Mitigating Wildfire Risk in the Wildland Urban Interface: The Role of Regulations

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Abstract—*The growth of residential communities within forest areas throughout the country, and particularly in the West, has increased the danger to life and property from uncontrolled wildfire. The conflict of permanent residential settlements built next to a fire-adapted ecosystem has been further exacerbated by 100 years of fire suppression and an extended drought in the West. Under the police powers granted by the Constitution, state and local governments have the power to pass laws to protect the health, safety, and welfare of their citizens. As this relates to land use, the states have delegated this power to cities and counties. As a result, most laws for creating and maintaining defensible space around structures have been enacted at the local level. Research of state and local wildfire mitigation efforts found that many areas adopt regulations for defensible space as only one element of multi-faceted programs for wildfire mitigation. This paper will compare four model ordinances designed for adoption by state and local governments to protect communities from wildfire. In addition, results from a survey of wildfire program managers provide insight into the obstacles faced in administering defensible space regulations. In evaluating program options, managers must assess/balance wildfire risk and safety issues with public acceptance of regulations and the potential effectiveness of the regulation in mitigating wildfire hazard.*

Introduction

As communities have grown into forested areas, homeowners and forest managers have become aware of the threat posed by wildland fire to the safety of those communities. With the help of the National Fire Plan, many communities have taken steps to protect themselves by educating homeowners about the danger of hazardous fuels around homes, developing fuels reduction projects to create defensible space, and conducting disposal or chipping programs.

The State of California and many local areas require the reduction of vegetative fuels around structures through laws and ordinances. These ordinances are based on the police powers granted to states by the constitution, to protect the health, safety, and welfare of its citizens. States delegate this power as it relates to land use to local government entities. The unit of government closest to the people is thereby empowered to adopt, administer, and enforce regulations designed to control private behavior for the public good. Florida's Department of Community Affairs states, "because wildfire protection and mitigation activities must occur at a local level and in concert with local land use and development decisions, regulations for wildfire protections are most effective at the local level" (FDCA 2004).

In this paper we will look at research on public attitudes toward vegetation management regulations, the efforts of at-risk communities to encourage vegetation management, four model ordinances for wildfire risk reduction, and the experience of program managers in administering regulations for vegetation management.

Public Attitudes and Wildfire Risk Mitigation

One of the major challenges facing policy-makers as they formulate state and local risk mitigation programs is how to influence the behaviors of private property owners regarding vegetation management. Public risk perceptions concerning wildfire appear to affect

residents' support for regulations to mitigate the risk. For example, Bradshaw (1987) and Loeher (1985) reported that many residents within wildland-urban interface (WUI) communities had had no direct experience with the devastating effects of wildfire and, as a result, tended to underestimate the risk. A decade later, Winter and Fried (2000) found that focus groups in Michigan perceived wildfire to be inherently uncontrollable, with random patterns of damage, a perception that tended to discourage individual property owners from engaging in unilateral removal of vegetation. Further, they found that zoning and safety ordinances are viewed as unacceptable infringements on the rights of property owners to use their property as they see fit.

Similarly, Loeher (1985) cited a belief by residents that it is simply not their responsibility to protect themselves from wildfire risk. Further, some residents may not support vegetation management because they fear that removal of trees and shrubs will negatively affect the aesthetics and ecological functions of a natural landscape (Alan Bible Center for Applied Research 1998, Hodgson 1995, Davis 1990). On the other hand, support for more restrictive government regulations seems to increase after a community has experienced a wildfire (Abt and others 1990).

Vegetation Management Regulations

Research for the National Wildfire Mitigation Programs Database website, www.wildfireprograms.usda.gov, a clearinghouse of information on state and local programs for wildfire mitigation through vegetation management, shows that municipalities and counties adopting regulations to protect wildland urban interface areas use many different regulatory tools (wildfireprograms.usda.gov 2004). Wildland-Urban Interface regulatory mechanisms for vegetation management exist in the form of fire codes, building codes, subdivision regulations, zoning regulations, growth management, or comprehensive plans, and fire plans.

Out of 108 defensible space regulations found in 74 jurisdictions, 23 were in fire codes, 26 were in subdivision regulations or development standards, 19 were in fire plans, 11 were in general plans, 9 were in zoning overlay districts, and 9 were in state guidelines. Smaller numbers were in burn regulations, insurance guidelines, real estate disclosure laws, building codes and land use codes. This shows that there is no one right answer in regulating vegetation management. Jurisdictions are dealing with wildfire risk in ways that best suit their needs and the administrative structure of their fire codes and land use regulations.

Jurisdictions are not relying solely on the regulations to motivate citizens to reduce fuels. Most jurisdictions with regulations also have other aspects of a program to reduce fuel hazards within the community. These other program elements may include defensible space prescriptions, free or cost-share clearing programs, chipping and disposal services, demonstration projects, community fuelbreaks, and public education campaigns. Of the 74 jurisdictions with regulations, 54 of those jurisdictions supplemented the regulations with more than one other program element.

Ordinance Structure

Comprehensive regulations to protect communities from wildfire must include road, bridge and driveway specifications, requirements for fire resistant construction materials, adequate water supplies for fire fighting, multiple ingress and egress roads, visible addresses, and fuel breaks for defensible space. This paper will focus specifically on the defensible space regulations, one part of a comprehensive Wildfire Urban Interface ordinance.

The paper will examine four different model codes and will discuss the elements of vegetation management regulations included in each. Two of the codes are designed to be adopted by any community at risk in the nation; one of which is an international standard. The other two are state model codes for California and Florida, which are representative of the needs of their state's particular terrain and vegetative risk, and represent different areas of the country. It is hoped that this examination of four different ordinances will assist communities considering adopting a model code in finding one that best fits their needs. The model codes to be discussed are:

1. NFPA 1144: Standard for Protection of Life and Property from Wildfire (NFPA 2002);
2. International Urban-Wildland Interface Code (UWI) (International Code Council 2003);
3. Model Ordinance for the Defensibility of Space and Structures, (California Department of Forestry and Fire Protection 2000);
4. Model Wildfire Mitigation Ordinance (Florida Department of Community Affairs 2004).

While all of these ordinances contain the basic elements necessary for a comprehensive wildfire protection ordinance, each is unique in some way. This paper will look first at the similarities within the ordinance elements pertaining to vegetation management, and then the specific elements that make each stand out from the rest.

Findings of Fact and Risk Assessments

Most regulations begin with findings of fact which give reasons why the regulations that follow are necessary to protect to health, safety, and welfare of the citizens of the jurisdiction. The UWI Code includes an appendix which guides the jurisdiction in writing findings of fact which relate directly to the climate, topography and fuels situation of the local environment. The findings of fact form the basis for the designation of the WUI area within the jurisdiction. This area must be mapped, and the criteria and map must be reviewed every three years.

NFPA 1144 does not include an introductory findings-of-fact. Instead it requires the jurisdiction to do a hazard risk assessment based on the following factors:

1. Climate;
2. Vegetative fuels;
3. Rating of existing structures;
4. Slope and aspect;
5. Fire history;
6. Firesafe routes and egress;
7. Other factors determined by the local jurisdiction.

This risk assessment is to be reviewed by the jurisdiction annually.

The model ordinances put forth by Florida and California are structured differently. Both states have conducted hazard risk assessments on a statewide level, and make the information available to communities in map form. The communities may follow up at the local level with more detailed assessments, or they may impose restrictions based on the information provided by the state. In Florida, the entire state was mapped using Landsat imagery at 30 meter resolution and Ikonos imagery at 4 meter resolution. Fire protection service response time was included in addition to the factors listed above. The state plans to review its Florida Risk Assessment (FRA) every three years. However, the jurisdiction may select a different frequency for local review of risk.

California's Very High Fire Hazard Severity Zone (VHFHSZ) is mapped at one square mile resolution, and information is reviewed by the state every five years. Localities containing VHFHSZ areas are asked to adopt two ordinances. The first is the Model Ordinance for Very High Fire Hazard Severity Zone Adoption, which gives the Fire Chief the power to conduct a local hazard risk assessment to define the VHFHSZ based on findings of substantial evidence. The second is the Model Ordinance for the Defensibility of Space and Structures, which the locality must adopt unless it already has regulations in place that are equal to or more restrictive than those outlined in the Model Ordinance.

Table 1 shows the elements included in assessments to determine limits of the area where WUI regulations will apply for each model ordinance, i.e., the Wildland-Urban Interface Zone.

Hazard Risk Rating Guides

All four ordinances are supplemented with a fire hazard rating guide that allows inspectors to evaluate the fire hazard risk of proposed developments and existing structures. These hazard rating scales differ in complexity and in the weight given to the various factors. Many states have developed their own hazard rating forms which may be based on earlier versions of NFPA 299, but tailored to the environment found in their state. The new standard NFPA 1144 features a revision of the 299 Wildland Fire Risk and Hazard Severity Assessment system. The severity values for non-rated roofs, inadequate separation of vegetation from structures and separation of structures from each other have been increased (NFPA 2002). When choosing a model ordinance for a locality, the choices of hazard risk rating forms should also be considered, and the weightings of the various factors should be tested in the district.

Vegetation Management Plans

All four ordinances include oversight and review by the jurisdiction of new construction. The model codes all contain language requiring the submittal of a plan with a map showing the intended development, existing conditions, and proposed changes, including existing fuels and fuels modifications. All four ordinances hinge the issuance of a building permit and/or grading permit upon acceptance of the proposed plan.

Defensible Space Requirements

The four ordinances all require fuels modification to create defensible space around structures. Defensible

Table 1. Determining the WUI Zone – Findings of Fact / Risk Assessment.

	NFPA 1144	UWI Code	CA LRA Model	FL Model
Climate	X	X	X	X
Vegetation	X	X	X	X
Structure	X	X	X	
Slope/aspect	X	X	X	X
Density/lot size	X		X	
Access	X	X	X	X
Fire history	X			
Fire protection services			X	X
Review	1 yr.	3 yr.	5 yr.	3 yr.
Risk form	X	X	X	X

Table 2. Defensible Space Plan Requirements.

	Defensible Space Minimums					
	30'	Varying	Setback/ lot size	Greenbelt/ Fuelbreak	Fuel modification plan	Building permit issued
NFPA 1144	X				X	X
UWI Code	X	X			X	X
CA LRA Model	X	X	X	X	X	X
FL Model	X			X	X	X

space clearing and pruning requirements are comparable, but the mandated distances are different. A comparison of the defensible space requirements is shown in table 2.

NFPA 1144 and the Florida Model Ordinance require a minimum of 30 feet of defensible space around structures. UWI Code requires a minimum of 30 feet for moderate hazard areas, 50 feet for high hazard areas, and 100 feet for extreme hazard areas. The California Model Ordinance requires a minimum of 30 feet, which can be extended to 100 feet at the determination of the Fire Chief. The California Model Ordinance also requires a minimum setback of 30 feet on parcels over one acre, and for parcels less than one acre the jurisdiction shall provide for the "same practical effect." The other ordinances do not specify setback requirements.

Greenbelts or Fuelbreaks on Common Areas

A fuelbreak is a strip of land surrounding a subdivision or community which provides a barrier to adjacent wildlands by modifying the fuels in this area. Greenbelts act as fuelbreaks, but are lands used for purposes other than fire control such as golf courses, swimming pools, parking lots, parks, playgrounds, and orchards. The Florida Model Ordinance requires 12 foot fuelbreaks around the perimeter of new subdivisions. The California Model Ordinance recommends greenbelts, but does not specify a width for the greenbelt. The ordinance requires the greenbelt to be strategically located as a separation between wildland fuels and structures, and to be approved by the jurisdiction.

Maintenance of Defensible Space and Enforcement

All four model ordinances require the maintenance of defensible space as an element of the fuel modification plan described above. However, since vegetation can grow back quickly, the challenge lies in enforcement of this requirement.

NFPA 1144 states that the fuel modification plan shall include a maintenance element with the responsibility for maintenance defined. No enforcement or penalty language is included in the ordinance.

UWI Code contains language which requires a plan to maintain the defensible space included in the approved Vegetation Management Plan. The UWI Code gives the code official the authority to inspect, the right of entry, and the authority to issue corrective action orders. Persons failing to take immediate action to abate a hazard when notified to do so by the code official are guilty of a misdemeanor.

The California Model Ordinance for the Defensibility of Space and Structures does not include penalty language in the ordinance. Since the model provides for the insertion of component statements into the Uniform Fire Code (UFC), penalties are cited in the UFC. Penalties for failure to maintain fire breaks exist in the California Government Code. Fines may be levied for first, second and third offenses. Or, if a landowner fails to correct the conditions, then the local agency may have the work performed, and the charges become a lien on the property.

The Florida Model Ordinance also includes a procedure should the landowner fail to perform the necessary wildfire mitigation, charging the costs as a lien against the property. As in the UWI Code, the Florida Model Ordinance gives the code official the authority to inspect, the right of entry, and the authority to issue corrective action orders. Persons failing to take immediate action to mitigate a hazard are guilty of a misdemeanor.

Table 3 shows the enforcement penalties for defensible space violations in the four model ordinances.

Public Awareness and Disclosure of Wildfire Hazard

To make the residents of high wildfire risk areas aware of the dangers that surround them, the NFPA 1144 and the Florida Model Ordinance require the jurisdiction to create public education programs. The NFPA 1144 program emphasizes wildland urban interface and intermix issues including: wildland fire hazards, life and property risks, fire causes, prevention and safety programs, directed to target audiences. The Florida Ordinance recognizes that many homeowners are unaware that they live in an area

Table 3. Maintenance of Defensible Space and Enforcement.

	Maintenance	Fines	Misdemeanor	Liens
NFPA 1144	X			
UWI Code	X		X	
CA LRA Model	X	X	X	X
Florida Model	X	X		X

susceptible to wildfire. The ordinance requires buyers of buildings or undeveloped property in wildfire hazard areas to be informed in writing of the wildfire risk and potential nuisance posed by fuel management activities such as prescribed burning. And it requires the Wildfire Mitigation Official to hold a series of public workshops, and distribute informational brochures to homeowners, builders, developers, and realtors. The state of California requires the disclosure of wildfire hazards to purchasers of property in the VHFHSZ.

Unique Characteristics of the Ordinances

NFPA 1144

Unique to NFPA 1144 are regulations dealing with fire protection during construction. NFPA 1144 provides for the control of combustible materials and requires the presence of extinguishing equipment on the job site. Among other requirements, an approved hose with nozzle must be available, and have enough length and water supply that water can reach 20 feet into the vegetative fuels adjacent to the construction site.

Another innovation in NFPA 1144 is the section on Community Planning for Protection of Life and Property from Wildland Fire. This requires the jurisdiction to create an operational plan for command, training, community notification and involvement, public safety and evacuation and mutual assistance elements. The public education component is an important element of the operational plan. In addition to being prepared for evacuation and mobilization of attack, the operational plan will help the community prepare to be recognized through the Firewise Communities USA program. The community planning element may also prove valuable under the Healthy Forests Restoration Act. By having local leadership in place, and working relationships built, the community is well prepared to develop the required Community Wildfire Protection Plans.

UWI Code

The UWI Code, like NFPA 1144, sets out minimum standards for protection from wildland fire. It differs in that it provides for increased defensible space around structures in areas deemed high and extreme hazard, increasing the distance up to 100 feet. The distances may also be increased by the code official based on his determination of site-specific conditions. This makes defensible space less of a one-size-fits-all formula. The UWI Code includes a section on vegetation control around roadways and electrical transmission and distribution lines. In addition, the language on enforcement and penalties strengthens the regulations.

California Model Ordinance for the Defensibility of Space and Structures

California's Model Ordinance is unique because it is mandated by the state, setting out minimum standards for jurisdictions with high and very high hazard zones to enforce. It is the only ordinance of the four in which the defensible space regulations also apply to existing structures. However, localities have the option to dispute the VHFHSZ designations, and communities with pre-existing ordinances are exempt. As a result, adoption of the model ordinance has not been universal.

The model ordinance is just one piece of California's complex set of laws for administration of wildfire hazards statewide. For fire-protection purposes, the state is divided into the State Responsibility Area (SRA) and the Local Responsibility Area (LRA). State Responsibility Areas are "areas in which the financial responsibility of preventing and suppressing fires is primarily the responsibility of the state. The prevention and suppression of fires in all areas that are not so classified is primarily the responsibility of local or federal agencies, as the case may be (PRC 4125[a]). Local Responsibility Areas are places where a local fire district is responsible for preventing and suppressing fires.

California first enacted regulations for fire hazard zoning in the State Responsibility Areas in 1982. Over the years, California added regulations setting out vegetative clearance and roof and structural requirements for the SRA. In 1992, with the adoption of the "Bates Bill", fire hazard assessment and zoning were mandated in the LRA. Minimum fire safety standards were set for local governments to adopt. The regulations are comparable to those that existed in the SRA since 1985, and brought fire hazard reduction regulations to all high wildfire risk areas throughout the state.

Even with state mandated regulations, a Blue Ribbon Commission which studied the 2003 Southern

California wildfires found that "Currently, appropriate minimum building standards and fire safety requirements are neither mandated nor consistently enforced in all communities in High and Very High Hazard Severity Zones." Additionally they found that "Most structural losses occurred where homes had little or no vegetation clearance or were built using combustible building materials, and were thus vulnerable to wildfire" (Schell 2004).

Florida Model Ordinance

The Florida Model Ordinance was created to be a resource for local governments considering wildfire mitigation regulations. It was not intended to be adopted verbatim. It includes a wide range of elements which local governments can choose from in creating their own regulations.

For example, a section on tree protection reconciles defensible space regulations with pre-existing tree protection ordinances. This section provides language which exempts highly flammable trees within 30 feet of a structure from the tree protection ordinance, and allows the planting of replacement trees of a less flammable nature. The jurisdiction should attach a list of flammable exempt trees and less flammable replacement trees.

The Florida Model Ordinance also includes language providing incentives to homeowners in the overlay district to create defensible space. One incentive is an ad valorem tax break. The ad valorem tax exemption is a one-time exemption of the amount paid by the homeowner for improvements made for the purpose of wildfire mitigation.

Another incentive is recognition of homeowners who have demonstrated results and commitment to accomplish the goals of wildfire mitigation. These individuals will be recognized with Landowner Awards that are publicly displayed in the City or County Hall.

The Florida Model Ordinance is meant to be adopted by local governments as one piece of their land use regulations. All Florida counties and municipalities are required to adopt a comprehensive plan to guide their physical development and growth, and all local land use decisions must be consistent with the adopted comprehensive plan. Therefore, the wildfire mitigation goals should be included in the comprehensive plan, and should be integrated into other land development regulations, including subdivision regulations, zoning ordinances, and building and development standards. Florida also recommends that wildfire mitigation standards be included in deed restrictions or subdivision covenants, and be required in a homeowners' associations plan for management of common areas.

Experience of Program Managers with Wildfire Mitigation Regulations

Although model ordinances are excellent tools for providing guidance to local governments in planning for wildfire protection, our research looks beyond these blueprints to examine the policies and programs currently employed in high-risk communities. A survey of 100 wildfire mitigation program managers, conducted in 2003 examined the broad spectrum of mitigation strategies being implemented. Managers were asked to characterize their programs in terms of the types of activities implemented, obstacles to achieving program goals, and the effectiveness of program strategies. Of particular interest to the study at hand, are the responses of managers concerning regulatory programs. Of the 56 survey responses, 25 managers indicated that regulation of some type was a component of their wildfire risk management program whether through ordinances, zoning and/or planning requirements. In all but three responses, managers indicated that regulatory strategies were a component of broader, comprehensive programs that also included education and public outreach efforts, homeowner assistance, and wildfire hazard assessment and mapping. Managers reported that the focus of their regulatory programs included mandatory standards and/or review processes for new developments in all 25 jurisdictions. In addition, thirteen managers reported that prescribed treatments for fire hazards around existing homes through defined defensible space standards were required in their jurisdictions.

Program Barriers

The effectiveness of wildfire risk reduction efforts may be constrained by socio-political, economic, and technical obstacles. The questionnaire asked managers to rank the importance of 12 potential obstacles to achieving program goals on a scale of 0-5, with 0 being of no importance. "Budgetary limitations" were considered major barriers by all the respondents; closely related was "lack of qualified personnel" reported by nineteen managers. Other important obstacles included "public apathy" and "homeowner resistance to conducting fire-wise improvements on their properties" with 17 of the 25 program managers indicating that these social and political factors were impediments to achieving program goals. Perhaps most important to the analysis of regulatory strategies was that the barrier "inadequate enforcement of regulations" was reported as a major obstacle for only eight of the twenty-five managers. Linkages among barriers may

create complex challenges for managers. For example, effective regulatory programs require adequate funding and personnel to review planning documents, conduct inspections, administer permit systems, and enforce standards. Public acceptance may also affect the effectiveness of regulatory strategies. Program managers may be averse to enforcing unpopular regulatory policies when the success of other components of their programs, such as education and homeowner assistance depend upon a good rapport with the public and cooperative homeowners.

Effective Strategies

Managers were asked in an open-ended question to identify their most effective program element for creating defensible space. Interestingly, thirteen of the twenty-five managers of programs with a regulatory element, indicated that homeowner services, strategies involving one-on-one assistance to homeowners – such as fire-wise prescriptions, cost-share assistance for reducing hazards around homes, or chipping and fuels disposal - was their most effective program element. Only eight of the 25 managers felt that the regulatory component of their program was the most effective strategy.

Conclusion

Regulations for wildfire mitigation are an important tool which communities can use to prepare the built environment for the eventuality of wildfire. In most communities the enacted regulations apply only to new construction and substantial remodels, so the sooner regulations take affect the better. Communities should compare the provisions of the model ordinances to their needs. They may find that by adding language from one ordinance to another, or by supplementing the ordinance with a more sensitive hazard rating form or increased defensible space standards, it well serve them better. For example, The Village of Ruidoso, New Mexico adopted the UWI 2000 Code, but substituted its own fuels management standard which brings defensible space requirements out to 120 feet in some areas, and a hazard rating form which factors in the indigenous vegetation identified on each property.

Minimum standards to reduce structural losses from wildfire are built into the model ordinances. For a community at risk, each ordinance would put in place an administrative structure and regulations to improve the safety of the built environment as it grows into forested areas. The unique features of each model ordinance should be considered when drafting an ordinance for local adoption. In areas of extreme risk an ordinance with greater distances for defensible space and stronger enforcement options may be appropriate. In areas where existing tree ordinances conflict with the goals of wildfire mitigation, exceptions, as provided in the Florida ordinance can solve the problem.

Wildfire hazard mitigation is a planning goal that should be included in comprehensive plans and growth plans and considered on a par with transportation, open space, housing density, and other land use issues, as recommended in the Florida Model Ordinance. A study by the American Planning Association (American Planning Association 2002) found that in many states, enabling legislation for local planning dates back to the 1920's. The smart growth initiative to modernize planning legislation is an important step toward giving localities zoning and subdivision review powers to effectively deal with contemporary growth issues, but it does not list wildfire mitigation as a goal. Wildfire mitigation needs to be balanced with all growth and development issues, and included in the smart growth planning process.

Regulations are not a quick fix to wildfire susceptibility, and they need the support of the community. They should be part of a broader program of risk awareness and fuels reduction, which demonstrates a commitment by the local government to safeguarding the public. Emphasis should be placed on establishing fuelbreaks between the community and forested land. In developed areas, cost-share clearing, demonstration projects and slash disposal programs will be needed to create defensible space around existing structures and in common areas. Many states and high risk communities are already doing this. Homeowners need to see that the responsibility for wildfire risk reduction is shared between themselves and the larger community, and that wildfire mitigation is an ongoing process. They cannot wait until wildfire threatens their homes to take action.

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