A Fire Place for Climate: The Role and Use of Climate Information in Fire Management and Policy

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Abstract: Since 1910, the U.S. Forest Service has developed and transformed policy for wildland fire suppression and management of federal lands utilizing prescribed fire and fire use. The fire management issues of today have evolved from 100 years of influence from three shaping factors - fire management practices, land use activities and climate. All three have been on parallel but related paths.

Climate has a pronounced role in fuel dynamics, fire behavior, ecosystem health and desired management outcomes. However, the role that climate plays directly in fuels and treatments is poorly understood, and management of fuels would likely benefit from a better understanding of climate impacts on vegetation and treatment schedules. Fuel loading fluctuates at multiple temporal scales related to climate, but few attempts have been made to quantify these relationships. Additionally, the timing of optimal treatment periods (such as prescribed burning "windows" for both fire behavior and air quality) depends on climatology to adequately meet treatment objectives. The understanding of climate variability and change on fire and fuels may necessitate a paradigm shift in land management or at least in the assumptions inherent in management plans.

In this presentation we argue that the benefits of climate information can be realized in both operational and constitutive or policy formulation settings. We review national and regional fire policy plans and identify the potential and practical role for climate information in improving the outcomes identified within these strategies. More precisely we document (1) Policy changes: What was learned in the last ten years about prevention, suppression and the role of climate (and are resources and practices commensurate with these lessons); (2) Climate-sensitive factors which drive up firefighting (suppression and mitigation) costs; (3) Policies and programs that might experience increased fire risks and severity if climate is not taken into account especially within present fire preparedness plans; (4) Reforms that have been proposed. Lessons are drawn from recent major fires and fire hotspots in the western United States, but these have international applicability. We show that a risk assessment approach, which incorporates cross-scale climatic information including forecasts, can improve policy formulation and implementation in several areas.

For many global fire management programs, incorporating climate into the decision-making process may help to facilitate a shift in problem framing from emergency response to pro-active risk assessment and management.

Keywords: *: climate, fire management, fire policy*

1. Introduction

The fire management issues of today in the U.S. have evolved from 100 years of influence from three shaping factors, all of which could be similarily recognized in any fire prone country:

- Past management practices
- Land use activities and expectations
- Climate extremes, variability and changes

Each of these factors can be discussed separately (see below), but all three are intricately linked. Past management practices were significantly influenced by climate (e.g., drought patterns concurrent with fire and wet periods concurrent with fuel buildup), as is occuring today. Land use expectations, in particular for recreational areas and the wildland-urban interface (WUI), are that these environments will be protected via management practices (suppression and prevention). For much the western U.S., climate is a desirable attribute for many land use activities, but these activities feedback on climate (e.g., carbon sequestration, climate change). Climate is directly linked to potential fuel availability for fire. All three of these shaping factors will continue to influence future fire management and policy.

1.1 Past management practices

Since 1910, the U.S. Forest Service (USFS) has developed and transformed policy for wildland fire suppression and management of federal lands (including prescribed fire and fire use). Pyne (1997) identified USFS policy changes since the agency's establishment in the early 1900s (Figure 1). Clearly, a driving force for the agency was supression, though the broad policy changed over time, starting with economics, becoming full-suppression strategies and transitioning to prescription. Over time the problem fire changed starting with frontier fire, then backcountry fire, then mass fire (largely related to the U.S. and Soviet Union cold war), then wilderness fire and most recently intermix fire.

Specific policy change was often due to a large fire event. For example, large fires in the early 1930s lead to the implementation of the 10 A.M. policy, which stipulated that all fires were to be contained and controlled by 10 A.M. following the report of a fire. But not all large fire events lead to a major policy change. Any fire that includes fatalities will be investigated and reviewed (e.g., Thirtymile fire in 2001). These events often lead to a policy change regarding safety and protocols, but they have not changed broad landscape scale fire management. One departure from this was the 1994 South Canyon fire, which is discussed in section 3.

1.2 Land-use activities and expectations

The western U.S. has seen a dramatic increase of population and expansion of the WUI especially over the past two decades. Figure 2 shows the desirability of this living arrangement as yellow points within forested and rangeland vegetated areas. WUI areas are prevelant in the eastern U.S. which has its own fire issues, but most of the areas in the West

are in proximity to dry, fire prone environments with a history of large scale events and national public and political awareness. The exodus from urban to wildland has brought changing values. In the beginning of formalized land management, forests were primarily for agricultural benefit, now their value is largely aesthetics, recreational and WUI. New management strategies have evolved in attempts to address tradeoffs between social benefits, biological benefits and competing ecological values. Public health issues from thoses that are smoke related to fire managment are becoming a dominant concern. Large amounts of smoke are produced from large fires, but prescribed burning and wildland fire use also produces smoke, though with usually lower particulate concentration compared to wildfires. Generally, smoke from wildfire is accepted as an uncontrollable though undesired by-product. Some public information specialists assigned to larger incidents have begun including smoke impact updates as part of the briefing material. But smoke from prescribed burning or fire use is considered controllable and is often a public concern from both health and environmental nuiscance perspectives. Conflicting policies arise where fire agencies prefer to increase burning to improve ecosystem health, reduce hazardous fuels or some other management objective, and while air quality agencies are trying to reduce pollutants and particulants for human health and regional visibility.

Era	Problem Fire	Policy
1910-30	Frontier fire	Economic policy
1930-49	Backcountry fire	10 A.M. policy
1950-69	Mass fire	10 A.M. policy
1970-89	Wilderness fire	Fire by prescription
1990-present	Intermix fire	Fire by prescription

Figure 1. US Forest Service fire eras and policies since 1910. Adapted from Pyne (1997)

1.2 Climate

The extent to which fuels and climate contribute to fire activity is a highly debated topic (e.g., *Conservation Biology*, vol. 15, 2001). Locations can be identified where effective suppression has led to fuel accumulation outside of historic range, and other locations where historic range and frequency have not changed appreciably, and thus weather and climate seem to be primary controlling factors of fire extent and severity. Schoennagal *et al* (2004) suggests that fuel types and amount in cool, moist Rocky Mountain subalpine forests are less limiting to fire spread than climate variability compared to dry lower elevation ponderosa pine forests. These dry ponderosa forests are in need of

priority mitigation and ecological restoration. But as Schoennagal *et al* (2004) point out, applying these areas uncritically as a broad scale problem across the western U.S. is of concern (e.g., Healthy Forests Initiative (White House, 2002)). This particular initiative became law in 2003 and explicitly mentions climate – seasonal drought – in combination with disease and insects as being the primary factors for increasing fuel accumulation and risk of fire. It is difficult to find direct mention of climate in policies and laws related to wildland fire, yet the impact of climate is readily seen by forest managers and increasingly in scientific form by researchers.

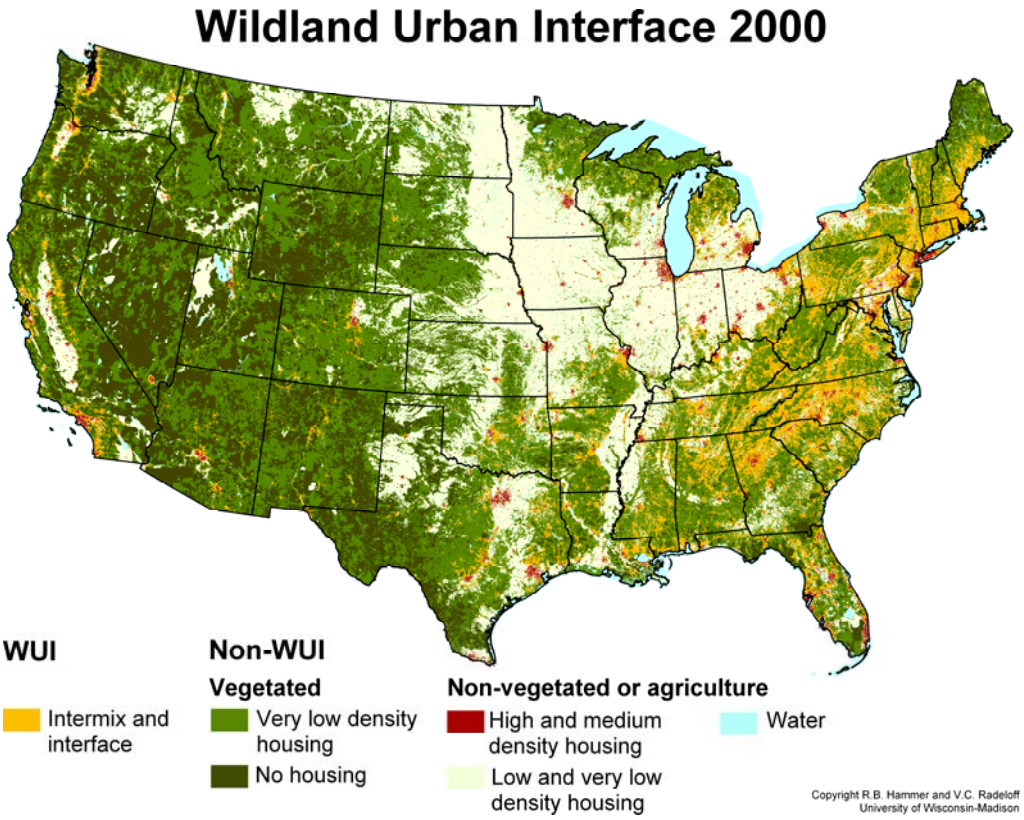

Figure 2. Map of the wildland-urban interface areas in the U.S. based on 2000 census data. Source: University of Wisconsin - Madison

While there is still debate on climate versus suppression as specific causal factors for fire extent and severity, other studies have begun to quantify associations with climate and fire. Clearly, climate will play some role in fire extent and severity even if it is not the primary factor. Monthly and seasonal atmospheric anomalies influence fire activity in the climate short-term (Johnson and Wowchuck 1993). Temperature and precipitation anomalies are important for fire, but other anomaly patterns, such as wind, relative humidity and lightning, also contribute to overall fire activity. Annual to decadal influence of climate on fire is largely a function of oceans. Swetnam and Betancourt (1990) discuss the influence of tropical Pacific climate variability on vegetation dynamics and fire activity in the southwestern U.S. The low phase of the Southern Oscillation (SO) and wet springs

tend to be associated with smaller burn areas, and the high phase of the SO and dry springs tend to be associated with larger burn areas. The synchrony of greater and lesser burn patterns over diverse southwestern forests indicates climate forcing of fire regimes on a subcontinental scale. Reconstructed fire occurrence and precipitation variability from tree rings indicate climate forcing on wildfire regimes on interannual to century timescales (Grissino-Mayer and Swetnam 2000). Fire and the SO is also linked in Florida (Brenner 1991); in fact, the ocean influence on wildfire seems to be synchronous on inter-hemispheric scales (Kitzberger *et al* 2001). The Atlantic Ocean may also be a factor along with El Nino-Southern Oscillation (ENSO) and trend in relation to fire occurrence and severity (Skinner *et al* 2006). Climate-disturbances related to fire include insect outbreaks and altered age structure and species composition of woodland and conifer forests (Swetnam and Betancourt 1998). Climate trend and change occur over decadal to century timescales. Numerous papers have suggested impacts on wildfire from climate change (CO_2 induced warming) including increased lightning occurrence (Price and Rind 1994), increased length of fire season (Wotton and Flannigan 1993), increases in area burned (Torn and Fried 2002), and increases in the number of days with extreme fire danger (Stocks *et al* 1998; Brown *et al* 2004).

Climate and associated fire risks across time scales are depicted in Figure 3. Shorter-term (e.g., monthly-seasonal) climate and fire associations begin on the left side of the figure and transition through annual and multiyear to decadal and century scales to the right. Some climate factors associated with the time period are listed above the timeline and generalized fire factors below. There are no clear boundaries for transition of the time scales, and the physical events listed for both climate and fire are interconnected and connected through time as well. Generally, the short time scales reflect annual fire agency operations and activities such as suppression and management burning. Here monthly and seasonal climate anomaly patterns are the impact, though they might be related to ENSO or a longer-term factor (e.g., decadal variability or trend). The multiyear grouping reflects management and planning for post-fire rehabilitation and invasive species. At these timescales, ENSO and drought are the potential climate risks. The decadal timescale consisting of climate decadal variability and trend represents the longest term strategic planning associated with overall ecosystem health and desired future conditions.

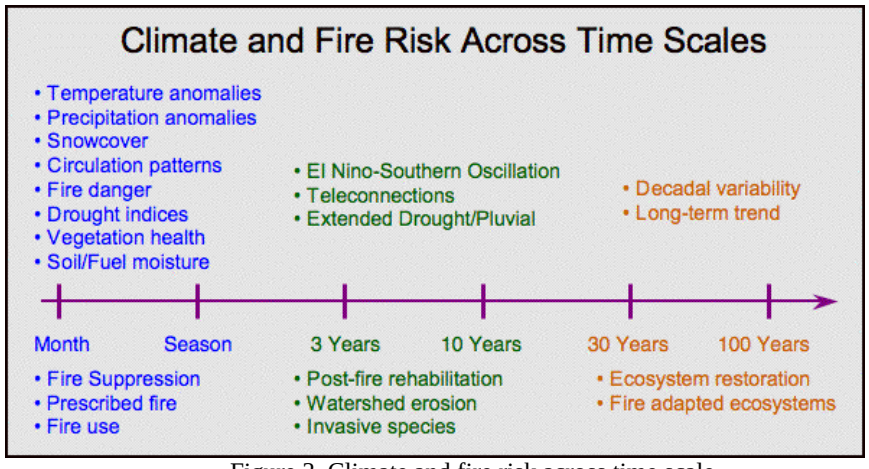

Figure 3. Climate and fire risk across time scale.

2. Fire problem/fire hazard

Fire management is expensive. While it is difficult to precisely reference a U.S. dollar amount related to wildland fire expenditures, annual federal agency budgets consistently show over $1 billion U.S. dollars appropriated annually for suppression, preventation, fuels management and other related business. The harder numbers to pinpoint are state and local budgets, especially since many volunteer fire departments are involved. In California alone, it is thought that over $3 billion is spent annually (Williams 2005). Though 99% of wildfires are successfully contained, the 1% of those that are not are driving record costs, losses and damages. In 2002, five western U.S. states experienced their largest fires on record. The fire problem includes the progressive degradation of ecosystem conditions in fire-dependent forests and grasslands. Most of the total dollars spent is focused on suppression and fuel reduction, but very little on assessing resource goals that exacerbate wildfire risk (Williams 2005). These, along with population growth trends, land use behaviors (e.g., WUI), and climate change and variability exacerbating fire extremes defines the fire problem.

The fire problem is persistent. The Insurance Services Office (1999) identified several factors for this persistence:

- Resistance from property owners and developers
- Expense of fuel management
- Development and land use patterns in the wildland/urban interface
- Diffusion of responsibility among a wide range of government agencies
- Priorities and jurisdictional issues
- Constraints imposed by law on fuel reduction and other mitigation efforts

Of this list, identified nearly 10 years ago, only the first factor has shown some limited positive change. State wide fire prevention efforts, such as FIREWISE and fire safe councils, have been effective at education and hazard reduction from largely a grass roots level. Some insurance companies are now encouraging homeowner mitigation education, and some are even restricting policy coverage without a demonstration of this mitigation. As for the other bullets, expense and WUI developments are increasing, and diffusion of responsibilities, priorities and jurisdictional issues remain. Fuel reduction and mitigation constraints largely remain due to law (e.g., air quality regulations) or public perception/interests (e.g., environmental concerns, politics, aethestics).

3. Fire policy and paradoxes

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In the past fifteen years, no fewer than eight national policy/initiative documents have emerged related to fire, fuels, ecosystems and communities:

- Wildfire Disaster Recovery Act (1989)
- National Commission on Wildfire Disasters (1990)
- Federal Wildland Fire Management Policy and Program Review (1995)
  - Implementation Action Plan Report (1996)

- Protecting People and Sustaining Resources in Fire- Adapted Ecosystems: A Cohesive Strategy (2000)
- National Fire Plan (2000)
- Review and Update of the 1995 Federal Wildland Fire Management Policy (2001)
- A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment, 10-Year Comprehensive Strategy (2001) - Implementation Plan (2002)
- Protecting People and Natural Resources: A Cohesive Fuels Treatment Strategy (2006)

The 1995 Federal Wildland Fire Management Policy and Program Review has been a cornerstone document for fire management during the past 10 years. This policy, a response to the fires of 1994, is the first comprehensive national wildland fire policy document given nearly 100 years of formal fire and land management. Its primary focus points are protection of life, recognizing wildland fire as a critical natural process, requiring comprehensive fire management plans, requiring consistent fire management decisions with land and resource management plans, and clarifying the role of federal agencies in the WUI. In 2001, a review and update of the 1995 policy was undertaken. It was found that the policy is still generally sound and appropriate; however, some significant updates and changes were made. The critical updates included: 1) the condition of fire-adapted ecosystems continues to deteriorate; 2) the fire hazard situation in these areas is worse than previously understood; and 3) the fire hazard in the WUI is more complex and extensive than understood in 1995. The 2001 Policy indicates several implementation actions for successful achievement of the policy: 1) fire management and ecosystem sustainability; 2) response to wildfire; 3) wildland-urban interface; 4) planning; 5) science; 6) workforce and organization; 7) funding; 8) communication and education; 9) program management and coordination; 10) evaluation; and 11) completion of 1995 action items.

Implementation of a national fire policy with so many comprehensive elements is a daunting task, especially when considering the wide range of government agencies and jurisdictions. The five primary federal operational fire agencies – US Forest Service, Bureau of Land Management, National Park Service, US Fish and Wildlife Service and Bureau of Indian Affairs have established over the years a number of strategies and collaboration processes (e.g., Wildland Fire Leadership Council). States are closely involved with these policy processes via the National Association of State Foresters. Signatures on the 2001 Federal Policy also included Department of Defense, Federal Emergency Management Agency, US Geological Survey, Department of Energy, Bureau of Reclamation, US Fire Administration, and National Weather Service.

The paradoxes of wildland fire risk and management can serve as barriers to successful implementation of policy components. The duality of wildland fire is that it can be viewed as a hazard or as a benefit depending upon the perspective. For much of the Forest Service history, fire has been viewed in a negative context, though not by all. For example, the southeastern U.S. has maintained a long history of prescribed burning despite an overall national plan emphasizing suppression. In the past two decades, fire has become recognized as an important aspect of ecosystem health for many areas, and fire adapted ecosystems and sustainability is now a primary management objective. This policy is now

so much embedded, that the notable Cerro Grande escaped burn fire in 2000 only shut down prescribed burning temporarily. In fact, that fire brought further attention and awareness of the growing fuels and forest health problems. The acreage target goal of fuels treatment is increasing annually. Scaling up and scaling down between federal and local can be a barrier to implementing policy. The coordination problems between these scales are recognized, and perhaps for some aspects (e.g., incident command structure) coordination works relatively well, but the general concerns are different at the different scales. Land use planning and management can be a barrier to policy implementation because though preventive, hazard usually is not perceived until after development has occurred. Code compliance can be a barrier as well, because even though strong codes are necessary, strong opposition can be in place for a variety of reasons (e.g., cost-cutting measures).

4. Integrating climate into fire risk assessment

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Despite climate being a critical conditioning component of fire, it is rarely explicitly mentioned in national policy or initiatives. When it is stated, the most likely reference is in the context of drought. From an operational perspective, climate information appears to be explicitly used when employing fire as a management tool, but there is very little direct use in suppression or prescribed burning. The difference between these is perhaps that fire use can often be a one or two month operation and hence at a climatic scale so that managers incoporate more climate information, whereas suppression and prescribed burning are more akin to day-to-day operations and hence, are more weather-related and climate is assumed to be less important. A potential problem with this perspective is that the underlying climate background of daily weather variability is still an associated risk factor for fire. This was highlighted in the Cerro Grande escaped burn report noting that moderate drought at least one year in the making was not adequately considered in the prescribed fire planning and implementation. Climate information is used extensively in the development of monthly and seasonal significant fire potential outlooks (Crawford *et al* 2006), and climate information is now being used by the USFS in seasonal planning for national fuels management. Recent interagency panel reports on suppression costs and the quadrennial fire and fuels review do explicitly mention decadal climate variability (in particular drought) and climate change as potential significant impacts on fire management costs and long-range strategies. But a fundamental question remains: Are fire managers still working on the fixed baseline principles instead of acknowledging a varying climatic background?

Integrating climate and fire risk assessment requires several key procedures:

- Determine requirements for developing effective utilization of climate information
- Determine if planning assumptions are supported by what is known about the climate record
- Determine how policy and operations can benefit from what is known about interannual and decadal variability, climate change and climate extremes
- Determine entry points for climate information across scales in policy, management and operational responses
- Establish effective pathways from policy through operations at multi-jurisdictional levels: national, regional, state and local

A first step in implementing these recommendations is to create an adaptive managment approach to integrating climate risks and fire management that (1) allows for explicit learning from past events, and (2) ensures that such learning is actually employed in practice. Such an approach requires a clear interagency mechanism for monitoring, documenting and evaluating such lessons, and ensuring dissemination and training across agencies and ogranizations. A major support role can be played by the research community in the development of criteria for such a process drawn from carfeul studies of co-evolution of climate and fire hazard relationships in the past and of catastrophic cases in particular.

The use of climate information in fire management is limited at present, yet there is a strong potential role given fire-climate associations. Climate information needs have not be well recognized by agencies over the years, though this is now slowly changing. This change is largely due to increasing awareness of recent persistent drought conditions and climate change, and as importantly increasing interactions between the climate research community and mission agencies. The value of using climate information must be established from operations through policy, and climate information must be incorporated at the multi-jurisdictional levels of national, regional, state and local. It is increasingly necessary to determine, through researcher-pratictioner partnerships, key entry points for climate information across scales in policy, management and operations (e.g. fuel treatment effectiveness), and to identify and overcome barriers to the flow of information across these scales. A second but equally weighted goal would be to use such information in public education and outreach campaigns to communicate or make transparent the “riskiness” of particular locations, and to inform choices or expectations from community development and resource management.

This paper presents initial synthesis and concepts in assessing the role and use of climate information in fire management. A more detailed paper is in preparation that will expand upon these concepts with particular focus on: (1) Policy changes: What was learned in the last ten years about prevention, suppression and the role of climate (and do the budgets reflect these lessons?); (2) Climate-sensitive factors which drive up firefighting (suppression and mitigation) costs; (3) Policies and programs that might experience increased fire risks and severity if climate is not taken into account especially within present fire preparedness plans; and, (4) Reforms that have been proposed.

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5. Acknowledgements

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