



Research Brief for Resource Managers

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Hot, Dry, and Windy: A tool to understand and predict dangerous fire weather

Developing the Hot-Dry-Windy Index

Fire behavior is complex, which is why predicting when a wildfire will become difficult to control is a major challenge. Conditions can change quickly and vary from place to place.

Fire managers have long known that the most dangerous fire conditions occur when the weather is “hot, dry, and windy.” However, it is difficult to use those observations to build reliable forecasting tools. Many fire prediction tools rely on data from specific regions or past fire events. Because of this, they may not work as well in different places or under changing environmental conditions.

In 2018, a team of researchers introduced the Hot-Dry-Windy Index (HDWI; Srock et al., 2018). The HDWI harnesses the basic science of how weather affects fire behavior. The index answers the question: “What physical weather conditions make fires difficult to manage?” This is distinct from other fire indices, which typically analyze weather patterns from past fires. The HDWI approach has two main advantages. First, hot, dry, and windy conditions can be applied to different locations and time periods. Second, these conditions can often be reliably forecasted several days in advance. As a result, HDWI helps anticipate periods when fires may become difficult to control.

Equation 1:

HDWI is the product of wind speed (U) and VPD:

$$HDWI = U \times VPD$$

This simple formula allows HDWI to capture conditions when strong winds and dry air occur at the same time. Simply put, hotter, drier, and windier conditions lead to higher HDWI values.

HDWI combines two important weather factors: wind speed and a measure of atmospheric “thirst” known as the vapor pressure deficit (VPD) (see **Equation 1**). The VPD measures the capacity for air to pull moisture from plants and other fuels. High VPD values indicate that more moisture from plants will go into the air over time. During a fire, dry fuels are more likely to burn intensely, rapidly spreading the fire.

Testing HDWI across four historic wildfires

To test the index’s power as a forecasting tool, the researchers applied HDWI values to four historic wildfire events across the United States:

- the Pagami Creek Fire in Minnesota (2011)
- the Bastrop County Complex Fire in Texas (2011)
- the Cedar Fire in California (2003)
- the Double Trouble Fire in New Jersey (2002)

Using a consistent record of past weather based on observations and models – commonly known as “climate reanalysis” – the authors estimated daily values of HDWI for a period of 29 days centered around the most difficult day of fire control. For each of the fires, HDWI was consistently high on days when fire behavior was the most dangerous. More importantly, the HDWI peaks had a better match with observed significant fire behavior than the Haines Index, a commonly used fire weather tool.

The Double Trouble Fire in New Jersey is especially relevant for the Northeast. This fire burned on the edge of the Pine Barrens in June 2002 under dry and windy conditions. HDWI plainly highlighted the presence of weather conditions conducive to rapid fire spread. While the Haines Index also showed elevated values on several days before and after the fire, the HDWI more precisely identified the specific day when the fire became most dangerous (**Figure 1**). In particular, HDWI reached its highest value two days before the fire started. This supports the potential of HDWI to help identify periods when new fires could quickly become difficult to control.

Management implications for fire planning and risk reduction

Weather patterns over short timescales and small areas are important drivers of fire behavior. However, HDWI focuses on large-scale weather patterns – those that are larger than ~125 miles across – as such patterns are easier to predict and apply across broader fire management regions. As a result, it may help fire managers identify dangerous conditions. Even several days of advance notice can vastly improve wildfire preparedness and public communication of fire risk.

HDWI suggests that dangerous fire weather is not limited to the western United States. Even humid

regions like the Northeast can experience periods of high fire risk when hot, dry, and windy conditions occur together. This elevated risk is increasingly urgent with rising temperatures and drought stress in many parts of the region.

It is important for users to recognize the limitations of HDWI. The tool is not meant to replace local knowledge or other fire behavior tools. There are also many important aspects of fire behavior that HDWI does not account for. These aspects include fuel, landscape features, and sudden localized weather events such as [dry lightning strikes](#). Instead, HDWI works best as a tool to measure daily weather conditions that can make fire behavior hard to manage.

Agencies and natural resource managers continue to look for practical tools to better understand and communicate fire risk. In February 2026, Dr. Jay Charney (a co-author of the 2018 study) presented a [webinar](#) through the North Atlantic Fire Science Exchange (NAFSE) and Lake States Fire Science Consortium (LSFSC), who are both part of the Joint Fire Science Program’s Fire Science Exchange Network. The goal of the webinar was to help researchers and land managers understand the HDWI tool. Dr. Charney emphasized that HDWI is still evolving, and future work will focus on improving the tool’s performance and how it can directly support timely fire management on the ground.

References

This is a research brief based on: Srock, A. F., Charney, J. J., Potter, B. E., & Goodrick, S. L. (2018). The hot-dry-windy index: A new fire weather index. *Atmosphere*, 9(7), 279.

For more information see also: McDonald, J.M., Srock, A.F., & Charney, J.J. (2018). Development and application of a Hot-Dry-Windy Index (HDW) climatology. *Atmosphere*, 9(7), 285.

For real-time HDWI products and case studies visit: <https://hdwinindex.fs2c.usda.gov/>

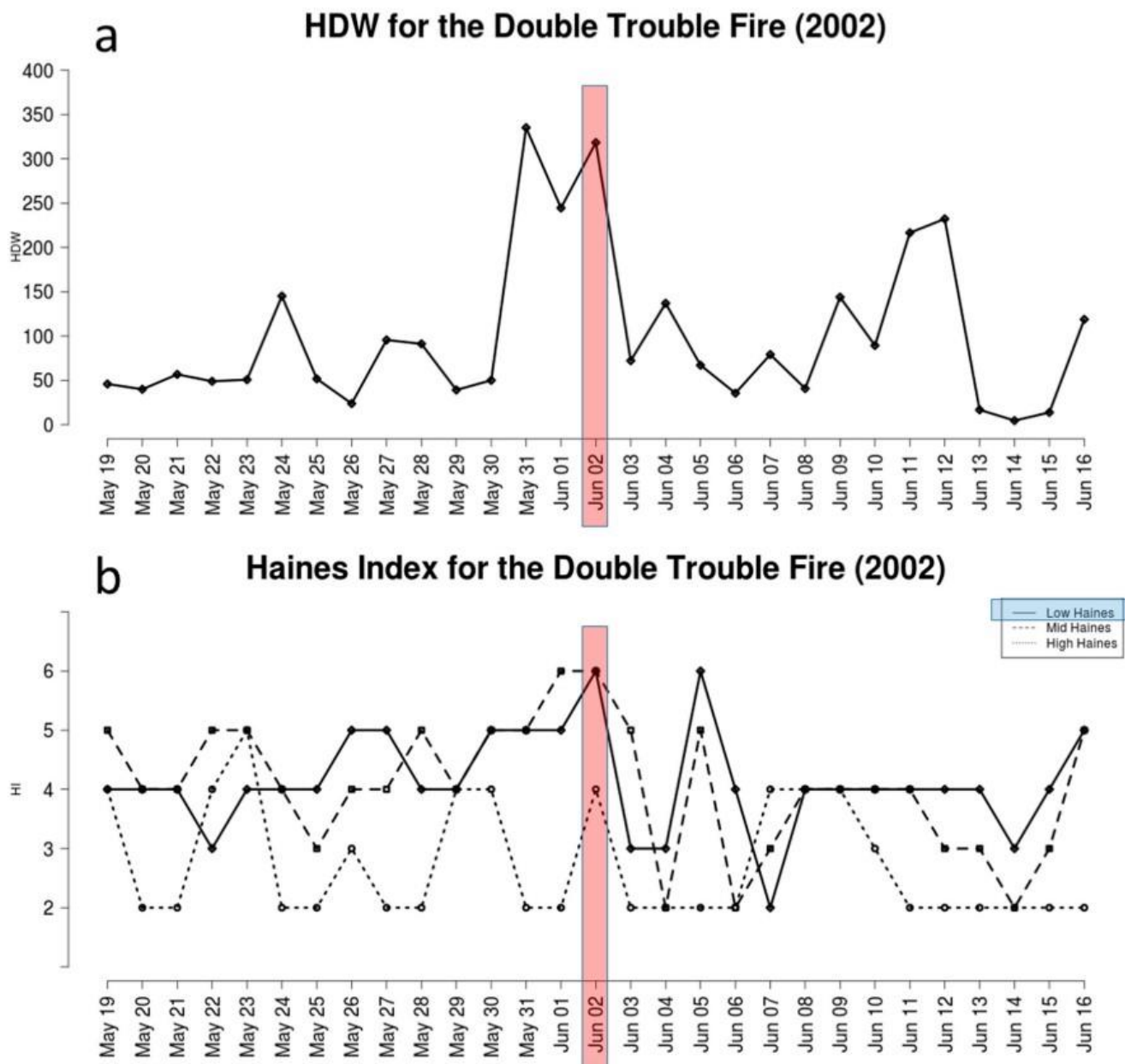


Figure 1. A comparison of (a) the HDWI and (b) the Haines Index for the Double Trouble Fire in New Jersey (Srock et al. 2018, Fig. 3). The fire occurred on June 2nd, 2002 (red rectangles). Each index has a high value the day of the fire. However, the peak for the HDWI around the day of the fire is much clearer than the Haines Index (specifically the Low Haines, the solid line, which is the appropriate Haines variant for this location). In other words, the HDWI around June 2nd (~325) is very high relative to the average HDWI values during the full sample period (~100, or a 225% increase on June 2nd), while the Low Haines value on June 2nd (6) is only marginally higher than the average Low Haines values over the same period (~4, or a 50% increase on June 2nd). Also, only HDWI clearly shows distinct, elevated fire risk immediately before the fire occurred.