

## APPLICATION AND STATUS OF THE *FARSITE* FIRE AREA SIMULATOR

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### INTRODUCTION

Fire growth simulation is the modeling of fire spread and behavior across landscapes with heterogeneous fuels, weather, and topography. *FARSITE* is a computer program designed to simulate fire growth using existing models of fire behavior found in BEHAVE (Andrews 1986) and in the Canadian Forest Fire Behaviour Prediction System (Forestry Canada Fire Danger Group 1992). There are numerous uses for fire growth simulation, including planning for potential wildland fires, prioritizing and locating fuel treatments, tactical support on active fires, and fire incident reconstruction. Because *FARSITE* can generate spatial maps of fire behavior, it is useful for producing detailed analyses of fire behavior and fire effects on geographic information systems (GIS). This modeling capability however, requires digital maps of terrain and fuels in GIS formats, which is the main limitation for users wanting to do simulations. Nevertheless, *FARSITE* is widely used by State, Private, and Federal agencies in the U.S. who recognize the value of having GIS-based data on fuels and vegetation for a variety of applications. A national, interagency training course has been developed for *FARSITE* application and operation. Other special purpose workshops are also taught. This paper summarizes the uses, capabilities and data requirements for *FARSITE* and identifies some new features that are planned for a future release.

## APPLICATION

Application of *FARSITE* falls into three main categories: simulation of past fires, of active fires, and of potential fires. Analysis of past fires reveals how well the simulation reproduces known fire growth patterns given available input data. Simulating past fires is critical in developing confidence for using *FARSITE* to project the growth of active fires.

*FARSITE* was originally developed for long-range projection of active prescribed fires, generally in National Parks or wilderness areas (Finney 1994). Fire simulations are run for general long-range weather scenarios to suggest possible outcomes of fire growth over many weeks. Potential fire growth is examined under various weather patterns such as persistence of current conditions or periodic frontal passage. A similar procedure using manual methods was reported by Mutch (1998) and Rothermel (1998). Recently *FARSITE* has also been used for short-range (1-2 day) projections on large wildfires, where simulation results are used in support of strategic fire fighting decisions. If only part of the fire perimeter is of immediate interest, *FARSITE* can be used to simulate partial sections of the fire front. This application of *FARSITE* is similar to manual methods described by Rothermel (1983).

Fire planning is an appropriate and currently the most common use of *FARSITE*. A potential fire can be simulated at various locations under a variety of fuel and weather conditions. Fire planning activities include, for example, analyzing spatial fuel management alternatives and examining suppression opportunities for fires starting in different locations or under various weather scenarios. Finney et al. (*in press*) used *FARSITE* to examine the economic consequences of potential wildfires occurring with and without fuel management activities.

## CAPABILITIES

The fire behaviour models currently included in *FARSITE* calculate surface fire, crown fire, fire acceleration, spotting from torching trees, and fuel moisture (Finney 1998). The surface fire model (Rothermel 1972) is linked to the Van Wagner (1977, 1993) crown fire criteria to simulate transition to crowning and to the Rothermel (1991) crown fire spread correlation model. Spotting distance is simulated using the torching tree model by Albini

(1979). Buildup of fire spread rate over time and with changes in environmental conditions is simulated using the point-source fire acceleration model of the Canadian Forest Fire Behavior Prediction System (Forestry Canada Fire Danger Group 1992, McAlpine and Wakimoto 1991).

*FARSITE* produces maps of fire growth (perimeter positions) and fire behavior in data formats that are suitable for ArcInfo, ArcView and GRASS geographic information systems. Most fire perimeter data are in vector format showing time-contours of fire position. Vectors can be produced in ASCII as well as ArcView Shapefile formats. Raster maps can also be produced to show frontal fire behavior at each cell within the fire area. Fire behavior maps can be used for analyses of fire effects or for estimating suppression options.

Fire suppression can be simulated in *FARSITE* using several ground attack tactics as well as aerial attack. Ground tactics include direct, indirect, and parallel attack. Direct attack follows the immediate edge of the fire front using data on line production rate according to fuel and crew type. Indirect attack builds impermeable fireline along a predetermined route. Parallel attack is used to build fireline at a specified constant distance from the moving fire front, similar to direct attack. The air attack features currently allow the user the place retardant drops by coverage level (retardant density) for a given aircraft (George 1992).

## DATA

Data required for *FARSITE* simulations comprise the three legs of the fire environment triangle: fuel, weather, and topography. Fuel and topography are required as spatial themes, whereas weather data is generally provided as a "stream" or table of values over time. The spatial data must come from a GIS. GRASS and Arc/Info ASCII raster data formats are accepted. Currently, spatial data for eight variables are used in *FARSITE*: elevation, slope, aspect, surface fuel model (Anderson 1982), canopy cover, canopy height, crown base height, and crown bulk density.

Weather data are divided into two files; one contains temperature, humidity, and precipitation data used for calculating changes in dead fuel moisture, and the other contains wind and cloud cover data. The source for these data depend on the *FARSITE* application. Analysis of past fires is based on observed weather records. Short-range simulation of active

fires requires the user to translate specific fire weather forecast information into the proper data format. Long-range simulation of active fires requires weather that goes beyond the period for which weather can be forecasted. Weather scenarios may be developed from summaries of nearby Remote Automatic Weather Stations (RAWS) over several years and percentile weather variables. Fire simulation for planning applications can use local weather and wind data to define typical or extreme weather patterns.

The fire suppression module of *FARSITE* requires the user to have estimates of line production rates in local fuel types for actual crews and crew types, as well as knowledge of the capabilities of available air resources.

## TRAINING AND IMPLEMENTATION

Learning how to run the *FARSITE* program is different from learning how to define inputs and properly interpret the results. A Fire Behaviour Analyst uses *FARSITE* to simulate the growth of an active fire in support of decision making on wildfires and prescribed fires where lives and property may be at stake. This person is required to successfully complete the newly developed course, S493—*FARSITE* Fire Growth Simulation, and its prerequisites, and also have a firm foundation of on-the-ground fire experience. This training provides a thorough understanding of the technical workings of *FARSITE*, including its limitations, so that the person can make the required judgement calls that must be made in simulating an active fire.

Other less formal training sessions and workshops have been offered to meet specific needs. Less training is needed if a person is using *FARSITE* for educational purposes, or exploring the interactions among components of fire and environment. Overview presentations have been offered to those who are interesting in learning the range of possible uses of *FARSITE*.

Improvements to *FARSITE* are likely to be included in the next several years. Better models for fire behaviour will likely be substituted when they become available. Specifically, the current fuel moisture model will be replaced. Also, *FARSITE* will be modified to simulate general post-frontal combustion. This will allow smoke and heat from the fire to be calculated behind the flaming front. The results will be useful as input to separate atmospheric models used for estimating smoke dispersion.

The status of *FARSITE* and the most recent version of the program can be found on <http://fire.org>.

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