A Review of Wildland Fire and Air Quality Management

Douglas G. Fox,
CIRA, Colorado State University, Ft. Collins, CO

Allen R. Riebau,
USDA Forest Service, Research and Development
Washington, DC

ABSTRACT:
In this presentation, we review the need for managing smoke that results from wildfire and other forms of biomass burning. The management of smoke is a steadily maturing activity in the US. It is driven by both a desire on the part of fire managers to do the right thing and increased regulatory interest, specifically because of Regional Haze regulations and ambient air quality standards for $PM_{2.5.}$ Here we propose that fire managers consider adapting a formal "Smoke Management System (SMS)" based on ISO 14001 the Environmental Management System continual improvement series of international standards. Five years ago we completed an assessment of technical tools to help manage smoke for the Joint Fire Sciences Program. In that report, we considered tools needed for strategic and tactical planning, operations and evaluation and made specific recommendations for new tools. Here we review what has been accomplished, and in so doing, we will discuss continuing research needs in monitoring and modeling smoke and other remaining challenges. Finally, we will address the possibility of establishing formal SMS identifying the available tools and highlighting the remaining needs for fire managers.

DETAILS:

Smoke contributes to air pollution.

Forest, range and agricultural burning contribute to air pollution, locally, regionally, nationally and globally. Global emissions estimates from biomass burning are quite uncertain but suggest that fires may contribute up to 40-50% of fine particulate and carbon in the atmosphere. Locally, regionally and nationally in the United States emissions are equally significant. Figure 1 shows the emissions of $PM_{2.5}$ for the western States in 1996 from a variety of different sources (total emissions are 1,618,959 tons. Fire sources represent 45% of the total emissions. In addition, fire represents 10% of VOC, 4% of NO_x, 3% of SO_2, 27% of CO and 22% of PM_{10} emissions.

Since smoke makes a significant contribution to air quality it is no longer sufficient to fall back on the natural nature of smoke, on the fact that biomass will burn either naturally or in a managed way. Although this is true, it is also increasingly clear that human influences on fire are significant and smoke

impacts need to be planned, managed, and to the extent possible, mitigated in much the same way as other air pollution sources.

Regulatory considerations.
In 2000, the US implemented new Regional Haze regulations. These regulations protect Class I area visibility, specifically 156 federal Wilderness and National Park locations. The regulations are based on the IMPROVE monitoring network. Based on IMPROVE data, States (& participating Tribes) are required to develop State Implementation Plans to reduce emissions of visibility degrading aerosol. Since forest fire smoke is recognized as a significant contributor to regional haze but one that is different from other pollution sources (e.g. industrial & transportation activities), the States are also mandated in the regulations to implement **Smoke Management Programs (SMP)**.

The regulations specifically require States to identify for each Class I area in their State, what is the natural background for visibility, what is the mean of the 20% haziest and 20% cleanest days (based on a 5 year average) and establish a program of emissions limitations to reduce the haziest days to **natural background conditions** (whilst not reducing the cleanest days) over the next half century, measuring progress in 10 year increments.

Natural background is a complex determination but it is specifically identified in the regulations to be: reflective of contemporary conditions and land use patterns (not historical, pre-European conditions); a long-term average condition analogous to the 5-year average best-and worst-day conditions that are tracked under the regional haze program, and; estimated for each Class I area in the absence of human-caused impairment.

Recently, the US EPA has issued new designations of attainment and non-attainment for $PM_{2.5}$. Figure 2 presents EPA data showing the county average data from PM2.5 for 2000-2002. The National Ambient Air Quality Standard for PM2.5 is 15 ug/m3 so all the areas colored yellow, orange and red are measuring concentrations the above standard. Clearly, conducting burning programs in these counties will be subject to added complexity and possible limitations.

Available tools
As a result of advances in computing and remote sensing technologies, there have been significant advances over the past decade in the ability to monitor and to predict smoke from burning activities. There are a number of satellites and sensor packages allowing steadily improved temporal, spatial, and spectral monitoring of smoke. Similarly, the cost and accessibility of computers allows simulations of fire events in predictive and real time modes, including all the burning in a region and comparison with other pollution sources to discern the relative contribution of the burning.

Smoke Management – Programs & Systems

Smoke Management Programs are identified in the Regional Haze Regulations as being required in selected States to ensure that smoke from managed fire is properly managed. The Western Regional Air Partnership (WRAP), the group which technically facilitates the regulations in the Western US where the regulations require SMPs, has developed a policy that specifically includes requirements to: i) minimize fire emissions; ii) evaluate smoke dispersion; iii) identify alternatives to fire; iv) notify the public; v) monitor resulting air quality; vi) provide surveillance and enforcement of burning programs; vii) evaluate the program; viii) specific burn authorizations, and; ix) coordinate regional burning. (WRAP Enhanced SMP policy, 2003)

As such Smoke Management Programs share much in common with the International Standards ISO 14000, for environmental management systems (EMS) (http://www.iso.org/iso/en/iso9000-14000/index.html) ISO 14000 concerns environmental management, or more specifically what an organization does to:

- minimize harmful effects on the environment caused by its activities;
- achieve continual improvement of its environmental performance.

It is a "generic management system standard" meaning that the same standards can be applied:

- to any organization, large or small, whatever its product;
- including if its "product" is actually a service;
- in any sector of activity, and;
- whether it is a business enterprise, a public administration, or a government department.

No matter what the organization's scope of activity, if it wants to establish an environmental management system, then such a system has a number of essential features identified by the ISO standard. “Management system" refers to the organization's structure for managing its processes - or activities - that transform inputs of resources into a product or service which meet the organization's objectives, such as complying with regulations, meeting environmental objectives, or accomplishing the job in a professional manner. The components of an EMS are illustrated in Figure 3.

We propose the consideration of a Smoke Management System built on the generic elements outlined in Figure 3.

Plan

In smoke management there are a number of planning activities that occur. These range from management planning at the broadest possibly level, namely the Forest Plan which might identify general fuel management targets, to specific accomplishment targets for this particular burning season. An important aspect of planning is permitting. Permitting is specifically identified in various State SMPs and takes a variety of different formats. In general it requires identification of a prescription for the burn, which includes windows

of wind speed, direction, fuel moisture, humidity and other meteorological parameters, a location and a specific time frame for it. However, in the context of an SMS, this planning needs to take a step or two back and look at the Agency policy with regard to its broadest goals, i.e. wishing to maximize the health and productivity of the forest, to maintain the urban interface as a safe place for people to live, maintain firefighter safety, minimize negative impacts from forest burning, etc. A SMS will also needs to identify the environmental "aspects" of the Agency. These "aspects" include positive as well as negative effects of the Agency activity on the environment. Finally, the SMS should specify goals for the Agency, as specifically as possible.

Do (Implement)

This of course represents the actual conduct of the burning activity. Burning should be carried out in as safe and environmentally benign manner as possible. The implementation phase includes utilization of many of the tools we have been developing, i.e. *BlueSky*RAINS to best manage the burning.

Check (Evaluate)

This involves the evaluation of the burning program. It requires post fire monitoring, evaluation utilizing for example satellite remote sensing and ground based monitoring networks to evaluate the effectiveness of smoke management activities, to evaluate the quality of the smoke modeling estimates and the overall accomplishments of identified targets. This is phase of the current fuel management program that might be considerably enhanced by formal identification of requirements and activities through a formal SMS.

Act (Improve)

This is a critical component of the SMS, and one which traditionally is not formally identified and commissioned. Thus, it may be the single most important contribution that adopting a formal SMS can generate. This element would require formal management review of the fuel management activity, a formal comparison with identified goals and an evaluation of accomplishment, identification of inadequacies and developing plans for improving next year.

SUMMARY:

It seems appropriate for the fire and fuel management communities to start to think in terms of developing and establishing formal **Smoke Management Systems** at appropriate levels in the Agencies. In the Forest Service, for example, this might be at a District or a Forest level. It will require resources to be developed, to be monitored and to be evaluated. We feel the potential benefits of adopting such a SMS will be significant. For one, it will place the forest manager in a definite leadership position with regard to smoke management issues. It will serve to communicate to the public as well as to State and local regulators, that the agency is responsible and professional. Further, it will clearly identify that theAgency is trying to do the right thing.

Finally, the bottom line will be better burning programs, better smoke management and fewer negative outcomes

FIGURES:

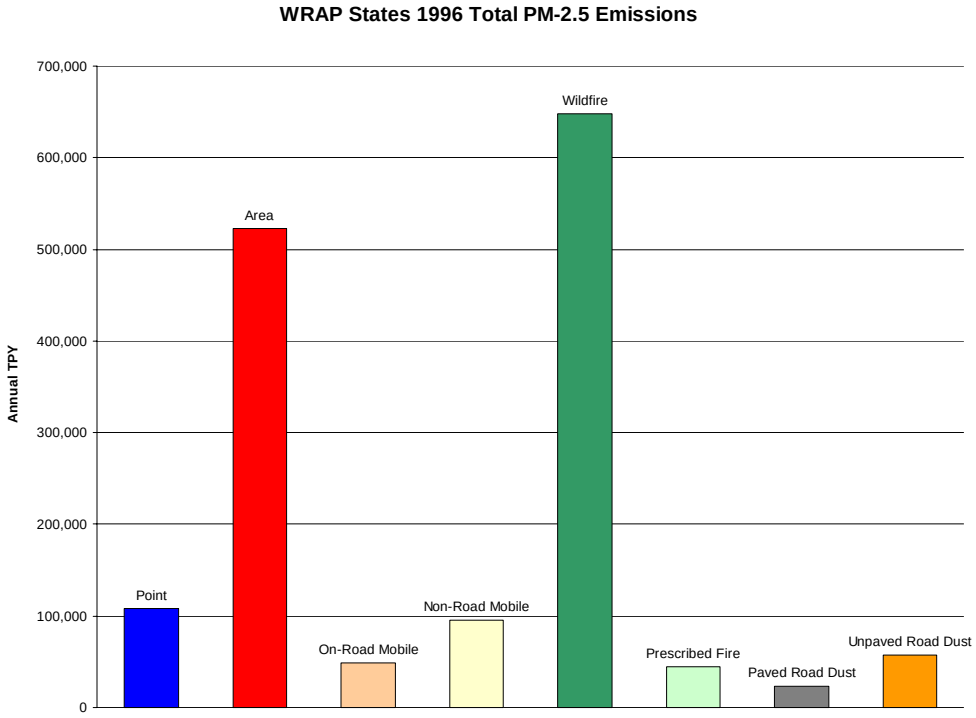

Figure 1. (from the WRAP "309 Technical summary")

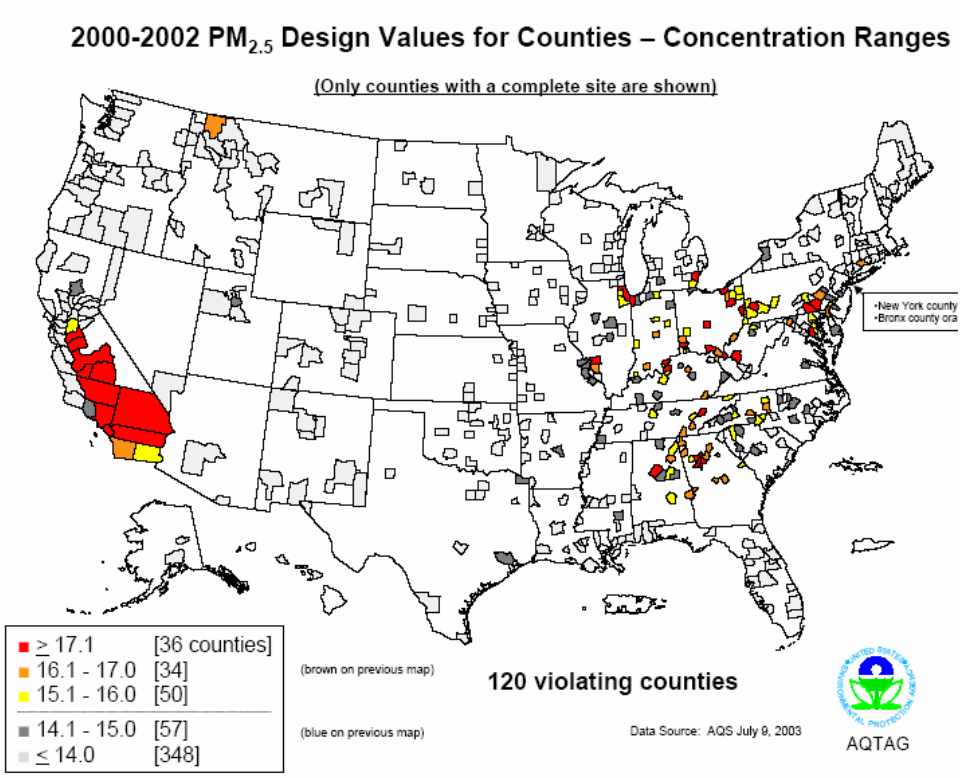
2000-2002 PM2.5 Design Values for Counties – Concentration Ranges
(Only counties with a complete site are shown)
•New York county
•Bronx county ora
≥ 17.1 [36 counties]
16.1 - 17.0 [34]
15.1 - 16.0 [50]
14.1 - 15.0 [57]
≤ 14.0 [348]
(brown on previous map)
(blue on previous map)
120 violating counties
Data Source: AQS July 9, 2003
AQTAG

Figure 2.

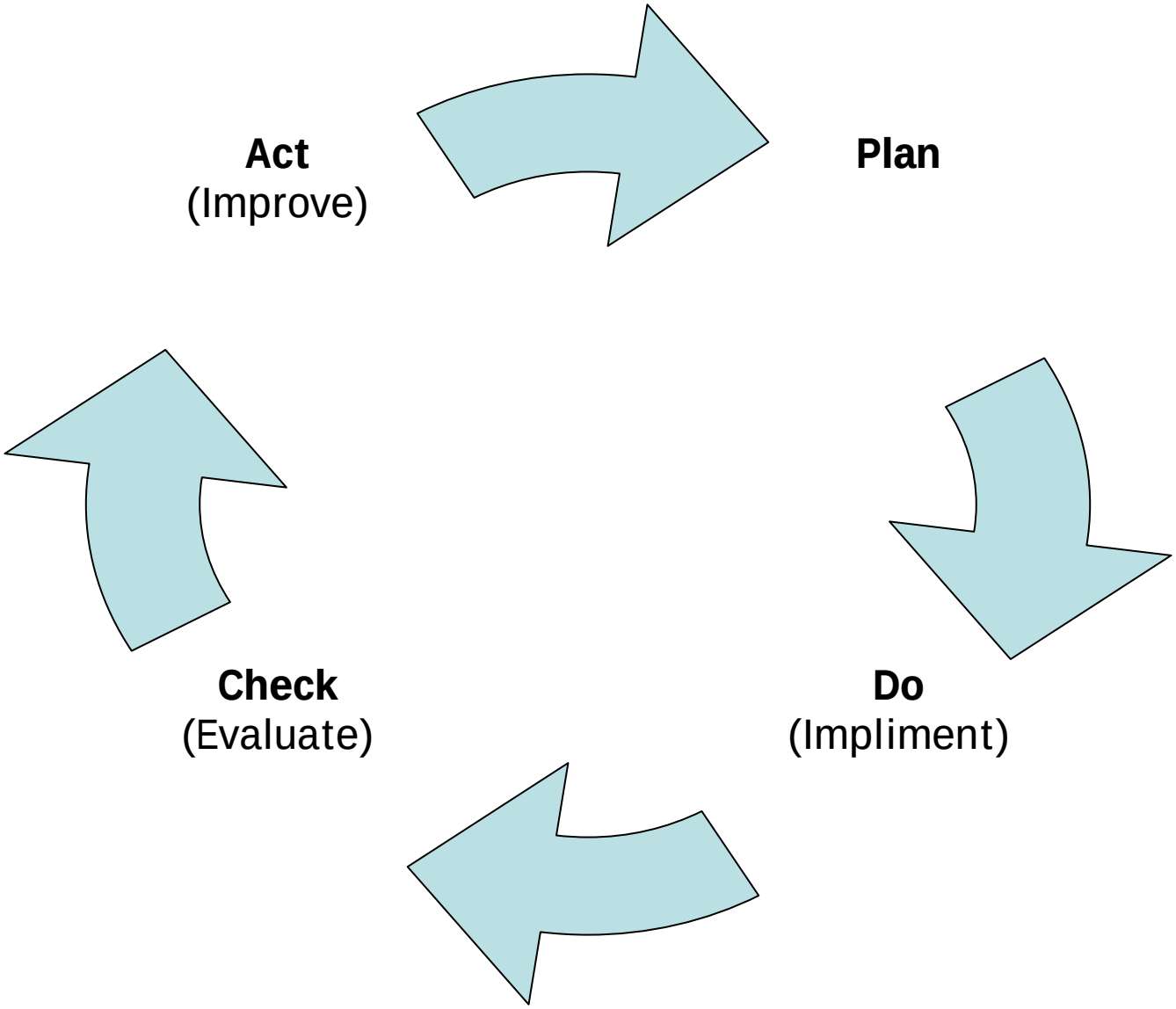

Figure 3. Generic Environmental Management Plan.