

Rocky Mountain Research Station Science You Can Use *(in 5 minutes)*

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The Safe Separation Distance Evaluator: Is My Safety Zone Big Enough?

Building containment lines and removing fuels can bring wildland firefighters close to advancing flames. In these high-risk situations, firefighters depend on safety zones—large, open areas with little flammable material where they can retreat if conditions turn dangerous.

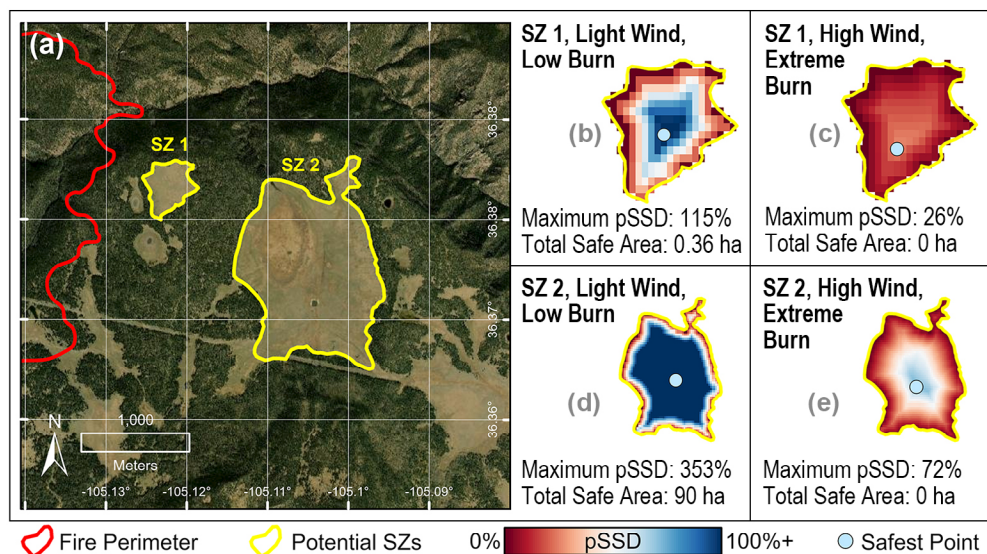
The difference between a good safety zone and an insufficient one can be the difference between life and death. But how can wildland fire personnel know if a safety zone is large enough to protect them?

Alongside Mickey Campbell and Phil Dennison from the University of Utah, Rocky Mountain Research Station (RMRS) scientists Matt Thompson and Bret Butler (emeritus) developed a new tool to help answer this question: the [Safe Separation Distance Evaluator](#), an interactive, Google Earth Engine-based tool that helps identify and evaluate potential safety zones. RMRS engineer Dan Jimenez helped create an easy-to-use online platform for the tool and is now working to share it with the fire

community. The online platform provides nationwide coverage.

The effectiveness of a safety zone is determined by whether it can provide a safe separation distance (SSD) from surrounding vegetation or the distance one must maintain from fire to avoid burn injury. Following the deadly South Canyon Fire in 1994, fire scientists developed

a rule of thumb for determining SSD—four times flame height. Recent updates to this standard have used vegetation height as a proxy for flame length and added factors to better account for slope and wind. Even these updated methods, however, require making estimates and predictions in the field, and firefighters are left with the difficult task of locating a safety zone that meets the mark.



Results of the evaluation of two potential Safety Zones (SZs) in a simulated wildland fire scenario in northern New Mexico, including an overview map (a), and the suitability analysis results for SZ 1 under light wind and low burn conditions (b), SZ 1 under high wind and extreme burn conditions (c), SZ 2 under light wind and low burn conditions (d), and SZ 2 under high wind and extreme burn conditions (e). Figure from Fire; Volume 5 Issue 1 10.3390/fire5010005

This tool combines slope and vegetation height data from LANDFIRE with user-defined burn conditions and wind speeds. It allows users to:

1. Map SSD at the scale of about a quarter acre, showing how far a person would have to be from that location to avoid burn injury. These maps can help identify potential safety zones.
2. Draw a potential safety zone on the map and evaluate the degree to which that safety zone would provide SSD from the surrounding vegetation and the size of the safe area within it.

“Convective heating increases the heating of fuels ahead of the flame front. That increases the fire rate of spread, increases the depth of the flame front, and increases the amount of energy that is being released. When it comes to safety zones, the result is much larger distances to be safe.”

—Dr. Bret Butler

SSDE is not currently intended to be a real-time decision-making tool for firefighters on the ground. Instead, Jimenez foresees this analysis being performed by an incident management team and incorporated into Incident Action

Plans. He also stresses that wind and fire behavior are likely to change over the course of a day—and when they do, previously identified safety zones may need to be reevaluated. SSDE enables rapid comparisons of different wind and fire conditions and their effects on safety zone suitability. SSDE should be treated as the first step in identifying potential safety zones. It is important that the suitability of safety zones is further validated on the ground prior to establishment.

Now that the SSDE is operational, the team is focused on outreach. They are planning to have their work integrated into the training curriculum for fire personnel. They also developed an instructional video that walks through how to use the interactive interface. In addition, Jimenez is working with Technosylva to incorporate the new safety zone guidelines into a user-friendly phone app that will include high-resolution terrain and fuels data for any location on the landscape.

Key Findings & Management Implications

- The new Safe Separation Distance Evaluator, developed by RMRS scientists and University of Utah colleagues, helps identify safety zones and determine whether they will be sufficient to protect firefighters under a variety of conditions.
- This tool combines slope, vegetation height, user-defined burn conditions, and wind speeds with an updated safety zone standard in an interactive online map. An instructional video and [user guide](#) describe how to use SSDE.
- While this tool can help incident management teams locate safety zones, users should keep in mind that fire behavior and wind speeds can and will change over the course of a day—and when they do, previously identified safety zones may no longer be sufficient.

Lead Scientist

Dan Jimenez is a Mechanical Engineer with the Rocky Mountain Research Station. His research has included studies on heat transfer and fluid flow modeling used to predict wildland fire heat, temperature, and wind profiles and fire effects on forest landscapes, vegetation, and soil types.

Further Reading and Viewing

Butler, B.W. 2014. [Wildland firefighter safety zones: A review of past science and summary of future needs](#). *International Journal of Wildland Fire*. 23(3): 295–308.

Campbell, M.J.; Dennison, P.E.; Thompson, M.P.; Butler, B.W. 2022. [Assessing potential safety zone suitability using a new online mapping tool](#). *Fire*. 5(1): 5.

Campbell, M.J.; Dennison, P.E.; Butler, B.W. 2016. [Safe separation distance score: A new metric for evaluating wildland firefighter safety zones using lidar](#). *International Journal of Geographical Information Science*. 31(7): 1448–1466.

[WFSTAR](#): Latest research on estimating safety zones.

View introduction video [here](#).

The Rocky Mountain Research Station is one of seven units within USDA Forest Service Research & Development. RMRS maintains 14 field laboratories throughout a 12-state geography encompassing parts of the Great Basin, Southwest, Rocky Mountains, and the Great Plains. While anchored in the geography of the West, our research is global in scale. RMRS also administers and conducts research on 14 experimental forests, ranges and watersheds and maintains long-term research databases for these areas. Our science improves lives and landscapes. More information about Forest Service research in the Rocky Mountain Region can be found here: <https://www.fs.usda.gov/rmrs/>.

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