SFE Fact Sheet 2016-1

SimpleFFMC: A New Calculator for Fine Fuel Moisture Content

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Introduction

Fine dead fuel moisture content (FMC) is a critical factor in fire behavior. As 1-hour fuels (needles, grass, leaves) dry out, flame length, rate of spread, fire intensity, and probability of ignition from embers increase. With grassy fuels (fuel models 1, 2, 3), a 5% decrease in dead fuel moisture content can produce approximately a 30 to 50% increase in rate of spread (ROS) on flat ground (BehavePlus). ROS increases are less dramatic in other fuel models, but it is clear that incorrect estimation of fine fuel moisture can have significant impacts on prescribed fire or wildfire suppression planning.

As part of the process for planning a prescribed burn or wildfire suppression activities, burn managers want to determine or estimate how fire behavior will change as weather and fuel conditions change. The BehavePlus fire behavior model is one method for evaluating the effects of factors such as relative humidity and fuel moisture on rate of spread and flame length. Fuel moisture is one of the primary input factors for BehavePlus simulations. Thus, reliable measurement or estimation of fine dead fuel moisture is critical for predicting fire behavior.

In the past, FMC has been estimated directly using various lab or field drying devices or indirectly from the common 10-hour fuel sticks. The direct process can be time consuming and is limited by the specific samples that are collected. They require repeated sampling to overcome the variability in fuel moisture across a site and over time. Alternatively, more general FMC estimates are calculated using tables based on weather and site measurements–the most common of which are those developed in 1983 and available in the Fireline Handbook Appendix B, the Introduction to Prescribed Fire in Southern Ecosystems, or in other resources. However, the accuracy of those tables for humidity and fuel conditions in the South has been questioned.

Beginning in 2014, a joint project between the Rocky Mountain Research Station Fire Lab (Matt Jolly) and the Florida Forest Service (Jim Brenner) focused on developing a fine fuel moisture model specific to the South. This fact sheet briefly describes how that project was conducted and focuses on the *SimpleFFMC* app that is now available for quick estimates of fine dead fuel moisture content.

How Was SimpleFFMC Developed?

Two pound samples of surface litter and fine fuels (pine needles, grass, hardwood leaves, palmetto leaves) were collected by state forestry staff from 25 different sites in seven states and shipped to the Forest Service Fire Lab in Missoula, MT where they were subjected to 12 combinations of relative humidity (20%, 60%, 80%, 95%) and air temperature (50°, 70°, 99° F) in carefully-controlled environmental chambers. Once fuels were equilibrated in each atmospheric combination, oven dry weight moisture contents were determined, and then used to calibrate a new and well-validated dead fuel moisture model (Nelson 2000). Jolly and Brenner then translated the complex Nelson model "to a simple linear model that calculates fine dead fuel moisture based on the measured fine dead fuel moisture from the previous time step plus corrections for evaporation, moisture movement and rainfall" (Jolly 2016).

Reliable measurement or estimation of fine dead fuel moisture is critical for predicting fire behavior. Photo: Andrew Ruth.

Calculating Fine Dead Fuel Moisture Content with SimpleFFMC

SimpleFFMC is now available for determining fine dead fuel moisture in two formats, both based on a stepwise process using weather measurements (steps 1 and 8) and a set of reference tables (steps 2 to 6):

1) Measure air temperature and relative humidity, and estimate local rainfall and solar radiation;
2) Estimate fuel surface temperature;
3) Estimate equilibrium fuel moisture content;
4) If it rained over the last hour, look up rainfall moisture factor;
5) If previous moisture content is less than 30%, look up moisture correction factor;
6) If previous moisture content is greater than 30%, look up evaporation correction factor;
7) Calculate the new FMC by adding the previous FMC and the correction factors in steps 4 to 6;
8) Repeat the process at time of next weather measurement, using the FMC in step 7.

The calculation flowchart, reference tables and a computation worksheet are available online in PDF format at www.wfas.net/ffmc/docs.

Field use of *SimpleFFMC* has been facilitated with a new web-based interactive mobile app which only requires the inputs in Step 1 and 8 above (Figure 1). The app is available for online use at www.wfas.net/ffmc. The top four entries in Figure 1 are the weather measurements and estimates in steps 1 and 8 above. If it is the first observation, double click on the Prev MC box and it will calculate the equilibrium fuel moisture content as the New MC (bottom entry in Figure 1). At the next measurement period, click the Copy to Prev button at the bottom to copy the New MC to the Prev MC and start a new set of calculations.

How It Will Be Applied in the Future

The equations that were translated from Nelson's complex model will be included in the next major release of the BehavePlus Fire Modeling System, and will be used to create the next generation of tables for the Fireline Handbook and other firefighter field references. Additionally, the new fuel moisture calculations will be included in a future version of the Fire Weather Calculator mobile app that is available for Apple and Android-based devices.

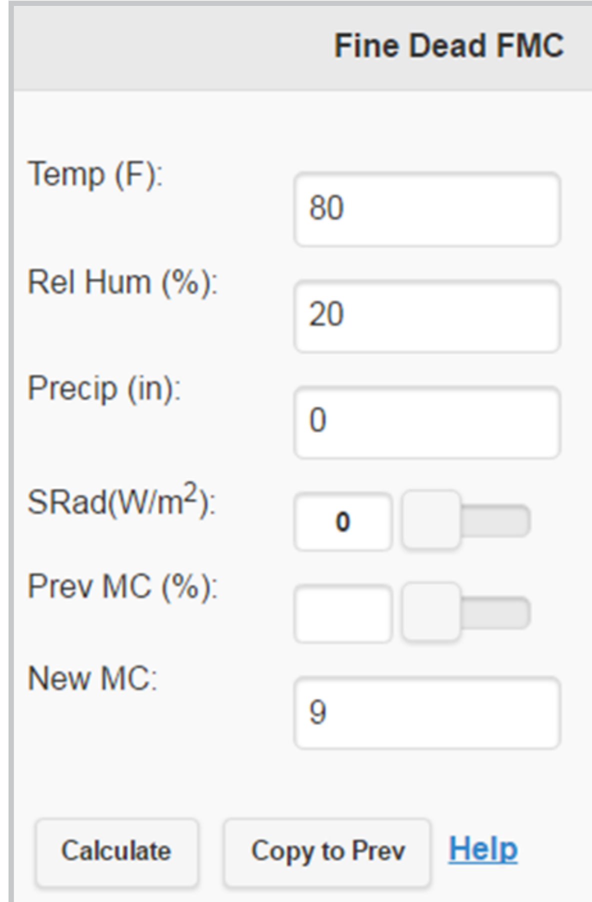

Figure 1. Online input screen for FMC calculations (www.wfas.net/ffmc).

References

Jolly, M. 2016. Development of fine dead fuel moisture field references for the Southeastern United States: SimpleMC. Final Report. 22 p.

Nelson, R.M. Jr. 2000. Prediction of diurnal change in 10-h fuel stick moisture content. *Canadian Journal of Forest Research 30*(7): 1071-1087.

Waldrop, T.A. & S. Goodrick. 2012. Introduction to prescribed fires in Southern ecosystems. Science Update SRS-054. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 80 p.

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The Southern Fire Exchange is funded through the Joint Fire Science Program, in agreement with the United States Forest Service, Southern Research Station. This institution is an equal opportunity provider.