Potential Applications of Keetch-Byram Drought Index Forecasts for Fire Management Decisions in Georgia and Florida

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Abstract

Georgia and Florida combined have some 40 million acres of forests worth approximately $20 billion and employing nearly 200,000 workers. Most forest holdings are private ownerships. In a typical year wildfires burn about 100,000 acres. A wildfire forecast was developed by the Southeast Climate Consortium and has been available on the Internet at AgClimate.org since January 2005. In May and June 2006 a stakeholder assessment was conducted to understand current and potential uses of the forecast and to elicit feedback for product improvement. Although few forest managers were aware of the KBDI forecast, most judged it to be a very useful, informative, and easy to interpret tool. Decision makers mentioned they will incorporate the KBDI forecast into their planning for human resource, equipment, transportation, wildlife, and financial management; prescribed burning, procurement, and education or extension programs. Managers recommended that SECC should undertake several actions to improve the effectiveness of the KBDI forecast, namely: 1) conduct an outreach campaign targeted to key stakeholders; 2) send out a monthly KBDI outlook to relevant stakeholders; 3) refine the presentation of the forecast to respond to stakeholder feedback; 4) continue efforts to fine-tune spatial resolution; 5) include tutorials and explanations of how the forecast is produced; and 6) monitor and report on accuracy of the forecast.

Introduction

Studies have shown a connection between the El Niño Southern Oscillation (ENSO) and the potential for wildfire activity in Florida and in the southern coastal plain of Georgia. (Brenner, 1991; Jones et al., 1999). While this connection lends a degree of predictability to future wildfire activity, human intervention such as ignition, prescribed burns, and effective suppression, can also play a role. Wildfire occurrence and wildfire potential are not the same. Potential may be high and occurrence low where stands have burnt in previous seasons.

In 2001 a fireworks company inquired about the possibility of a wildfire risk forecast for planning and marketing purposes because bans on burning during periods of drought affected their business. The Center for Ocean Atmospheric Prediction Studies (COAPS) at Florida State University produced an ENSO-based forecast of mean monthly Keetch-Byram Drought Index (KBDI) values. The Keetch-Byram drought index is a continuous reference scale for estimating the dryness of the soil and duff layers. Duff is the thick, spongy forest floor that results when decomposition is slower than accumulation of new litter. The index is well-suited as a climate forecast medium for two reasons: a) it is based on daily temperature and rainfall measures and

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responds to changing climate and weather conditions on time scales of days to months, and a) foresters and fire managers in the Southeast US are familiar with it, since it has been widely used for the last 30 years.

An experimental probabilistic forecast of the KBDI for the entire wildfire season (January through July) was created in 2002-03 for the State of Florida. The forecast is now produced operationally for Florida, Georgia, and Alabama, and posted on the Southeast Climate Consortium (SECC) outreach website (www.AgClimate.org; Fraisse et al., 2006).[2] Weather data that drive the KBDI forecast are taken from hundreds of National Weather Service (NWS) observer sites in Florida, Georgia, and Alabama. This large network enables the formulation of forecasts at the county scale. The KBDI forecast is presented in a series of four color-coded maps showing the probability of the KBDI being in the following categories:

Abnormally dry (KBDI of 450 or above)
Moderately dry (KBDI of 500 or above)
Severely dry (KBDI of 550 or above)
Extremely dry (KBDI of 650 or above)

Because KBDI is driven by daily weather and can change drastically based on one or more rainfall events, the maps show the probability of exceeding the threat level for at least 7 days during the month, rather than for the month as a whole. Goodrick (1999) has shown that increased wildfire potential is linked with the deviation of the KBDI from seasonal normal levels. In the forecast maps, counties are given a plus sign to indicate a greater than normal wildfire threat for that month or a minus sign to indicate a risk level lower than normal. Normal conditions are based on the long-term climatology for the county consisting of all observed historical conditions since 1948. Forecasts are based on initial conditions, that is, current KBDI values, and expected temperature and precipitation patterns associated with climate impacts of ocean temperature variations in the tropical Pacific. Forecasts are updated monthly as conditions change.

2 The SECC is a multidisciplinary research partnership, involving researchers of six universities -- University of Miami, University of Florida, Florida State University in Florida, University of Georgia, Auburn University, and University of Alabama-Huntsville. The primary goal of the SECC is to develop climate-based decision support tools and information for crop, livestock, forest, and natural resource management. The SECC receives funding as a Regional Integrated Sciences and Assessments Center from the Climate Program Office of the US National Oceanic and Atmospheric Administration. The SECC also receives funding from the Risk Management Agency and Cooperative State Research, Extension, and Education Services of the US Department of Agriculture.

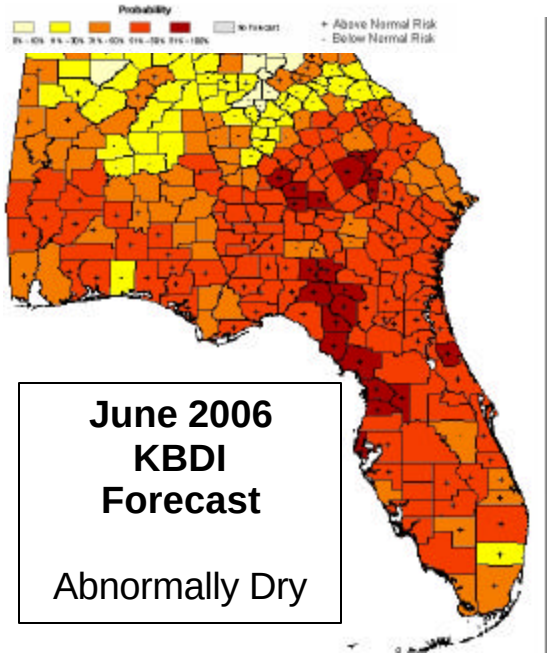

Figure 1. Example KBDI forecast graphic issued in January 2006 and displayed on *AgClimate* (http://agclimate.org).

The KBDI forecast format was developed through many discussions with fire weather experts at the Florida Division of Forestry, the Georgia Forestry Commission, USDA Forest Service, and with extension forestry specialists. The first KBDI forecasts were produced at the climate-division scale in 2002 and 2003 with limited distribution. The first county-level KBDI forecasts were produced in 2004 and were first distributed on AgClimate in 2005. The KBDI forecast in its current form was first presented at the Eastern/Southeastern States Seasonal Assessment Workshop, sponsored by the National Interagency Coordination Center in January of 2006. The outcome of the workshop was a seasonal wildfire outlook for the Southeast, which included the KBDI forecast as one of its components. The SECC also presents the KBDI forecast as a component of the AgClimate information delivery system, which has been introduced to potential users in a variety of workshops and meetings (Fraisse et al., 2006).

In June 2006 a stakeholder assessment was conducted, based on approximately 20 phone interviews with a purposive snowball sample of respondents. In a purposive sample respondents are selected based on specific criteria rather than by random sampling. A snowball sample is formed when respondents are asked to provide names of other people to interview. The sample included scientists, forest and fire managers, timber industry representatives, NGOs, and private forest consultants. At the time of the interviews, both Florida and Georgia were in the midst of a severe drought, which meant that wildfire activity was higher than usual. Forest managers estimated the number of wildfires in Georgia to be about three times greater than normal. Likewise, according to industry representatives, wildfires burned about three times the average number of acres in Florida, causing many losses, particularly in pine plantations.

Interviews followed an open ended format to understand how the KBDI forecast may be applied to management decisions. Examples of questions asked are:

- What is your assessment of the current fire season?
- How is fire management different in your area from that in other areas?
- What are the main management options and decisions that you are considering?
- What are the processes and principles that shape your decisions?
- What types and sources of information do you use in reaching your decisions?
- What are the potential uses of SECC forecasts in fire management?
- What factors may influence the value of the SECC forecast?
- Who are the principal stakeholders in fire management in your area?

In most cases respondents were asked to access the AgClimate website during the interviews and provide feedback on the presentation of the KBDI forecast. This paper synthesizes the key findings from the assessment. The information presented draws on the respondents' personal opinions and does not represent an official position of the federal, state, or local agencies mentioned.

Forest Resources and Wildfires

Forestlands are of great economic importance for Georgia and Florida. Forestlands not only supply timber products, but also provide wildlife habitat, watershed protection, and opportunities for recreation and tourism. Georgia has the largest acreage under commercial forest in the US. Forest covers two-thirds of the state (24.7 million acres). About 74% of forestland is owned by private non-industrial landowners. The forest industry employs 65,700 people and has a direct economic impact of $12.7 billion. In a typical year, 8,700 separate fires burn about 38,000 acres, with 25% to 50% of the fires occurring in the Okefenokee National Wildlife Refuge. Hotspots for fire activity in Georgia are in the mountains of the northeast and the swamps of the southeast, both of which are difficult to reach with fire fighting equipment (http://www.gfc.state.ga.us/AboutUs/AboutUs.cfm).

Florida has over 16 million acres of forests, representing nearly half of the state's land area. Of this total, Florida has over14 million acres of commercial timberland, mostly located in northern peninsular Florida and the Panhandle area. Almost half (47%) of forestland is owned by private non-industrial landowners. The forest industry employs 133,000 persons with an annual payroll of $5 billion. Typically, each year over 3,000 fires burn some 50,000 acres, but numbers vary widely from year to year. In the first half of 2006, there were 3,234 wildfires that burned a total of 178,357 acres. (http://www.fl-dof.com/wildfire/stats_fires_since1981.html).

Key Fire Management Stakeholders

Government agencies: The two main agencies involved in wildfire management that were contacted for this report are the Florida Division of Forestry (FDF) and the Georgia Forestry Commission (GFC). Each state is divided in a number of wildfire management districts (15 in Florida, 10 in Georgia), each of which includes multiple counties. A district forester or ranger supervises chief foresters or rangers, each of whom supervises a forester or ranger in one or more counties. The FDF uses information from various sources, including the SECC, to produce and post a 3-month outlook for the forest sector on their website [http://www.fl-

dof.com/fire_weather/forecast/seasonal_forecast.html]. The outlook is probabilistic and explains trends for upcoming dry or wet conditions. The GFC issues fire danger ratings based on observed conditions at weather stations across the State. It also publishes a daily map of KBDI value on its website [http://weather.gfc.state.ga.us/Maps/kbdi.gif].

The US Fish and Wildlife Service Fire Management Program is administered as part of the National Wildlife Refuge System under the Division of Natural Resources. This program protects and manages burnable acres on federal lands, including the Okefenokee National Wildlife Refuge. Other potential stakeholders among federal agencies are the Department of Agriculture and Department of the Interior. These agencies conduct hazardous fuels reduction projects on National Forest System and Bureau of Land Management lands, which aim to protect communities and watersheds from catastrophic fires and to enhance the health of forestlands, rangelands, and other fragile lands. The US Department of Transportation conducts research on road safety under low visibility conditions that forest fires often cause. Water quality, which is one of the priority issues of the Environmental Protection Agency (EPA), is affected when fires burn vegetation on banks of pond and steams, causing erosion and increasing runoff. Forest fires also affect air quality, which is also in the domain of the EPA.

The Southern Area Coordination Center (SACC) is one of 11 incident management centers in the US. The SACC is an interagency center that coordinates the mobilization of resources from federal and state agencies to manage wildfire and natural disasters in 13 southern states. Their Predictive Services section issues short-term forecasts and 30-days outlooks [http://gacc.nifc.gov/sacc/predictive/outlooks/outlooks.htm].

Private sector: The Florida Forestry Association and Georgia Forestry Association are trade organizations composed of companies that deal in forest products and forestry services. They handle the regulatory and political side of forestry, engaging in lobbying, public relations, and some outreach and education efforts. While unlikely to use the KBDI forecast themselves, these agencies can endorse and publicize tools that are considered useful to the industry and supported by the state agencies.

There are also multi-stakeholder organizations, such as the Greater Okefenokee Association of Landowners (GOAL), that include private landowners, timber and forest products companies, and state and federal agencies. The GOAL is active in the political arena, lobbying representatives on behalf of the industry. It disseminates technical and market information in coordinating wildfire management and invasive species control. Its biannual meetings provide outreach opportunities.

Forestry contractors and consultants provide services such as prescribed burning and fire management. Private companies and large individual landholders make extensive use of their services.

Civil society: The Southwest Georgia Prescribed Fire Council (SGPFC) is a non-profit non-governmental organization, composed of public and private landowners. The SGPFC is devoted to promoting safe use of fire for forest management. It includes government agencies, private landowners, and conservation groups. It has been particularly active in Southwest Georgia,

where quail plantation owners apply prescribed fire to restore quail habitats, but it is currently trying to expand to include Southwest Georgia and the Okefenokee National Wildlife Refuge.

Organizations such as Quail Unlimited and the Wild Turkey Federation represent plantation owners, hunting operators, and other groups interested in preserving game habitat, through prescribed fire and other management practices. Quail hunting is a major economic activity in Southwest Georgia and in the Florida Panhandle.

The Nature Conservancy uses prescribed fire to restore native longleaf pine forests and other fire dependant natural habitats in the Southeast US. In 2005, the Nature Conservancy worked with federal, state, and private partners to apply prescribed fire to 11,000 acres in Georgia.

Fire Management in Georgia and Florida

Best Management Practices (BMPs) for forest management include fire prevention and control. State agencies, such as FDF and GFC, control fire control on private and most public lands. They are sometimes aided by the fire departments when fires threaten inhabited areas. For public agencies, the foremost concern of fire control is to protect life and property, as wildlife and vegetation can recover rapidly after fire events,

Fire plays an important role in the natural ecology of certain ecosystems, such as the Okefenokee National Wildlife Refuge. In such areas, federal regulations require that natural fires be allowed to burn, unless conditions are such that fire threatens nearby homes or businesses. Fire escape is especially a risk during long periods of drought when dead logs dry out inside and can harbor fire for several weeks. In these protected areas, fire can be suppressed by aerial means or manpower, but no motorized equipment or mechanical or chemical means of fire control are allowed. Controlled burns and fire lines are used to clear areas of debris and eliminate dead vegetation that may fuel wildfires.

Prescribed burns are used to restore native vegetation and wildlife habitats in the Southern Coastal plain, where suppression of wildfires during the past century has permitted hardwoods to replace stands of longleaf pine. At the same time, burning is used to clear land for farming or development. Burning in the urban-wildland interface, which is dangerous and requires careful planning, is increasingly common. Overall, however, the use of prescribed burning by timberland companies has declined, as their management philosophy and economic interests have shifted towards shorter term rotations. In addition to prolonged droughts and population growth, declining use of prescribed burning has led to an increase in the number, extent, and severity of wildfires, particularly in Florida, where fires are intensified by the palmetto understory, which contains oils that fuel the fires.

Most prescribed burns in Georgia and Florida are applied during the period from December through April. The best time is January, when plants are still relatively dry and dormant yet temperatures are relatively cool, which reduces the risk of injuring plants and having fire get out of control. When ambient temperatures are warmer, fires can easily scorch trees, particularly pines, leading to immediate or long-term injury. But, in protected areas the natural fires that occur in April-May are best for restoring native vegetation. About half of the wildfires in Georgia occur between February and April, so this is the busiest time of the year for fire

managers. In July and August, the risk of wildfire subsides, except for the Okefenokee area where lightning from summer thunderstorms can trigger large fires.

To carry out prescribed burning, landowners or technical consultants who work for landowners must obtain burn permits from the state agencies (FDF or GFC), which are valid for the day they are issued. Though it is not always the case, burn permits should be based on an overall land management plan drawn up by a professional. Public agencies must have more extensive and formalized prescribed burning plans because of the potential liabilities from fire damage or smoke-related accidents.

In most cases, decisions concerning burn permits are made by the county foresters or rangers, although in extreme conditions district foresters or rangers may ask county agents to stop issuing permits. District foresters and rangers receive regular fire weather forecasts produced by the agencies' in-house meteorologists, which they circulate to their colleagues at county level. These forecasts include: 7-day forecasts, which are mostly based on wind; 3-day forecasts, which consider relative humidity, dispersion levels, and fuel condition; and daily forecasts, which include all these indicators. District managers also use information from the National Interagency Fire Center, and some consult NOAA, CNN, and Weather Channel sites to compare notes with their in-house forecasts. Most of them watch weather forecasts on TV each morning.

Decisions are based, not only on the KBDI, but also on other factors, such as fuel conditions, daily rain series, wind speed and direction, and relative humidity. According to weather conditions, various levels of restrictions are applied. For example, burning piles of debris, which can be easily contained, is generally allowed except during high wind conditions. Greater restrictions are imposed on land clearing burns, especially when relative humidity falls below 35%. Restrictions may range from exclusion of non-certified burners to a required on-site inspection by state rangers before allowing certified burners to apply fire. Agents' own assessment of the level of experience or past performance of the landowner or consultant in question also influences permit issuing decisions.

State agencies certify agents to conduct prescribed burning based on either online or classroom training programs. In Florida, certificates must be renewed after 5 years, while in Georgia there is no recertification requirement. Experience also plays an important role. It teaches specialists about the site-specific aspects of fire behavior that often cannot be learned from books. For example, most dangerous fires in Florida occur when wind blows from the southeast: therefore, an experienced fire manager may react differently to 15 mph wind that comes from that direction as opposed winds from other quadrants.

Stakeholder Feedback

From its inception, the SECC has followed a demand-driven approach to product development, whereby stakeholders are involved in each stage to ensure that the tools and information generated respond to their needs and are presented in ways that facilitate their understanding and uptake (Jagtap et al. 2002, Breuer et al. 2005). Each element of the AgClimate website is evaluated by different client groups and refined on the basis of their feedback (Fraisse et al., 200). The KBDI forecast assessment exemplifies this process.

Most of the stakeholders interviewed reacted positively to the KBDI forecast, finding it useful, informative, and easy to interpret. Some bookmarked the address so they can regularly consult the forecast and offered to circulate the address among their colleagues. Most respondents, particularly those at district and county levels, were unaware of the county-level KBDI forecast, which has only been produced and disseminated on AgClimate since 2005.

Communication and Content

As is true for many other SECC products, the KBDI forecast is still unknown to many key stakeholders and commonly accessed websites, such as those of the FDF and GFC, do not include links to AgClimate. Annual meetings, trainings, workshops, and other events organized or attended by stakeholders constitute opportunities for outreach and capacity building. The visibility of the forecast would also be enhanced by its translation into a timely outlook, issued in December and updated monthly. The outlook could be a short email, including a brief message and a link that is sent to key stakeholders. A regularly updated product may increase perceptions of reliability.

In terms of its presentations, respondents mentioned that the visual format "can be grasped at a glance," and is therefore better than other outlooks that are expressed in terms of graphs, formulae, or text. Respondents also appreciated its ability to render both spatial and temporal variation. Temporal variability is important because even when KBDI values are low, if they appear to be rising rapidly over time, there might be a reason for concern. Another positive aspect was that the forecast is expressed in terms of ranges of values rather than in a tercile format, expressed in terms of above normal, normal, and below normal. Tercile forecasts may be confusing because 'above' or 'below' normal can refer to both marginal and extreme deviations and because the meaning of 'normal' is also not always clear to users.

Stakeholders proposed ways of improving both presentation and content of the KBDI forecast page. Map titles -- Abnormally, Moderately, Severely, Extremely Dry -- were found to be misleading because normal values of KBDI change with location and time of the year. One respondent advised using anomalies maps instead. Although the forecasts indicate anomalies with plus and minus signs for each county, some respondents misunderstood these signs as indicating locations of rainfall stations or representing a link to more detailed information. Other respondents took the 'neutral' color in the map, which corresponds to a 0-10% fire risk, to mean that the forecast did not cover that area. The color scheme in the KBDI forecast also differs from that used by agencies such as FDF and GFC in their maps monitoring current KBDI levels. Using a color scheme in forecast maps similar to that used in monitoring maps produced by other agencies may improve the product's user-friendliness. Another suggestion was to add a 'mouse over' option to display the names of counties for out-of-state users.

Local fire managers commented that the forecast may not have enough spatial specificity, given extensive and highly variable nature of the terrain and the odd shape of some counties. They asked how values are assigned to each county and whether they reflect the normal for that particular county. The SECC began investigating the use of Stage III radar estimates independently, but feedback from this KBDI assessment strengthened the case for incorporating the data into its forecast methods. Clarifying what 'normal' means for different areas and times of the year would assist users in understanding the management implications of different degrees

of deviation. Respondents also requested that the forecast be extended through August or, possibly, to the entire year, given that some areas, such as the Okefenokee National Wildlife Refuge and several national forests in Florida, are vulnerable to fires caused by lightening during late summer thunderstorms.

Regional decision makers pointed out that the potential use of the KBDI forecasts in regional scale management decisions is limited by the fact that the forecast covers only 3 of the 13 states covered by the Southern Area Coordination Center. The differences in coverage of the SECC KBDI forecast and the regional center makes it difficult to effectively coordinate emergency response in the entire region. Unfortunately, expansion of the KBDI forecast is constrained by the uneven strength of the ENSO signal in the region. An explanation of how forecast skill and the correlation between KBDI and potential for fire activity varies for different parts of the region and at different times of the year would also help decision makers assess its applicability in their particular circumstances. Periodic feedback on forecast accuracy may also enable decision makers to assess to what extent they may trust it. Technically oriented stakeholders recommended including a page with a detailed account of how the forecast is produced, where the data come from, what models are being used, and what the product's limitations are.

SECC research and extension specialists are already considering these suggestions for implementation. Besides their operational value, the comments point to key communication challenges that have characterized most experiences of dissemination of climate forecasts to different categories of users (Hansen 2002, Hansen et al. 2004, Roncoli 2006). They pertain to issues such as visual representation, spatial and temporal scale, definition of 'normal,' assessment of skill, data quality, and data availability. The basic question is how much and what kind of additional information would empower decision makers reach their own judgments concerning the relevance and reliability of forecasts, without confusing or overwhelming them with details. For other tools, AgClimate addresses this challenge by providing a layered structure, with increasing levels of technical complexities for different users.

Potential Applications

Most of the respondents who operate at district and county level believed the forecast will be useful in organizing their time and their human and material resources to be better prepared at times of increased risk. Private sector stakeholders appreciated the extra 'edge' that the forecast offers to make their operations more competitive and profitable. Respondents outlined several areas of potential application of the KBDI forecast.

Human resource management

- Organizing workload: e.g. getting things done ahead of time to lighten workload later if high KBDI levels are predicted.
- Granting vacation time to staff: e.g. encouraging staff to take time off early in order to have manpower available later if high KBDI levels are predicted.
- Scheduling training: taking advantage of periods when low KBDI levels are predicted, avoiding scheduling trainings at a time when high KBDI levels are predicted.
- Committing staff and equipment to out of state intervention through the SACC agreement: not committing when high KBDI levels are predicted, placing staff on stand-by to intervene in other states when low KBDI levels are predicted.

Equipment management

- Maintaining equipment: scheduling maintenance at times when KBDI levels are predicted to be low, ensuring equipment is in good shape when KBDI levels are predicted to be high.
- Determining the need for equipment to be deployed in the case of long-lasting wildfires, as the KBDI forecast can help assess how the fire will behave over the next several weeks.
- Requesting additional equipment, such as aircraft, from federal agencies or contracting for additional equipment from private providers.

Financial management

- Avoiding overspending the annual budgets if high KBDI levels are predicted in May-June, which is at the end of the fiscal year for fire management agencies.

Prescribed burning

- Fine-tuning burning plans on public or private lands to avoid burning when KBDI levels are high, as fire can get out of control and high heat can damage trees. If high KBDI levels are predicted, it may be best to conduct burns earlier, before the forests become too dry for safe burning. If low KBDI levels are predicted, it may be best to spread the workload by staggering burns over time.
- Not scheduling prescribed burns at times when high KBDI levels are predicted because state agencies may be too busy suppressing fires elsewhere to be able to intervene if the fire gets out of hand.

Forest management

- Where possible, agents may switch mitigation practices from fire to mechanical (choppers, mulcher, mower, thinning) or chemical (herbicide) means if KBDI levels are predicted to be high.
- Scheduling reforestation efforts: avoid or delaying planting, or plant only in lower, wetter areas if very high KBDI levels are predicted for the normal planting season (Jan-March); or planting in higher, drier areas if very low KBDI levels are predicted.
- Timing of harvest: e.g. harvesting early if high KBDI levels are predicted to prevent damage from drought or drought-related pests. If very low KBDI levels are predicted, harvest timber before rains makes it difficult to access forest areas.
- If a relatively wet season is forecast, landowners with forests on relatively dry land can increase profits by harvesting as much timber as possible, because there is usually a shortage of timber on the market and prices are higher during wet years as low areas cannot be harvested.

Procurement

- Deciding when and where to begin preparing sites for harvest.
- Storing timber on decks to prevent warping and fungal damage, if low KBDI levels are predicted.

Wildlife management

- Organizing tourist activities, photography and filming, and other activities centered on wildlife and its habitat when KBDI levels are low.

- Planning hunting leases, keeping in mind that big fires in early and late spring negatively impact ground nesting birds.

Transportation

- Avoiding smoke-related accidents, by rerouting traffic, increasing patrolling on interstates if high KBDI levels are predicted.

Education/extension

- Planning, implementing education campaign, especially fire prevention if high KBDI levels are predicted.
- Responding to questions from other professionals, legislators, media, and the public on long-term outlook for the state or locality.

Despite the overall positive response and prospects for application, stakeholders qualified their comments by stressing that KBDI should not be taken in isolation. For instance, KBDI is a measure of soil moisture, but to assess fire risk one needs to know about the conditions of the fuel on the ground. In addition, many fire management decisions, such as issuance of prescribed burn permits and movement of staff and equipment across and among states, are still based on shorter-term outlooks, including not only weather, but also average fire activity during the particular month. Being costly, movement of human and material resources is usually left to the last minute, when the need is certain. Nonetheless, the KBDI forecast can help balance short-term and long-term considerations and support strategic decision making. In order to do so, however, it must be integrated into a suite of other tools, as it is the case with many other climate forecast products.

Conclusions

The SECC outreach website (AgClimate.org) offers a broad range of decision support tools directed to decision-makers in agriculture, livestock production, and natural resource management. Innovations in climate forecasting, such as the KBDI forecast produced by the SECC, create new opportunities for mitigating the negative consequences of drought. In recent years, the southeastern US has suffered from severe and prolonged droughts, so there is great interests in climate forecasts that may benefit a wide range of stakeholders, including government agencies, natural resource managers, private sector operators, conservation organizations, and general public. This pilot study based on interviews with a selected sample of stakeholders identified a large number of potential applications of the KBDI forecast and elicited several suggestions for how to improve communication of the forecast to stakeholders in the region.

Because the KBDI forecast has only recently added to the AgClimate website, few respondents were aware of its existence. Thus, outreach efforts are needed to increase awareness of the availability and potential applications of the forecast among targeted to relevant stakeholders, particularly those strategically positioned to further disseminate the product and educate others in its interpretation and application. Ensuring that frequently accessed sites include a link to the KBDI forecast and participating in inter-agency meetings, sectoral fora, and public events will help enhance product awareness. The timely release of a monthly outlook addressed to key decision-makers and fire managers will also increase the visibility and value of the KBDI

forecast. At the same time, its understanding by potential users can be improved by adding tutorials, help functions, and relevant links to its presentation on AgClimate. As other climate products, the KBDI forecast entails some degree of uncertainty and methodological limitations, which must be clearly communicated to potential users. A more explicit discussion of data and methods and periodic monitoring and feedback on performance will help decision makers assess the reliability and applicability of the KBDI forecast in specific settings.

The study found that, despite the limits of the information and the challenges faced by users, the KBDI forecast can be applied effectively to a wide range of fire management decisions. Potential applications span beyond natural resource management to include transportation, marketing, and education and can yield substantial benefits to the environments, economies, and societies of the southeastern U.S.

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