research ecologist for the Rocky Mountain Research Station in Albuquerque, New Mexico. Her work involves using a variety of methods to assess future threats and impacts to wildlife species and habitats arising from climate change and related disturbances. Megan holds bachelor's and master's degrees in biology from the University of New Mexico and a Ph.D. in forestry from Northern Arizona University. She is a past recipient of the Department of Interior's Partners in Conservation award. Connect with Megan at www.fs.usda.gov/rmrs/people/meganfriggens.



KATELYN DRISCOLL is a research ecologist with the Rocky Mountain Research Station in Albuquerque, New Mexico. Her research interests include ecosystems and the complex interactions that drive large-scale patterns across landscapes, particularly how the structure and function of aquatic and riparian systems are affected by natural and anthropogenic stressors and how disturbance regimes alter ecosystem complexity. She holds a bachelor's degree in biology from Gonzaga University and a master's degree in systems ecology from the University of Montana. She is currently a Ph.D. student in biology at the University of New Mexico. Connect with Katey at www.fs.fed.us/rmrs/people/katelyndriscoll.



EMILE ELIAS is a research hydrologist with the USDA Agricultural Research Service and the director of the USDA Southwest Climate Hub in Las Cruces, New Mexico. Her research interests include land use and climate change impacts on hydrology, water quality, and agricultural communities in the southwestern United States. She holds a master's degree in watershed science from Colorado State University and a Ph.D. in hydrology from Auburn University. Connect with Emile at www.climatehubs.usda.gov/hubs/southwest/people/emile-elias.



ANNE BRADLEY is The Nature Conservancy's forest conservation program director in Santa Fe, New Mexico. Her work focus is the development of collaborative strategies to improve the health and function of forested ecosystems in the State. She is also the New Mexico lead for the Fire Learning Network—a national partnership between The Nature Conservancy and Federal land management agencies that seeks to restore the natural role of fire to the ecosystem while helping communities become fire-adapted. Anne has a bachelor's degree in biology from Colorado College and a master's degree in botany from the University of Montana. Connect with Anne at www.nmconservation.org/about/our-team.



CARA FARR is the Forest Service's national Burned Area Emergency Response & Watershed Improvement program leader. Based out of Fort Collins, Colorado, she is a forest soil scientist with experience in rangelands, carbon and wetlands. Cara holds bachelor's and master's degrees in soil science from West Virginia University. Additional information on BAER can be found at www.fs.fed.us/naturalresources/watershed/burnedareas.shtml.

ANNA JARAMILLO-SCARBOROUGH is a hydrologist with the Forest Service's Southwestern Region. Her responsibilities include managing the watershed improvement program and Burned Area Emergency Response program for the Southwestern Region. She holds a bachelor's degree in environmental science from the New Mexico Institute of Mining and Technology.



About the Science You Can Use Bulletin



The purpose of SYCU is to provide scientific information to people who make and influence decisions about managing land.

Nehalem Clark: Bulletin Editor / Science Delivery Specialist
nehalem.clark@usda.gov

Jessica Brewen: Bulletin Editor / Science Delivery Specialist
jessica.brewen@usda.gov

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Rocky Mountain Research Station is one of 7 Forest Service Research & Development Stations located throughout the U.S. Within the 12 state RMRS footprint, we maintain 12 research locations, conduct long-term ecological research on 14 experimental forests, ranges and watersheds and work in hundreds of research natural areas.

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