**7.8** ASSESSING THE IMPACTS OF PRESCRIBED BURNING ACTIVITIES

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## 1. ABSTRACT

Over the past several decades, the United States has had a policy of suppressing fires in wildlands. This policy has led to negative effects on ecosystems, including a buildup of dead timber and excess forest litter that can contribute to uncontrolled, potentially catastrophic wildfires. Currently, various government agencies are implementing a policy of forest management that uses prescribed burning to help restore forest ecosystems to their natural state.

Government agencies are reviewing alternatives involving various levels of prescribed burning activity. Wildland fires, whether planned, accidental or natural, result in airborne emissions of criteria air pollutants such as $PM_{2.5}$, carbon monoxide, nitrogen oxides and sulfur dioxide. Of these, the pollutant that with the potentially most far-reaching impact is $PM_{2.5}$, which can pose a health hazard at sufficiently high concentrations and reduce visibility over a wide area. Therefore, it is an objective of land managers that forest management policies do not significantly increase emissions and alter the associated ambient air quality from the "natural" state. This paper describes a procedure that compares the air quality impact of the prescribed burning activities to those conditions that would occur if a natural wildfire policy, i.e., with no prescribed burning, were implemented. The paper also discusses the current techniques that can be used in support of prescribed fire initiation decisions.

## 2. INTRODUCTION

Wildland fire is a very powerful natural force that affects and defines landscapes over time. During the twentieth century, fire was aggressively suppressed to protect both public and private infrastructure and to prevent damage to forests, grasslands, and other such areas. Although the short-term impact of the fire suppression was seemingly beneficial, the changes and risks that resulted from this policy were hard to recognize and mounted inconspicuously and steadily over many decades. The accumulation of dead flammable organic material that serves as fuel can result in unusually severe wildfires. Fires allowed to burn under a natural cycle perform several useful functions, such as

- Reducing the build-up of surface fuels,
- Recycling and production of nutrients, and
- Allowing for the reproduction of fire-dependent species and eliminate non-native species.

One method that is being implemented to reverse the effects of the wildfire suppression is to clear out the excess accumulation of surface fuels through planned, or prescribed burning. Although such activities, if well-planned, will tend to prevent severe uncontrolled wildfires, they can also be managed in to prevent adverse air quality impacts, such as high concentrations of fine particulate matter and associated visibility impairment.

## 3. BEST MANAGEMENT PRACTICES FOR PRESCRIBED BURNING

Uncontrolled wildfires can be ignited by natural causes, such as lightning, but most are caused by human negligence or arson. Regardless of their cause, unplanned fires often ignite and spread more rapidly under with windy and dry conditions. On the other hand, if the following practices are followed, prescribed fires can be better controlled in terms of their severity and air quality consequences by application of best management practices listed below:

- Limit the total time of the controlled burn by rapid and efficient ignition techniques.
- Start a burn in the morning to take advantage of effective smoke dilution by deep convection during the middle of the day.
- Minimize burning and smoldering at night, when smoke will be trapped near the surface.
- Burn during periods of low relative humidity to minimize regional haze enhancement by growth of hygroscopic particles.
- Burn when smoke plumes will below away from areas of sensitive population and protected natural resources such as National Parks.
- Avoid prescribed burns during periods of predicted high winds or air stagnation.

## 4. AIR QUALITY IMPACTS OF PRESCRIBED BURNING ACTIVITIES

The use of prescribed burns and their air quality impacts need to be weighed against the catastrophic consequences of uncontrolled wildfires. Due to the long-term suppression of wildfires, it is necessary over the next several decades for Federal Land Managers to eliminate the excessive build-up of surface fuels by prescribed burning at a level that is higher, on average, than natural wildfires in terms of acres burned per year. However, use of best management practices, such as those described above, can optimize the level of prescribed burning and limit air quality impacts.

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The first step in evaluating the overall air quality consequences of various proposed levels of prescribed burning versus a plan of no prescribed burning activity over a specific region, is to define a typical annual level of fire activity for the "no-action" scenario. Data for the no-action fire activity can be obtained from actual wildfire records for a number of years with minimal prescribed burning activity. A specific baseline year (such as 1990) is then selected for dispersion modeling with the CALPUFF model (Scire et al., 2001). By modeling the actual periods of wildfires, the weather conditions that favored uncontrolled events will be simulated. The number of acres burned in the modeling of the no-action scenario can then be adjusted to be consistent with a long-term mean, but the locations and dates of the fires would be linked to actual events in the year to be modeled.

The second step is to characterize the fires in terms of the particulate emissions and buoyancy flux needed for model input. Emission rates associated with a specified burn scenario can be defined over a large region by applying EPA's AP-42 emission factors. Heat release rates needed for the computation of plume rise by the CALPUFF model can be supplied by the Emissions Production Model (Ferguson et al., 1998).

The third step is to apply a suitable long-range dispersion model such as CALPUFF with a full year of meteorological data to provide an estimation of particulate levels at an array of receptors over the region. A uniform receptor array might be suitable because if the actual location of the wildfires is unpredictable, the plume trajectory from the fire to sensitive areas is unknown. Alternatively, if the likely locations of the wildfires are known with more certainty, the receptor grid can be designed to assess impacts at specific locations such as population centers and protected natural areas such as National Parks and Wilderness Areas. The number of receptor-events of particulate concentrations over specified thresholds could be used as an indication of the air quality impact of the no-action (non-human intervention) case. Regional haze (the reduction of visual range) could be assessed with the use of the CALPOST post-processor.

The final step is to compare the air quality impact of the no-action scenario to alternative prescribed burning strategies. This could be done by distributing the periods of prescribed burning and lower incidences of wildfires over the course of the year to be modeled and assuming that best management practices are applied. This method would favor placing the hypothetical occurrences of the prescribed burning over the spring and summer months (long daylight periods), and during days of moderate winds, low relative humidity, and favorable wind trajectories. Once the distribution of hypothetical prescribed burning activities is defined for the year to be modeled, the actual emissions and related input needed for CALPUFF can be defined in a manner similar to that of the no-action case, and the air quality impacts can then be calculated with CALPOST. A tally of the number of receptor events with particulate or regional haze impacts above specified thresholds would then be made for comparison to the total for the no-action case. Prescribed burning strategies that result in a lower air quality impact than the no-action case can be interpreted as providing an air quality benefit.

## 5. RESOURCES FOR WEATHER FORECASTING PLANNING OF PRESCRIBED BURNING

A National Oceanic and Atmospheric Administration (NOAA) web site, www.arl.noaa.gov/ready, is a source of up-to-date information at all times through their site and links to others. The "Realtime Environmental Applications and Display sYstem" (READY) features links to wildfire smoke forecasts:

- NOAA's Boise Fire Weather Center
- NOAA's Air Resource Laboratory
- NOAA's National Fire Forecasts, Offices, and Outlooks.

In addition, there are several links to near real-time satellite images that can assist operational groups to view the progress of prescribed and unplanned fires.

For planning purposes, the READY web site offers continuously updated (4 times per day) Model Output Statistics (MOS) air quality dispersion forecasts for many locations throughout the United States. The Internet user selects either the NGM or the AVN forecast model for obtaining model trajectories and mixing heights. The user then selects the city closest to the site assumed to be the origin of a smoke release and also the release height. The result of the forecast is a display of the dispersion factor (chi/q) for the first 100 kilometers of plume travel, which is tailored to the release height and is computed for 3-hour intervals from the initialization time of the model out to 60 hours in the future.

These forecast and smoke assessment resources are useful tools in the planning process for groups in charge of managing prescribed burns and controlling unplanned burns.

## 6. REFERENCES

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