Understanding Fire Danger

Fire Danger is a description of the combination of both constant and variable factors that affect the initiation, spread, and difficulty to control a wildfire on an area. There are many system and schemes that attempt to provide accurate and reliable predictions of fire danger, that analyze the fuel, topography, and weather, and integrate their effects into a set of numbers that fire managers can use to meet his or her needs.

Relative Humidity

Relative humidity (RH) is the ratio of the amount of moisture in the air to the amount of moisture necessary to saturate the air at the same temperature and pressure. Relative humidity is expressed in percent. RH is measured directly by automated weather stations or manually by wet and dry bulb readings taken with a psychrometer and applying the National Weather Service psychrometric tables applicable to the elevations where the reading were taken.

Relative humidity is important because dead forest fuels and the air are always exchanging moisture. Low humidity takes moisture from the fuels, and fuels in turn, take moisture from the air when the humidity is high. Light fuels, such as grass and pine needles, gain and lose moisture quickly with changes in relative humidity. When the RH drops, fire behavior increases because these fine fuels become drier. Heavy fuels, on the other hand, respond to humidity changes more slowly. To see significant changes in heavy fuel moisture, there must be significant moisture, usually more than a single storm. (See FUEL MOISTURE)

Fuel Moisture

Fuel moistures are measured for live Herbaceous (annual and perennial) and Woody (shrubs, branches and foliage) fuels and Dry (dead) fuels. These are calculated values representing **approximate moisture content of the fuel**. Fuel moisture in live fuels varies through the growing season and between different climate classes. There are 20 different fuel models, representing the variety of vegetation in the area, a manager can use when calculating fire danger.

Dead fuel moisture is the moisture content of dead organic fuels, expressed as a percentage of the oven dry weight of the sample. Dead fuel moisture is controlled solely by exposure to environmental conditions and is **critical in determining fire potential**. Dead fuel moistures are classed by time lag. A fuel's time lag is the time necessary for a fuel particle of a particular size to reach 63% of equilibrium between its initial moisture content and its current environment.

Dead fuels in NFDRS have **four time lag classes:**

- **1 hour—Fine flashy fuels**, dried herbaceous plants or round wood **less than 1/4" diameter**. Also includes the uppermost layer of litter on the forest floor. **Responds quickly to weather changes.** It varies greatly throughout the calendar day and is principally responsible for diurnal changes in fire danger. It is computed from observation, time, temperature, humidity and cloudiness.
- **10 hour—Round wood 3/4" to 1" diameter**and the layer of litter that extends to 3" to 4" below the surface. It is computed from observation, time, temperature, humidity, and cloudiness, or may be a standard set of "10-Hr Fuel Sticks" that are weighed as part of the fire weather observation.
- **100 hour—1" to 3" diameter.**It is computed from 24 hour average boundary condition composed of day length, hours of rain, and daily temperature and humidity ranges.
- **1000 hour—3" to 6" diameter.**It is computed from a 7-day average boundary condition composed of day length, hours of rain, and daily temperature and humidity ranges.

Live Fuel Moisture

Live fuel moisture is the water content of live herbaceous plants expressed as a percentage of the oven-dry weight of the plant. Typical herbaceous fuel moisture values start low and increase rapidly as the growing season progresses. Lower values indicate drier materials and higher fire danger.

Critical live fuel moistures for Central Texas:

Eastern red cedar: ≤80%
Yaupon: ≤100%
Loblolly pine: ≤120%

Drought Maps

Keetch-Byram Drought Index (KBDI)—This can be used to **measure the effects of seasonal drought on fire potential**. The actual numeric value of the index is an estimate of the amount of precipitation (in 100ths of inches) needed to bring soil back to saturation (a value of 0 being saturated). The index deals with the **top 8 inches of soil profile** so the maximum KBDI value is 800 (8 inches), the amount of precipitation needed to bring the soil back to saturation. The index's relationship to fire is that as the index values increase, the vegetation is subjected to greater stress because of moisture deficiency. **At higher values** living plants die and become fuel, and the duff/litter layer becomes **more susceptible to fire**.

KBDI = 0–200—Soil moisture and large class fuel moistures are high and **do not contribute much to fire intensity**. This is typical of spring dormant season following winter precipitation.
KBDI = 200–400—Typical of late spring, early growing season. Lower litter and duff layers are drying and beginning to contribute to fire intensity.
KBDI = 400–600—Typical of late summer, early fall. Lower litter and duff layers actively contribute to fire intensity and will burn actively.
KBDI = 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.

Haines Index

The **Lower Atmosphere Stability Index**, or **Haines Index**, is computed from the morning (12Zulu) soundings from Radiosonde Observation (RAOB) stations across North America. The index is composed of a stability term and a moisture term. The stability term is derived from the temperature difference at two atmosphere levels. The moisture term is derived from the dew point depression at a single atmosphere level. This index has been shown to **correlate with large fire growth** on initiating and existing fires where surface winds do not dominate fire behavior. Haines Indexes **range from 2 to 6** for indicating potential for large fire growth:

- **2** Very Low Potential (Moist Stable Lower Atmosphere)
- **3** Very Low Potential
- **4** Low Potential
- **5** Moderate Potential
- **6** High Potential (Dry Unstable Lower Atmosphere)

Energy Release Component (ERC)

The Energy Release Component is defined **as the potential available energy per square foot of flaming fire at the head of the fire** and is expressed in units of British Thermal Units (BTU) per square foot. Like the Spread Component [anchor: "Spread Component"], the Energy Release Component is calculated using tables unique to each fuel model. The rate of combustion is almost totally dependent on the same fuel properties as are considered in the SC calculation. However, the principal difference in the calculation of the two components is that SC is determined primarily by the finer fuels, whereas ERC calculations require moisture inputs for the entire fuel complex, i.e., 1-hr. , 10-hr. , 100-hr. , 1000-hr. , and the live fuel moisture.

Useful Links

Most of this handout is taken from the National Park Service Fire and Aviation Page.
https://www.nps.gov/fire/wildland-fire/learning-center/fire-in-depth/understanding-fire-danger.cfm

Texas Fire Weather – twc.tamu.edu/tfd – Maps depicting KBDI, ERC, 10 hr. and 100 hr. dead fuel moistures.

Noaa.gov or weather.gov – After selecting your location, navigate to Hourly Weather Forecast under Additional Resources, which can be found on the right side of the page. Once the Hourly Weather Forecast is open, select Haines Index and Red Flag Threat Index to turn those layers on; click Submit to refresh the view.

Live fuel moisture - http://www.wfas.net/nfmd/public/states_map.php?state=TX
This site presents live fuel moisture levels for a variety of fuels in both tabular and chart formats.