Fire: Frequency and Size

By Zack Guido | The University of Arizona | September 14, 2008

In the Southwest, normal changes in seasonal climate make the landscape ripe for fires. Often, normal winter precipitation spurs plant growth while the dry months of April, May, and June turn them into tinder. At the time in which the landscape is most primed for fire, convective monsoon storms generate lightning, providing the match.

Under normal conditions, the Southwest experiences recurring fires. Add in fire suppression by federal agencies, population growth that increases numbers of campfires and careless people, and human-caused climate change and the relationship between fire and climate becomes complicated.

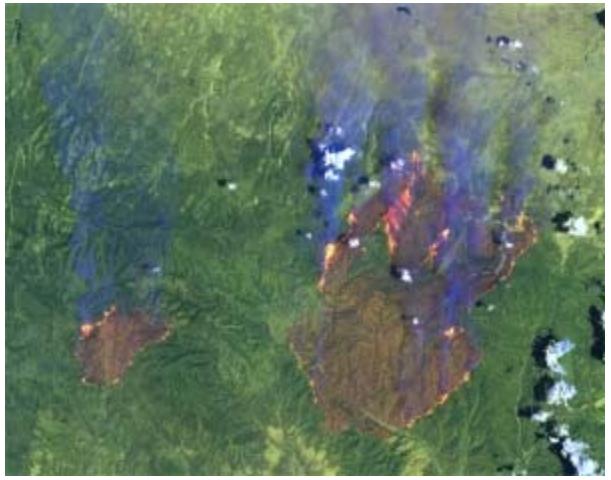

Figure 1. The Rodeo-Chediski fire on June 21, 2002 before the fires converged.
| Enlarge This Figure |
Credit: Jesse Allen, NASA

In recent years, wildfires have charred increasing areas of western U.S. forests, burning homes and wildlands and regularly siphoning more than $1 billion per year from federal land-management agencies[1]. With the general belief that future climate in the Southwest will become hotter and drier, recent research has focused on understanding:

- Observed links between climate and fire
- Climate change and wildfire in forests and deserts
- The predicted character of future fires

Observed links between climate and fire

In recent years, the size and frequency of fires have increased. In some regions, either human-caused forest change or climate variability and change is primarily responsible for this increase. In other cases, both factors play important roles.[2]

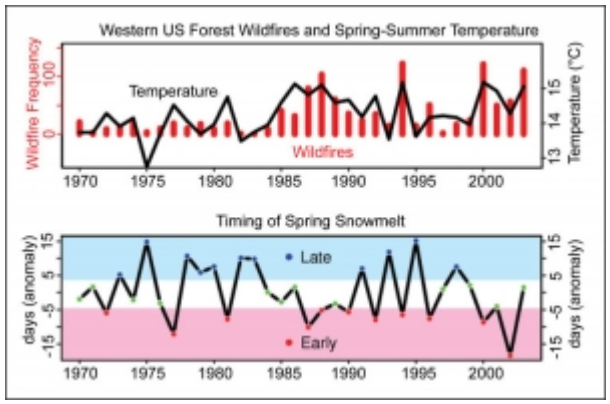

Figure 2. Relationship between Western U.S. forest wildfires and spring-summer temperature.
| Enlarge This Figure |
Credit: The American Association for the Advancement of Science

The frequency and size of fires in the Southwest is influenced by many variables. Change in climate, both short and long term and natural and human-caused, is one variable. Climate change causes shifts in temperature, which influences the timing of snowmelt. It also causes oscillations in wet and dry periods, fluctuations in the vigor of monsoons which influence the number of lightening strikes, and changes in phases of the El Niño and Southern Oscillation. Other influences on fires are the incursion of invasive species, particularly in desert environments where exotic grasses often provide fine fuels that feed fires; land use changes, such as grazing and logging; and changes in fire management policy.

Although human actions and the climate both influence the timing and size of fires, analysis of historical fire records have helped identify relationships between climate and fire. Some of the more conclusive relationships are:

- In western mountains during the last two to three centuries, years that had a high number of fires coincided with drought years.[2]
- The frequency of fires increases more during hotter springs and summers than during cooler springs and summers (Figure 2).[3]
- Wildfire activity at elevations between 5500 and 8500 feet has occurred predominantly during warm years and is associated with earlier spring snowmelt, which is driven by warmer temperatures.[3]
- In general, the size of fires in the Southwest is greatest during intense La Niña years in which winter and spring precipitation is low, while fewer acres burn during El Niño years characterized by exceptionally wet springs.[4]

Climate change and wildfire in forests and deserts

Historically, wildfires have been a recurring disturbance in conifer forests, pinyon-juniper woodlands, chaparral shrublands, and grassland ecosystems of the Southwest. Lightning strikes frequently initiated surface fires in ponderosa pine forest, clearing out much of the surface brush and vegetation while killing only a few of the thick-barked mature ponderosa trees. These low intensity fires created a more open forest,

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preventing the build-up of vegetation that could fuel more severe wildfires.[4] Meanwhile, fires were rare in the higher elevation spruce-fir forests but were likely severe when they did occur.[4]

Since about the mid-1970s, however, the total acreage of area burned and the apparent severity of wildfires in pine and mixed-conifer forest have increased, both from climate change and human activities. Management practices have made many forests more susceptible to severe wildfires; fire suppression and clear-cutting promote a high density of small trees, while grazing has reduced the grassy understory that formerly sustained surface fires.

Warming temperatures also have a clear link to the observed frequency of large western wildfires in recent times. An analysis of U.S. Forest Service and National Park Service data from 1970–2003 revealed that high spring and summer temperatures correlated with an unusually high number of large western wildfires.[3] The researchers identified earlier snowmelt as a contributing factor to the increase.

Wildfires have also been occurring in desert ecosystems that are ill-adapted to flame. A major contributor to desert fires in the Southwest is invasive grass. Red brome, Mediterranean grass, and buffelgrass are now growing in southwestern deserts and are providing fine fuels for wildfires. Desert fires now expand more easily than in the past, especially after wet winters, which boost the growth of the grasses. Wildfires in desert ecosystems have also increased the fire risk in urban areas and housing developments where urban areas and desert meet.

Predicted character of future fires

Increases in future temperatures are nearly certain. Regardless of precipitation, temperature alone will likely amplify the frequency and total area burned by wildfires[5]. If drought conditions become more common or if precipitation becomes more variable, these will likely combine with temperature change to exacerbate future fire risk. In addition, continued population growth will likely cause greater human-started fires since nearly half of the fires in the Southwest are started by humans. In 2002, for example, the Rodeo-Chediski fires in northern Arizona (Figure 1, above) were both started by humans and combined to burn nearly half a million acres, the largest fire on record in Arizona.

The frequency and size of fires will likely increase in the future because:

- warmer annual temperatures will cause the snowpack to melt earlier in the spring, therefore increasing the length of the dry season between winter and monsoon rains—a longer dry season creates drier fuels as well as a longer period in which fires can occur;
- increases in summer temperatures will cause trees to be more moisture-stressed, making forests more susceptible to fire;
- fire suppression has created an over abundance of snags and small trees that have increased fuel supplies; and
- growth in the human population will increase the number of wildfire starts.

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