LANDFIRE Drought Based Fuel Dynamic for the Southeast GeoArea

Overview

The LANDFIRE Program strives to produce consistent and relevant fire behavior fuel model grids for the U.S. While these models are relevant for predicting fire behavior, including spread and intensity, during average conditions, they often fall short during drought or seasonably dry conditions, particularly in the Southeast GeoArea. Drought in the Southeast manifests in two ways: 1) water tables recede, and 2) previously submerged fuel beds dry up and are exposed. When dry conditions persist, both living and non-living vegetation dries out, which adds combustible fuel. LANDFIRE, in a continuing effort to improve the functionality of the fuel products, has proposed the use of the Drought Based Fuel Dynamic (LF_DBFD) system to improve the accuracy of the Southeast fuel products. The LF_DBFD system systematically transitions surface fuel models, based on seasonal conditions, by addressing fuel loading and fuelbed depth. This document describes the LF_DBFD system and how it was applied to the Southeast GeoArea (Table 1).

Table 1) LANDFIRE Drought Based Fuel Dynamic system for the Southeast GeoArea.

1)	LF_DBFD begins with the 1988 revisions to the National Fire Danger Rating System
2)	Additional fuel weight and depth is added by KBDI drought classes
3)	LF_DBFD linkage of NFDRS 1988 fuel models to FBFM40 fuel models
4)	Fuel model transitions determined by LANDFIRE EVT
5)	Intersection of current KBDI levels with FBFM40 fuel layers to transition fuel models

1988 revisions to the National Fire Danger Rating System

The LF_DBFD for the Southeast GeoArea was developed based on the 1988 Revised National Fire Danger Rating System (NFDRS 1988; Burgan 1988). These revisions addressed concerns raised by users in the Southeast, particularly how fuel moisture changes during periods of drought (Schlobohm and Brain 2002). In the NFDRS 1988, there are descriptions of fuel bed characteristics for each fuel model, along with suggested fuel load additions based on severe drought conditions. Each fuel load addition has formulas that calculate fuel weight in proportion to the fuel time-lag size classes. These formulas also account for fuel bed depth, which increases along with fuel weight, to maintain the packing ratio of the fuel model.

Additional fuel weight and depth and associated KBDI drought class

In response to the NFDRS 1988 fuel model revisions for severe drought conditions, the Keetch-Byram Drought Index (KBDI; Keetch and Byram 1968) was included to account for additional fuel load and weight. KBDI estimates the amount of precipitation needed to restore the soil moisture content (top eight inches) back to saturation. Table 2 lists the KBDI values with a 0 value representing complete soil saturation and a value of 800 representing extreme drought.

Table 2) List of the KBDI values.

0 - 200	Soil moisture and large class fuel moistures are high and do not contribute much to fire intensity. Typical of spring dormant season following winter precipitation.
200 - 400	Typical of late spring, early growing season. Lower litter and duff layers are drying and beginning to contribute to fire intensity.
400 - 600	Typical of late summer, early fall. Lower litter and duff layers actively contribute to fire intensity and will burn actively.
600 - 800	Often associated with more severe drought with increased wildfire occurrence.

	Intense, deep burning fires with significant downwind spotting can be expected. Live fuels can also be expected to burn actively at these levels

Additional weight and depth from the NFDRS 1988 fuel models expressed as percentages were correlated with associated KBDI values. KBDI values were then divided into drought classes (low, moderate, and high), which in turn determined the fuel model transition (Table 3).

Table 3) NFDRS 1988 portion of additional fuel loading that was added, along with associated KBDI break points, and drought classifications.

KBDI Values	**Drought Classification**	**NFDRS 1988 Additions**
0 -200	No Drought	None (uses the LF 2012 FBFM40 fuel model)
200 -400	Low Drought	25% of additional weight and depth added to fuel model
400 -600	Moderate Drought	55% of additional weight and depth added to fuel model
600 -800	High Drought	100% of additional weight and depth added to fuel model

LF_DBFD linkage of NFDRS 1988 fuel models to FBFM40 fuel models

As fuel loading and depth are increased by drought, specific fuel attributes were assessed (Table 4) and compared with the NFDRS 1988 models. In the LF_DBFD system, additional loading and depth were divided by fuel size and class into three levels of drought, as expressed by KBDI, and then cross walked to the LANDFIRE Fire Behavior Fuel Model 40 (FBFM40) layers. The crosswalk was done for each of the three KBDI drought classifications by fuel attributes (Table 4).

Table 4. Specific fuel attributes assessed during severe drought conditions.

Fine dead fuel load
Total dead fuel load
Live fuel load
Fuel bed depth
Moisture of extinction

Fuel model transitions determined by LANDFIRE EVT

As the specific fuel attributes were assessed (Table 4), the Existing Vegetation Type (EVT) for each transitioning fuel model was considered. For example, the FBFM40 143 shrub model transitions differently when in a swamp EVT compared to an upland EVT. Herbaceous fuels and life-form pixels have different drought condition transitions (low, moderate, and high) in agricultural EVT's verses natural EVT's. In the Southeast, the majority of calibrated fuel models replicated the most frequent burning condition, which is during wet circumstances. Most of the acres in in the Southeast GeoArea were assigned timber litter models of FBFM40 182, 183, 186 (36% of the total area were in these fuel models, which is much higher than the next closest fuel type, grasses at 24%). A concerted effort was made during the transition process to use FBFM40 timber understory models when supported by EVT, rather than using timber litter fuel models, which have higher moistures of extinction, or humid climate models.

Intersection of current KBDI levels to FBFM40 fuel layers to transition fuel models

A look up table was developed, starting with the LF 2012 FBFM40 models which then transitioned to either the same, similar, or more aggressive fuel model depending on the EVT and drought class. The look up table is applied to the LF2012 FBFM40 layer, combined with the current KBDI layer provided by the Wildland Fire Assessment System, to determine which fuel model best represents the drought

condition being observed for each pixel. In this way, wall to wall fuel layers depicting the transitioned fuel models are generated and can then be distributed.

References

Burgan, Robert E. 1988. 1988 revisions to the 1978 national fire-danger rating system. Research Paper SE-273. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 144 pp.

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Schlobohm, Paul, and Brain, Jim. 2002. Gaining an understanding of the National Fire Danger Rating System. Boise ID: National Wildfire Coordinating Group, Fire Danger Working Team. 82 pp.