A High-Tech Approach to Open-Burning Authorization and Wildfire Response

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Figure 1 (right). A telephone call to a district office of the Florida Division of Forestry initiates a decisionmaking sequence for authorizing open burns. The system allows managers to quickly integrate information from multiple sources to determine potential effects of a proposed burn.

Figure 2 (opposite). A report of a wildfire to the duty officer triggers a sequence in which computerized databases provide information on pinpointing the location of the fire, proximity to populated areas, vegetative and meteorological conditions at the site, and availability of fire-suppression resources.
Recent developments in geographic information systems, the global positioning system, and remote sensing offer new opportunities to capture, process, and display spatial data. Advances in computers, software, and networking make these technologies available on the desktop so that decisionmakers in forestry and other renewable natural resource fields can address problems in real time and make informed choices among alternative courses of action (Green et al. 1995).

Such capabilities are particularly important for managers facing forest fires: they must quickly integrate information from multiple sources and make intelligent decisions to minimize damage to the resource and risk to human life and property. In Florida, a prototype decision-support system has been developed to help managers suppress wildfires and also handle requests for prescribed open burning.

Forests in Florida cover more than 16.5 million acres—nearly 48 percent of the state. They contribute significantly to maintaining a healthy natural environment, a high quality of life, and a strong economy. The Florida Forestry Association estimates that forestry and related activities add $8.8 billion a year to the state's economy. Historically, major forest ecosystems in Florida, such as longleaf pine, slash pine, loblolly pine, and sand pine, as well as nonforested ecosystems like sawgrass marshes, were maintained by fire (Brenner and Wade 1992; Brenner 1995). In the absence of fire, certain species cannot thrive and eventually disappear. Periodic fires help clear competing vegetation, thus providing suitable conditions for those species' regeneration and growth. Forest fires are also prescribed today to reduce hazardous fuels, control diseases, cycle nutrients, improve forage for grazing, enhance wildlife habitat, improve access, and enhance aesthetics (Wade and Lunsford 1989).

However vital periodic fire is to many of Florida’s ecosystems, uncontrolled fires in today's developed landscape can cause significant losses of life and property. In the past two years, more than 120,000 acres in Florida was burned by 6,575 wildfires. In the previous 14 years, more than 2.78 million acres burned. These wildfires are started by lightning, campfires, smoking, and careless use of combustibles.

The task of minimizing the damage caused by wildfires, while assuring proper use of prescribed burns, rests with the Division of Forestry in the Florida Department of Agriculture and Consumer Services (Wade and Long 1979). In authorizing prescribed open burning, the agency seeks to prevent smoke from drifting into sensitive areas,
such as schools, hospitals, airports, and highways; in controlling wildfire, the agency must make efficient use of limited resources. Geographic information systems (GIS), spot weather forecasting, and smoke plume dispersion modeling may provide the agency with the ability to effectively address these concerns.

**Current Approach**

For both prescribed burns and wildfires, the Division of Forestry must do its job with incomplete information. The existing open-burning authorization system uses computer terminals connected to a mainframe computer in Tallahassee. Duty officers in each forestry district can enter and view information for open-burning authorizations stored in a central database. Wherever there is a smoke-sensitive feature, such as a hospital or airport, the database notes the section, township, and range as given in the public land survey. No burning permits are issued for any sections thus flagged in the database.

There are several drawbacks to that approach: (1) the exact location of the smoke-sensitive feature within the section is not apparent, (2) the effects of smoke from an adjacent, nonflagged section are not considered, and (3) weather conditions, such as wind direction and dispersion index, are not taken into account. In addition, the duty officer has little indication of the level and spatial distribution of burning activity across a district on a given day.

Response to wildfires is based primarily on the experience of personnel within the affected district. The locations of both the fire and the fire-suppression resources in that district are tracked on a magnetic wall map, and duty officers work out strategy and tactics like generals in an old-fashioned war room. The officers may not know what fire trucks might be parked just across the district line.

**New Approach**

In response to pressing needs, a new, GIS-based approach is being developed by the University of Florida and the Division of Forestry. Called the Enhanced Open Burning Authorization and Wildfire Suppression System, it is still a prototype undergoing testing.

This project is part of a cooperative effort by the School of Forest Resources and Conservation at the University of Florida Institute of Food and Agricultural Sciences; the Division of Forestry in the Florida Department of Agriculture and Consumer Services; the Climate Center of the Florida State University Institute of Science and Public Affairs; Northern Forestry Centre of the Canadian Department of Natural Resources—Forest Service; and Environmental Systems Research Institute, Inc.

**Data.** The GIS database developed to support the project is composed of multiple thematic map layers: major highways, roads, rivers and streams, lakes and wetlands, fire towers, conservation lands, smoke-sensitive areas (airports, hospitals, road buffers, schools, etc.), general soils, public land survey, railroads, points of interest and other landmarks, county boundaries, 16-km grid cells for weather forecast data, and fire-
suppression resources locations. These layers are used to display a clear, accurate map of each forestry district. The individual GIS data layers were obtained from a variety of sources, including the US Census Bureau, Florida Department of Transportation, Florida Department of Environmental Protection, Florida Department of Community Affairs, US Natural Resource Conservation Service, digital satellite imagery, and global positioning system (GPS) surveys.

**Application framework.** The system uses an information network consisting of a central UNIX computer in Tallahassee linked via the Internet to remote PCs at each district office. The central computer maintains a database for open-burning authorizations, wildfire reports, and daily weather forecast data. Each district office runs software consisting of two main decision-support modules: (1) a module for issuing open-burning authorizations, which incorporates GIS, spot weather forecasting, and smoke dispersion modeling to determine the potential effects of a proposed burn before a permit is issued, and (2) a module for compiling and disseminating information for timely and efficient allocation of resources to suppress wildfires.

The primary module is the open-burning authorization, since it is used more frequently than the wildfire report. Its user interface is designed to follow a sequence of operations beginning with a telephone call requesting an open-burning authorization and ending with approval or denial (fig. 1, p. 10). The wildfire report's user interface follows a similar sequence, from a report of a wildfire through resource mobilization and coordination to fire suppression (fig 2, p. 11).

The application is based on Microsoft Visual Basic 4.0 Professional and makes extensive use of the object linking and embedding capabilities of this programming language. In addition, two custom controls (also called Active-X controls) are used to provide specific capabilities within the application. The first is MapObjects™ by Environmental Systems Research Institute, Inc. (Redlands, California). MapObjects™ components provide tools for displaying and querying ArcView shape files and ARC/INFO coverages. These tools allow advanced GIS mapping and analysis capabilities to be embedded within another software application.

The second custom control used is OracleObjects™ by Oracle Corporation (Redwood Shores, California). OracleObjects provides common programming languages, such as Visual Basic, with tools that enable the user to retrieve data from local or remote Oracle databases. The use of MapObjects and OracleObjects in this application facilitates the development of a simple, efficient user interface for performing complex tasks, such as GIS analysis and accessing large, remote databases.

**Open-Burning Authorizations**

The open-burning authorization user interface consists of an electronic form (fig. 3) used by the duty officer to issue permits to the public. The form allows the duty officer to query the database using a customer name, account number, or telephone number and then retrieve account information, including a list of all previously issued authorizations. After confirming account information, a new authorization may be issued, or a prior authorization, such as one from the previous day, may be continued. The form also allows the officer to add a new customer to the database or revise information for an existing customer.

Before issuing a permit, the duty officer enters information on type of burn, fuel type, acreage, date and time, and location (section, township, and range). Next, a map showing GIS data layers for roads, lakes, streams, landmarks, conservation lands, cities, and section lines is displayed on the screen and is automatically adjusted and scaled to the location identified. The duty officer identifies the precise location of the burn by clicking on the map with the mouse. The application then queries the weather forecast information for that location and retrieves relevant data, such as wind speed, wind direction, and mixing height. Weather forecasts are updated twice a day but provide predictions for three-hour periods between updates.
The data, along with information on fire type and size, are transferred into the smoke dispersion model VSMKGS (Harms et al. 1995). Next, the model is run and the resulting smoke plume is displayed on the screen as a set of three isopleths denoting different concentrations of smoke particles in the air. Finally, the application performs a GIS overlay analysis to determine whether any of the isopleths intersects a buffered smoke-sensitive area. If so, a red alert appears on the computer screen notifying the duty officer that the district supervisor’s approval is needed before a permit can be issued (fig. 4, p. 12). Buffers 500 meters wide are automatically applied to sensitive areas (state highways have 150-meter buffers; interstate highways have 300-meter buffers).

Each smoke plume on the map is linked to the corresponding authorization in the database, allowing the duty officer to retrieve an authorization by clicking on the plume itself. All smoke plumes for a given day are stored in a shared file so that each officer can simultaneously view all authorizations across the district for that day. Smoke plume files are archived for future reference and validation—an extremely important capability because of possible liability.

Wildfire Reports

Like the open-burning authorization module, the wildfire report user interface depends on an electronic form to access and query the Oracle database and interact with the GIS map. On receiving notification of a wildfire, the duty officer selects “wildfire report” from the authorization module to load the appropriate form. The officer then collects relevant information about the fire: general location, type of fire, and person reporting. Next, he or she puts the fire on the map by clicking on the location with the mouse. Distance and azimuth information provided by one or more fire towers can be used to help pinpoint the fire (fig. 5, p. 12), and latitude-longitude coordinates provided by a spotting plane equipped with GPS can be also used. All current authorized burn plumes are displayed on the map, allowing the officer to determine quickly whether the reported wildfire is an authorized fire. If so, the officer can click on the plume to retrieve the authorization for that fire to find out when it was scheduled to be completed and call the individual responsible to confirm that the fire is under control.

If the reported fire is indeed a wildfire, the system queries the GIS database to retrieve information on the conditions at the site, such as soil type, vegetation type, fire danger rating, and weather. The size and direction of the resulting smoke plume are displayed on the map, as for a prescribed burn. A red alert appears if the smoke has the potential to drift into smoke-sensitive areas.

In addition, the system allows the duty officer to view current locations and status of all fire-suppression resources, such as tractors, water trucks, aircraft, and personnel, including those in adjacent districts. On the map the officer can relocate resources once they have been dispatched to a fire by using the mouse to drag them to a new location. Fire-suppression resources may be tagged “in service” or “out of service” to indicate their availability for responding. The application allows the officer to dispatch the closest fire-suppression resources based on fire type, magnitude, proximity to populated areas, rate of spread, and site conditions.

Future Developments

The prototype will undergo extensive testing to identify areas where improvements or enhancements are needed. In particular, researchers want to determine whether the system will be effective under field conditions. For example, it is unlikely that everyone who requests an open-burning authorization will know the fuel type and load for the site. A simpler classification scheme, such as low, medium, and high fuel quantity, or estimate of approximate fuel load based on the last burning date for the site may be more realistic. Testing is also essential to determine whether duty officers can quickly locate the site of a proposed burn based on the caller’s answers to only a few questions.

A number of enhancements to the new system are currently under consid-
eration. Dispatching of fire trucks may be aided by the use of vehicle-mounted GPS receivers to keep track of fire-suppression resources in real time. New, high-resolution satellite imagery could provide the system with timely and cost-effective updates on vegetation, fuel loads, and land use and cover information for the GIS database. A high-performance server-based GIS database might facilitate administration of the central GIS data and, by storing map data for the entire state in continuous layers, eliminate the barriers that district boundaries impose on GIS analyses.

The goal of the system is to provide the public with quality service and reduce the harmful effects of smoke from open burning, as well as minimize the loss of human life and property caused by wildfires. This is especially important in Florida, where urban-rural interfaces are highly dynamic because of continuing population growth. Application of this innovative decision-support system will greatly enhance the ability of the Florida Division of Forestry to suppress wildfires and handle open-burning authorizations throughout the state.

**Literature Cited**


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