Keetch–Byram Drought Index: Can It Help Predict Wildland Fires?

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The Georgia Forestry Commission uses the Keetch–Byram Drought Index (KBDI) (Keetch and Byram 1968) to determine potential wildland fire hazards. (For an overview of KBDI, see the sidebar.) The objectives of our study were to better understand the relationship between KBDI and fire activities in Georgia and to evaluate KBDI computed from National Weather Service (NWS) observational data compared with KBDI computed from fire weather observations.

What We Did

Traditionally, fire weather observations for determining wildland fire hazards are recorded at 1 p.m. daily. This means that the maximum temperature recorded at this time usually occurs during the previous day's afternoon hours. Likewise, the 24-hour precipitation recorded is from 1 p.m. on the previous day until 1 p.m. on the present day. By contrast, the NWS reports maximum temperature and 24-hour precipitation for the 24-hour period ending at midnight.

To compare NWS data to traditional fire weather data, we used NWS hourly data from Athens Municipal Airport, Macon Regional Airport, and Savannah International Airport from 1957 to1995. From these data, we constructed a fire-weather-type observation for both 1 p.m. and midnight. Then we used the data to calculate a KBDI for the two defined observation times.

Daily records for the 24-hour period ending at 1 p.m. and daily records ending at midnight can yield different maximum temperature and rainfall data for the previous 24-hour period. If a heavy rain incident occurred after 1 p.m., the KBDI numbers from 1 p.m. and

Georgia's typical fire season from 1957 to 2000 ran from February through April—when the Keetch–Byram Drought Index was lowest.

What is the Keech–Byram Drought Index?

According to Melton (1989), the Keetch–Byram Drought Index (KBDI) is an index based "on a measurement of 8 inches (0.2 m) of available moisture in the upper soil layers that can be used by vegetation for evapotranspiration.

The index measure is in hundredths of an inch of water and has a range of 0 to 800, with 0 being saturated and 800 representing the worst drought condition. The index indicates deficit inches of available water in the soil. A K/B reading of 250 means there is a deficit of 2.5 inches (6.4 cm) of ground water available to the vegetation. As drought progresses, there is more available fuel that can contribute to fire intensity."

If a location has been dry during the previous 24 hours, the KBDI will increase, depending on the maximum temperature in the previous 24 hours, the previous day's index, and the annual rainfall amount at that location. Generally, high temperature and a low KBDI mean big increments.

When an area has received rain during the previous 24 hours, the index changes, depending on the rain-adjusted KBDI—for each 0.01 inches (0.03 cm) of net rainfall, one point is subtracted from the previous day's index—the maximum temperature, and annual rainfall amount at that location.

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In Georgia, the Keetch–Byram Drought Index alone is not a good indicator for fire activity.

midnight could yield a difference of a hundred points or more. Although KBDI computed from 1 p.m. averaged higher than KBDI computed from the midnight data, we decided that the midnight KBDI is a good approximation of the 1 p.m. KBDI (fig. 1).

After determining that the midnight and 1 p.m. indexes were comparable, we obtained daily weather data from selected NWS cooperative weather stations in Georgia between 1950 and 2001 through Georgia's State Climatologist Office. These cooperative daily stations record data once each day for maximum and minimum temperatures and 24-hour precipitation. Although observation times vary at these stations, our analysis of the NWS hourly data indicated minimal differences between a 1 p.m. and midnight observation time. Based on this analysis, we assumed that the differences due to varying observations at the cooperative stations would also be minimal, and we chose 14 stations across Georgia (fig. 2).

What We Found

Average quarterly temperatures from 1961 to 1990 at the stations we sampled are shown in figure 3. The hottest months were June, July, and August at all stations. The stations in northern Georgia had lower temperatures than those in the south. The temperature difference between the hottest and the coolest stations was less than 10 °F (5.5 °C).

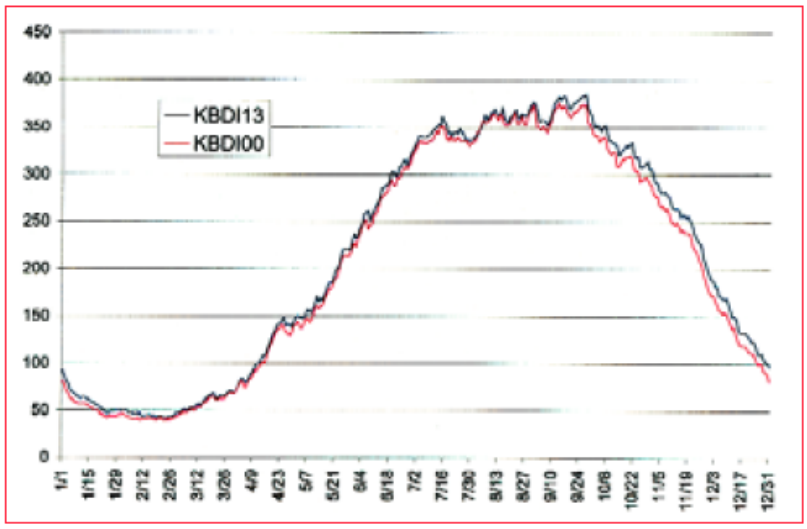

Figure 1—*Average Keetch–Byram Drought Index (KBDI) climatology at Athens, GA, for midnight (KBDI00) and 1 p.m. (KPDI13), 1957–95. There is no significant difference.*

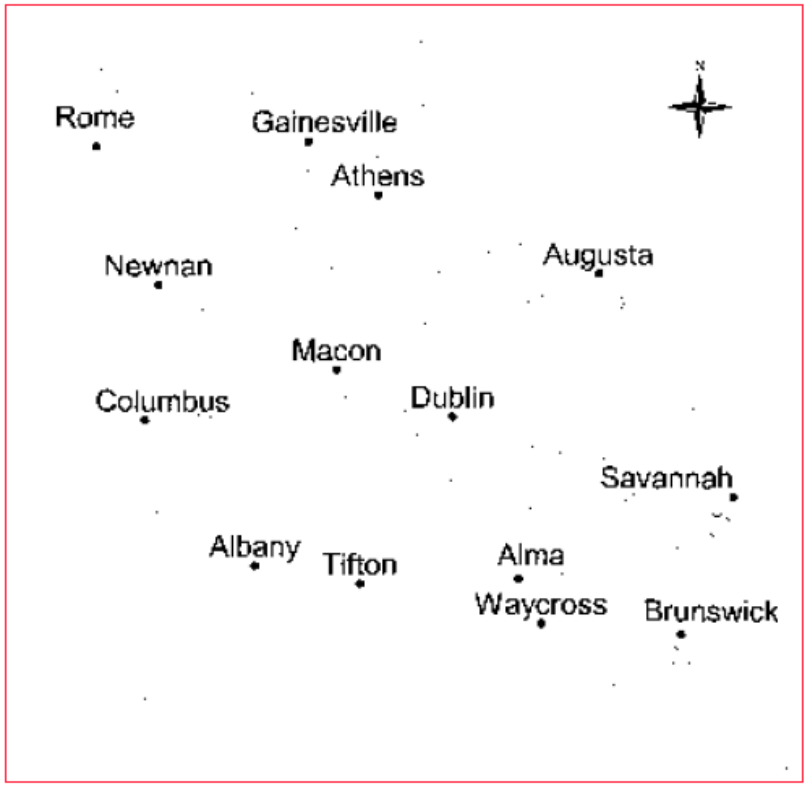

Figure 2—*The 14 National Weather Service cooperative weather stations chosen for the KBDI study, located across Georgia.*

Average quarterly rainfall from 1961 to 1990 for the selected stations is shown in figure 4. At stations in northern and central Georgia, January, February, and March are the rainy season. But at stations near the coast, such as Savannah, Waycross, Brunswick, and Alma, the rainy months are June, July, and August. We found

Wildland fire incidents in Georgia followed the burn seasons of spring and fall rather than the high Keetch–Byram Drought Index months of summer.

that KBDI was low at coastal stations during June, July, and August due to high rainfall levels in this region. Conversely, when rainfall was low at coastal stations during January, February, and March, KBDI was higher. Therefore, the seasonal range of KBDI at coastal stations was smaller than at stations located elsewhere (fig. 5).

In Georgia, KBDI is typically lowest in February or March and highest in August. However, the number of fires and acres burned from 1957 to 2000 suggested just the opposite (fig. 6). Georgia's typical fire season for those years ran from February through April, when KBDI was lowest. Fire activities then dropped off gradually from May through September and picked up again in October as KBDI began to drop. Obviously, other factors besides KDBI were influencing the fire episodes.

According to fire reports collected by the Georgia Forestry Commission, we found that human activities caused 95 percent of wildland fires in Georgia from 1957 to 2000 (fig. 7). Almost half of the fires were caused by outdoor burning, which is mostly done in spring and autumn. Therefore, wildland fire incidents corresponded to the burning seasons—especially spring—rather than the high KBDI months of summer.

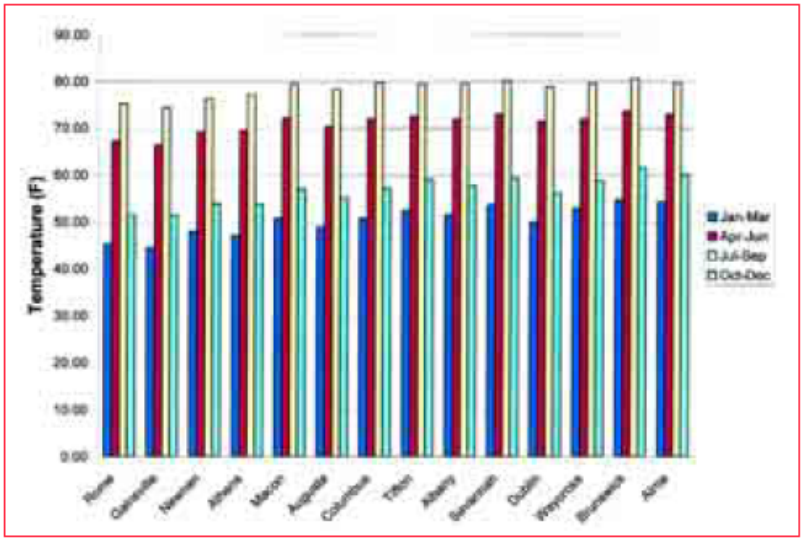

Figure 3—*Average quarterly temperature at 14 National Weather Service cooperative weather stations, 1961–90.*

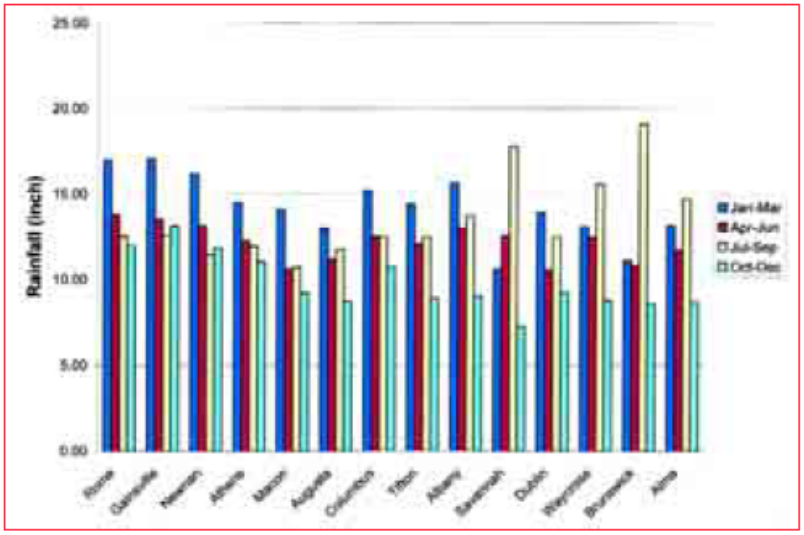

Figure 4—*Average quarterly rainfall at 14 National Weather Service cooperative weather stations, 1961–90.*

There were exceptions to a low KBDI during the spring. In 2001, KBDI at Waycross in southeastern Georgia rose steadily from 100 in April to more than 600 by the end of May (fig. 8), which is more than 150 points above normal. This finding suggests that fuels were very dry and fires could be difficult to control—which was exactly what happened. In late May, severe fire activities in southeastern Georgia burned almost 16,000 acres (6,500 ha). More than 360 people were involved in the firefighting effort, and about $1 million was spent to control the dangerous fires.

What We Think

All this information helped us to conclude that KBDI alone is not a good indicator for fire activities. It

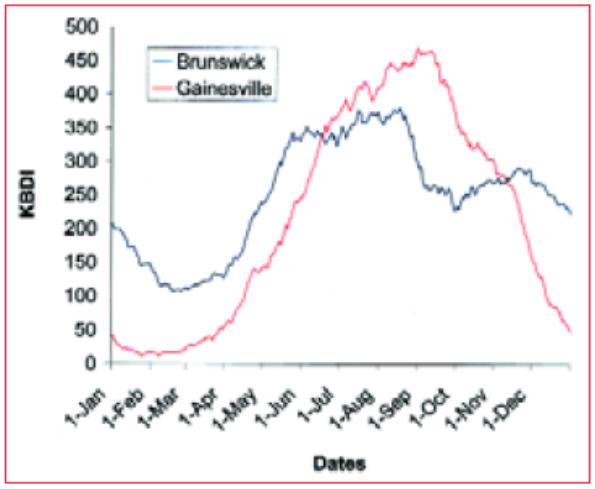

Figure 5—*Average KBDI climatology at Georgia stations on the coast (Brunswick) and inland (Gainesville), 1957–95. The seasonal range of KBDI is smaller on the coast.*

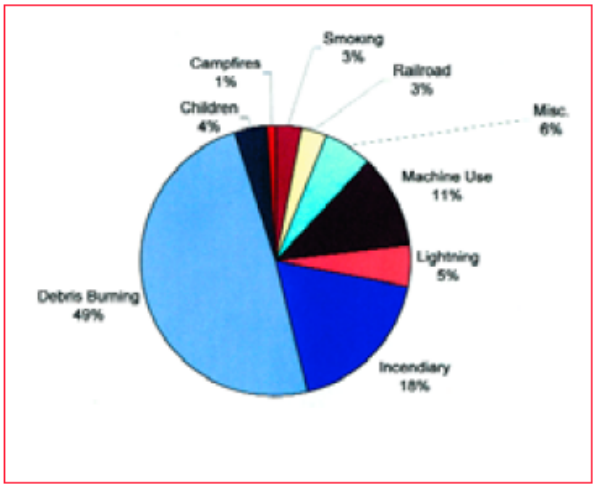

Figure 7—*Causes of wildland fires in Georgia, 1992–2001.*

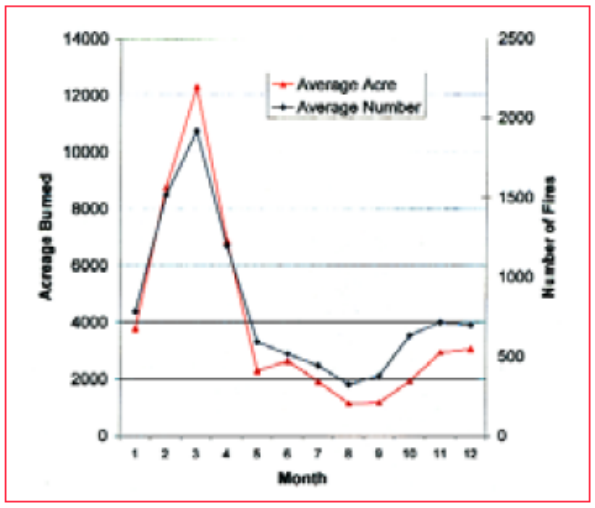

Figure 6—*Average number of wildland fires and acres burned in Georgia by month, from January (1) to December (12), 1957–2000.*

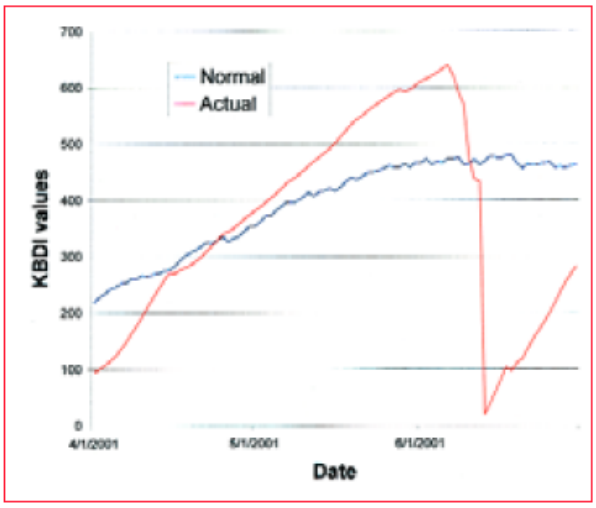

Figure 8—*KBDI values for Waycross, GA, from April to June 2001 differed greatly from normal, suggesting that fuels were much drier than usual and fires could be more difficult to control.*

should be used only in conjunction with other reliable sources of information to predict wildland fires. However, a higher-than-normal index or a sustained rise in the index could mean that the potential for wildland fire is high.

Knowing how KBDI varied across Georgia could be helpful to fire managers when planning resource allocation. Managers should be alert to a potential fire hazard when KBDI is higher than normal during summer.

References

Keetch, J.J.; Byram, G.M. 1968. A drought index for forest fire control. Res. Pap. SE–38. Asheville, NC: USDA Forest Service, Southeastern Forest Experiment Station.

Melton, M. 1990. The Keetch/Byram Drought Index: A guide to fire conditions and suppression problems. Fire Management Notes. 50(4): 30–34. ■