

Fire Effects on Watersheds

An Overview



By Leonard F. DeBano, University of Arizona

Fire has a ubiquitous role in wildland management. It is a frequent visitor to watersheds throughout the world and is of particular concern in the western and southwestern United States. Wildfires are uninvited events that sweep across thousands of acres of watershed areas annually. On the other hand, prescribed fire can reduce the accumulation of dead wood and other fuel that constitutes an ever-present wildfire danger, and thus plays an important role as a management tool on many watersheds. Prescribed fire can also be used to satisfy other management objectives such as seed-bed preparation, increased forage production, and improved wildlife habitats.

The Hydrologic Cycle and Fire Effects

A watershed's response to fire depends upon the effect that fire has on the individual components of the hydrologic cycle operating on the watershed. Not all processes and

pathways in the hydrologic cycle are equally affected by fire; for example precipitation is not affected at all. Those processes and pathways most affected by fire are those that are controlled by vegetation and the soils of the watershed: they include interception, infiltration, evapotranspiration, soil moisture storage, and overland flow of water. Fire can substantially reduce interception by destroying both the vegetation canopy and the organic litter on the soil surface, thereby exposing the soil to raindrop impact and subsequent runoff and erosion. Fire can reduce infiltration into the soil by forming a water-repellent soil layer or plugging soil pores with fine ashy material. Percolation through the soil can also be reduced this way. Reduced infiltration and percolation in turn can increase surface runoff and sedimentation. Increases in streamflow also may occur following fire because the removal of vegetation reduces transpiration losses by plants.

Watershed Responses to Fire

The major factors affecting the hydrologic response of a watershed to fire are fire severity and the magnitude and timing of precipitation following fire (DeBano and others, 1996). Fire severity, classified as low, medium, or high, describes the change that fire causes in particular ecosystem resources such as vegetation or soils. Wildfires, having greater severity than prescribed fires, prompt the greatest watershed response, particularly for large-magnitude hydrologic events. The inability to predict the magnitude and timing of precipitation that will follow a fire is a significant challenge to assessing potential damage from it: a 100-year event could cause extensive runoff and erosion, depending on local topography and soil conditions, whereas gentle rains could have minimal impact. Although general climatic rainfall patterns are known, rain distribution and intensity varies widely, so probability distributions can at best serve as guides for assessing potential damages.

Varying techniques for assessing fire severity in terms of canopy loss and soil changes have been developed along with descriptive terminology that can be used in the field following fire (Neary and others, 2008). Fire severity in soils is determined by field examination after a fire and rated according to the amount of surface litter that is charred and consumed and the amount of white and dark ash. Large amounts of white ash on the soil surface indicate a high severity fire. Likewise, the plant canopy's appearance following fire is rated in terms of scorch and the amount of the green plant material consumed. Complete consumption of both dry fuels and green plant material indicates high fire severity. Fire-severity levels are combined with the effects of precipitation events after the fire to determine the hydrologic response (or performance) of watersheds following fire. Post-fire damages are tied to the adverse soil and vegetation changes in watershed performance.

Mitigating Fire Effects on Watershed Performance

Neary and others (2008) reviewed a large number of burned-area emergency rehabilitation (BAER) treatments (both physical and vegetative) used to mitigate the impacts of fire on watershed hill slopes and channel structures with respect to their effect on runoff and erosion following fire. Their recommendations were:

- Rehabilitation should be done only where risk to life

and property is high, since significant resources must be invested to ensure improvement over natural recovery.

- Seeding treatments may not be needed as frequently as previously thought because seeding has a low probability of reducing erosion the first wet season following fire, when erosion rates are highest.
- Mulching can be an effective tool, but is expensive and should be limited to the most critical areas of the watershed.
- Channel treatments, such as straw bale check dams, should be considered secondary mitigation treatments although they can temporarily store sediment and desynchronize its release with storm flow events.
- A monitoring program should be initiated to evaluate the overall effectiveness of the applied treatments.

The most effective way to reduce overall

watershed damage by high-severity wildfires is to implement programs that effectively reduce the accumulation of fuels and therefore the probability of subsequent severe wildfires.

The effectiveness of treatment programs in reducing fire severity was demonstrated in ponderosa pine (*Pinus ponderosa*) forests during the 2002 Rodeo-Chediski fire in Arizona. This wildfire burned 468,000 acres and exhibited the most extreme fire behavior ever seen in the Southwest. Prior to the fire, long-term fuel reduction treatments were implemented on the White Mountain Apache Tribal lands and on the nearby Apache-Sitgreaves National Forest. These treatments involved thinning, timber harvesting, prescribed burning, or a combination of these. The purpose of these treatments was to transform a forest structure having dense forest floor fuels, ladder fuels, and canopy fuels to a more open forest structure characteristic of presettlement conditions. These treatments help limit natural or manmade ignitions to low-severity ground fires rather than high-severity crown fires (see photos).

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An evaluation of these treatments indicated that the severity of the burn was reduced substantially on the treated plots and that the beneficial effects of the treatments on stand structure characteristics were projected to persist for several decades (Finney and others, 2005; Strom and Fulé, 2007).

In conclusion, fire severity and post-fire weather significantly affect watershed performance. Although some remedial treatments can be applied after wildfires, enacting a regular program of fuel reduction by the use of forest thinning, timber harvesting, prescribed fire, or a combination of these can provide natural resource managers with a viable long-term option for protecting watershed performance.

References

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Finney, M.A., C.H. McHugh, and I.C. Grenfell, 2005. Stand- and landscape-effects of prescribed burning on two Arizona wildfires, *Can. J. For. Res.*, 35: 1714-1722.

Neary, D.G., K.C. Ryan, and L.F. DeBano, eds., 2008. *Wildland Fire in Ecosystems: Effects of Fire on Soil and Water*, USDA, Forest Service, General Technical Report RMRS-GTR-42, 4, 250 p.

Strom, B.A., and P.Z. Fulé, 2007. Pre-wildfire fuel treatments affect long-term ponderosa pine forest dynamics, *Int. J. Wildland Fire*, 16: 128-138.

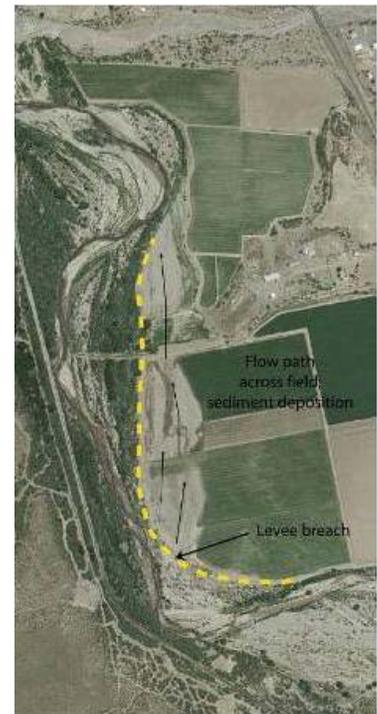
This month's meeting will feature Jim Zorne, acting Forest Supervisor, and Acting Assistant Forest Supervisor Christine Dawe will be giving us an update on the Wallow fire and restoration efforts.

Project and Program Status Report

E. coli Reduction on the San Francisco and Blue Rivers project E. coli Reduction on the San Francisco has started its Master Watershed Steward course focusing on the San Francisco and Blue Rivers. About 30 people have showed up for the first two sessions, the great majority of them enrolled students. Presenters in this course are from University of Arizona, U.S. Bureau of Land Management, U.S. Fish and Wildlife Service and local land owners and land stewards. Adults and kids ages 16 and up are welcome. Enrollment is free. For more info write rivers@drgroup.net or call Deborah at 928-200-0790. The MWS course, like the rest of the program, is funded by ADEQ.

The AWPF Gila River Water Conservation Education Program – The project had been stalled a bit due to the busy schedules of the folks involved. Susan Syfert has been hired to coordinate the project and help keep it moving. The City of Safford's water department has agreed to identify high water users in the community and send them a postcard that says that they may be using more water than they need to and inviting them to have a water audit to reduce their water consumption. Susan is working with Bill Brandau and his experienced and professional crew, as well as some new hires, and they will soon be back at work helping our community save money!

The AWPF Gila River Restoration Project at Apache Grove – The earthwork and re-vegetation is nearly complete. We will have a review of the project at the Arizona Riparian Council's annual meeting. On Thursday, March 29, the meeting begins with a workshop by Natural Channel Design, which will teach us how a restoration project such as the Apache Grove project is designed. Saturday, there will be a field trip to the project site. See the Arizona Riparian Council's web site for more information at: <http://azriparian.org>.



The Business District Façade Improvement program in Clifton and Duncan There are hammers flying all over Chase Creek in Clifton and Highway 70 and Main Street in Duncan as the Business District Façade Improvement program nears its deadline. The program is funded by Freeport McMoRan Copper & Gold Foundation. Nearly 40 building facelifts will be complete by the end of April.

AWPF Eagle Creek Riparian Restoration at Filleman Crossing Project - We have the approval from the landowner to go ahead with the project. Jan Holder is still working on final details on the contracts and agreements.

The USFW Syfert Wildlife Watering Facility – The Syferts are still waiting for some paperwork from the Arizona Department of Water Resources. As soon as it is complete, we will begin the permitting process.

ADEQ Education Master Watershed Steward Program, Phase II - This class has twelve students and Bill Brandau and his team have completed 8 classes and three field trips. There are 3 classes and one field trip remaining. A fourth field trip is scheduled for March 31 for the students to attend Arizona Riparian Council's field trip to the Apache Grove Project.



The class's on-the-ground project is on track. The spring 2011 class developed the project design, which is an inventory of the watershed erosion-control structures in the Upper Gila Watershed. Bill's students have researched all agencies and organizations that may house watershed structure GIS data bases, and we are sending a letter to them requesting their data. Upon receipt of the information, his class students will compile the data. Bill and his class are in discussion with Barron Orr at the Arid Lands Office as a place to house the data. The next class will begin to use the data as a means of completing the Watershed Structure Inventory.

The last class and previous Master Watershed Steward will ground truth the compiled GIS data. At the conclusion of this grant and all four classes we will have the first inventory of watershed structures for all jurisdictions within the area. This data base can then be used to help us make better decisions for the sediment TMDL on the Gila River.

AWPF The E.coli Reduction on the San Francisco River Through Alternate Livestock Water on Kaler Ranch – The changes were made and the Arizona Water Protection Fund gave us permission to move forward. The well has been drilled and the contractor, Rough Country Construction is hard at work installing the solar equipment.

The Chase Creek Business Support Center and Commercial Kitchen was awarded a \$50,000 grant by FMI to complete construction on the kitchen facility and to help with the costs of the first year of operations. The Town of Clifton expects to open the doors to the public later this year.

USFW Partners Eagle Creek Riparian Restoration at Filleman Crossing Project - The USFW Partners program, administered by Kris Randall, has generously granted us additional funds for the Filleman Crossing Project. The additional funding will be used for permits and the re-vegetation.

The BOR Graham County Fairgrounds Project - The water use analysis for the Graham County Park is complete; presentation and recommendations have been presented to the Graham County Board of Supervisors. Graham County, independent of this project, is in the final stage of establishing a water reclamation plant at the park to improve the water quality of the well water. When this is complete the improved water from the well will reduce the amount of potable water used on the park. There is a meeting scheduled with the City of Safford and Graham County on March 15 to discuss how to move forward on the Bureau of Reclamation Project.

AWPF Eagle Creek Riparian Restoration at Filleman Crossing Project - We have the approval from the landowner to go ahead with the project. Jan Holder is still working on final details on the contracts and agreements.

AWPF Eagle Creek Riparian Corridor Protection Project - Jan Holder is still working on the contracts and agreements.



Obstacles are those frightful things you see when you take your eyes off your goal.

- Henry Ford

Calendar of Events

Wednesday, March 14, 2012, 7 p.m. Our meeting will be held at the Graham County General Services Building, 921 Thatcher Blvd., Safford, AZ, and will feature a talk by Jim Zorne, acting Forest Supervisor, and Acting Assistant. Forest Supervisor Christine Dawe will be presenting at the March meeting about the Wallow fire and restoration efforts.

March 29-31, 2012, The Arizona Riparian Council Annual Meeting, at EAC.

Wednesday, April 11, 2012, 7 p.m. Our meeting will feature Dan Taylor, with Bat Conservation International will talk to us about bats, bat habitat, bat food, and bat hobbies.

Our partners include:

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| Arizona Department of Agriculture | Gila Valley NRC |
| Arizona Department of Environmental Quality | Discovery Park |
| Arizona Department of Transportation | Farm Bureau |
| Arizona Department of Water Resources | Freeport McMoRan Copper and Gold Inc. |
| Arizona Game and Fish Department | Graham County |
| Arizona Geological Survey | Greenlee County |
| Arizona State Land Department | Gila Valley Irrigation District |
| Bureau of Land Management | Natural Resource Conservation Service |
| City of Safford | University of Arizona Cooperative Extension |
| Town of Thatcher | University of Arizona NEMO Project |
| Town of Pima | U.S. Fish and Wildlife Service |
| Town of Clifton | U.S. Forest Service – Apache |
| Town of Duncan | Sitgreaves and Coronado Forests |
| | U.S. Bureau of Reclamation |
| | And many community members |

Get involved in your watershed

For more information, contact Jan Holder at the Gila Watershed Partnership, 711 S. 14th Avenue, 85546, 520-419-0374, email-watershedholder@gmail.com