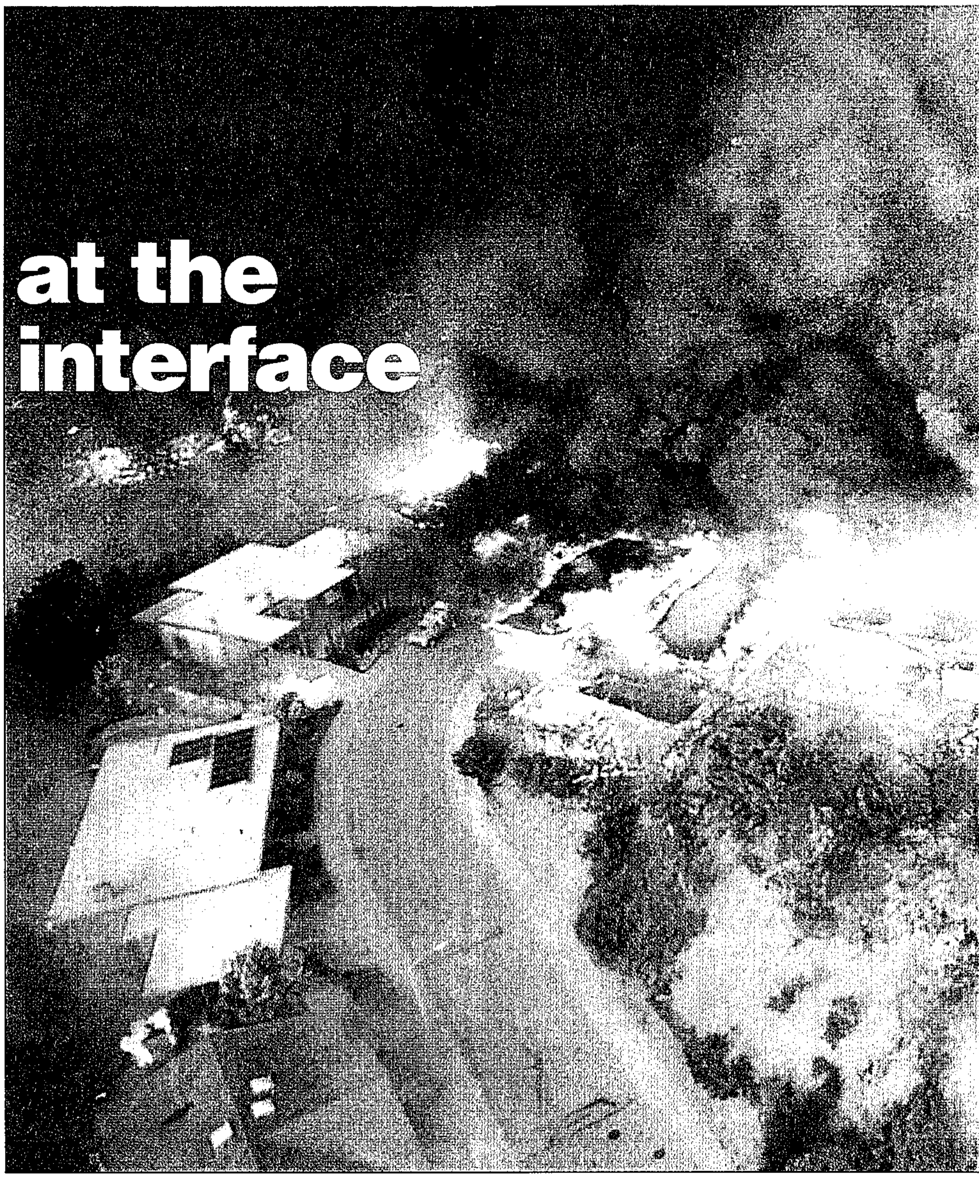
Hazard mitigation at the interface



Just like high-rise fires, interface conflagrations can overpower fire department resources. So why isn't interface hazard mitigation taken more seriously?

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Urban-wildland interface fires have become the fastest-growing source of value-loss due to fire in the United States. Every year thousands of homes are built in areas vulnerable to wildfire, yet little is being done to mitigate the increased fire hazard that results from such development.

In his 1971 article "Commingling of Urban and Forest Fires," Carl C. Wilson wrote, "The potential for disaster is growing faster than our ability to cope with it."[1] Wilson was writing in response to the California conflagrations of 1970, which destroyed 722 homes and killed 13 people.

Another fire researcher, Clay P. Butler, motivated by this destruction, provided the first generic description of structure loss on wildland fires and coined a term for the problem — the "urban-wildland interface."[2] (See sidebar on page 59.)

Neither Wilson nor Butler, however, anticipated the national scope that this problem would assume in the coming decade, although history had provided ample warning of a growing national problem. Wildfire losses included 450 structures in Massachusetts in 1941, 1,200 in Maine in 1947 and 458 in New Jersey in 1963.

Yet many were surprised by the 1,400 structures damaged or destroyed in 1985 in such diverse parts of the country as Florida, North Carolina and Montana. By the mid-1980s, interface fires were acknowledged to be more than just "a California problem," as evidenced by the beginnings of the National Wildland/Urban Interface Fire Protection Initiative.[3]

An important step in coping with the growing interface fire problem lies in recognizing the need for built-in fire protection not only from interior fires, but also from the threat of exterior exposure fires where flammable vegetation adjoins structures. Some of the world's most destructive peacetime fires of the 20th century have occurred in the past decade, when wildland vegetation fires have breached the interface to destroy thousands of homes by attacking their vulnerable exteriors.

There should no longer be any doubt that effective mitigation of the growing interface hazard requires a greater commitment to fire safety standards and financial incentives than has historically been applied to the problem.

What is the "fire interface"?

In coining the term "urban-wildland interface," Butler described a growing fire problem that was distinct from either urban structure fires or forest fires. He defined the urban-wildland interface as a zone characterized by two distinct fuel environments, with flammable vegetation on one side and flammable building materials on the other. The boundary between these two environments Butler called the "fire interface."[4]

The interface fire problem should be viewed as a dichotomy, that is, as a problem involving two contrasting and sometimes contradictory elements. Viewing interface fire this way enables us to begin to understand why the problem has persisted with so little useful corrective action. This dichotomy, it should be noted, extends beyond fuel environments and includes parallel dichotomies in both the fire service and fire research communities.

In the fire service, urban fire department operations are primarily based on a stationary strategy: Resources arrive and are put into

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The 1991 Oakland-Berkeley fire overwhelmed public fire protection with 13 structure ignitions a minute during its first hour. Note that each building has its own interface between vegetative and structural fuels. The proximity of adjacent structures illustrates that exterior exposure fire standards might be necessary in some interface areas to protect a neighborhood with high structure density (center of photo).

action in one geographical area. If the fire expands, additional resources are placed to cover the exposures.

Wildland fire protection agencies, on the other hand, traditionally approach fire with a highly mobile strategy. If the primary fire control line fails, resources can fall back to a secondary line and exercise the option of "firing out" the intervening vegetative fuels.

Unfortunately, neither approach works well on interface fires, for two reasons. First, typically there aren't enough resources to cover all threatened exposures and, second, unprotected structures make it impossible to safely "fire out" vegetation. The fire service is far from any kind of consensus on acceptable strategies for addressing these complications on interface fires.

In the research community, forest fire researchers have traditionally given little consideration to how fire moves from vegetation to structures, while fire protection engineers have tended to concentrate on interior building fires. Neither discipline has had much to say about protecting buildings from exterior vegetation fire exposure, the critical factor at the interface.

A similar dichotomy exists in the approach to hazard mitigation at the fire interface. Urban fire hazard mitigation has been accomplished largely by mandated compliance with fire safety codes based on years of fire protection engineering, research and product testing.

But at the interface, hazard mitigation has generally relied on education efforts and voluntary adoption of fire safety recommendations based on professional judgment. The difference in effectiveness of these two approaches deserves close scrutiny.

The high-rise comparison

Historically, urban fire disasters have resulted in permanent changes to attitudes about fire. The Great Chicago Fire of 1871 is memorialized even today by National Fire Prevention Week. The 1945 Cocoanut Grove Night Club fire in Boston (492 dead) led to changes from coast to coast in codes affecting such factors as egress, emergency lighting and combustible materials.

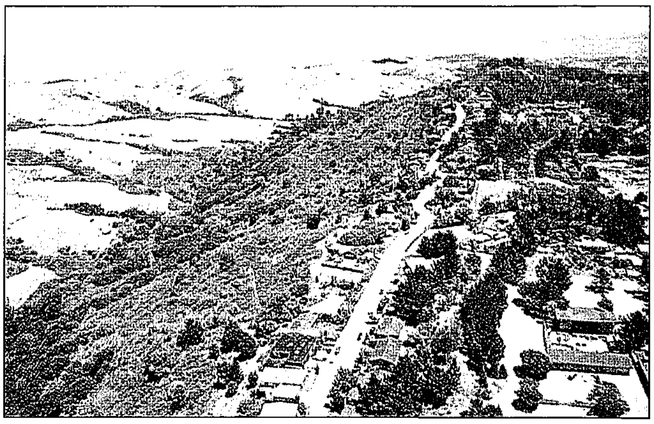
The Our Lady of Angels School fire in Chicago, with its 93 fatalities in 1958, led to vastly improved awareness and implementation of exit drills and fire safety inspections in schools. And high-rise fires like the 1980 MGM Grand Hotel fire in Las Vegas (85 dead) resulted in the nearly universal adoption of sprinkler systems in new hotels.

By contrast, disastrous interface fires have not resulted in effective hazard-mitigation measures. In 1871, on the same day as the infamous Chicago Fire, a forest fire near Peshtigo, Wis., killed 1,200 people in a single night. Yet few in the fire service today have even heard of this, the most lethal fire in North American history.

More recent interface fires, like the 1980 Panorama fire in California (4 lives and 325 homes lost), the 1985 Palm Coast fire in Florida (99 homes destroyed) and the 1991 Oakland-Berkeley fire (2,475 homes destroyed, 25 deaths) have resulted in numerous studies and recommendations,[5] but have not led to fire safety codes comparable to those developed in response to urban fires.

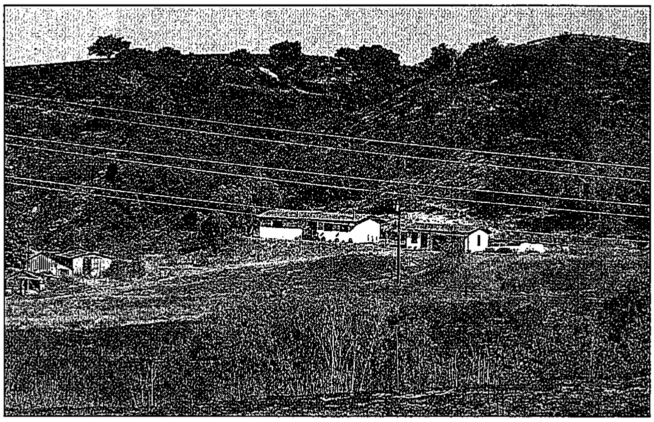
The dichotomy between these approaches to hazard mitigation can be illustrated by comparing two types of fire problems, both of which can overwhelm fire departments: urban high-rise fires and classic interface fires. In both cases, buildings are developed that are vulnerable to fires capable of overwhelming public fire protection as fire spreads from floor to floor in the one instance, or from house to house in the other. How society and the fire service respond to private development that has the potential to outstrip fire protection capabilities is the basis for this comparison, and might suggest alternatives for mitigating the interface fire hazard.

First, consider high-rise fires, perhaps the urban fire problem with the greatest potential for overwhelming fire departments. For example, in São Paulo, Brazil, a 31-



Jerry Kent

Above: This line of houses forms the development/wildland fringe pattern characteristic of a "classic interface." ***Below:*** *This house survived because of hazard-mitigation measures such as fire-resistive roof and wall coverings and vegetation clearance. It also illustrates the "mixed interface," where scattered structures are intermingled with rural flammable vegetation.*



Keith D. Cullom

story office building was destroyed and 16 lives were lost in 1972, and less than two years later, 90 people were killed when fire destroyed a 25-story building in the same city. New York City's fire commissioner later described these fires as "beyond the capabilities of the strongest fire department in the world."[6]

High-rise fires of this magnitude are considered extremely unlikely today in North America, because of mandatory built-in hazard-mitigation measures designed to minimize losses to life and property. These include fire wall requirements, occupancy and fuel load restrictions, and most recently, extensive fire protection systems.

In fact, nearly every aspect of high-rise construction and use is regulated by fire safety standards designed to reduce the potential for overwhelming fires. Thanks to such measures, it has been decades since a high-rise has been destroyed by fire in North America.

Now consider interface fires. The 1991 Oakland firestorm, with its average ignition rate of 13 homes per minute during the first hour, was certainly a fire that overwhelmed public fire protection. In contrast to the response to potentially overwhelming high-rise fires, hazard mitigation requirements at the interface have been extremely limited. It is a rare community that regulates such risk factors as exterior wall flammability, avenues of fire spread into structures or structure siting with respect to topography.

Progress has been slow at best for the two hazards most heavily targeted for mitigation: flammable roofing materials and vegetation fuel loading.

Since early in this century, the danger posed by wood roofing has been recognized as a general fire hazard, not unique to interface areas. City ordinances mandating fire-resistive roofing have coincided with a dramatic reduction in urban conflagrations,[7] and there has not been a major interface fire involving wood roofing in the eastern United States since 1963.

But the recent history in the western United States is another story. Even in areas plagued by repeated interface conflagrations, wood roofing restrictions, if any, are likely to be relatively recent, while existing wood-roofed structures are routinely exempted.

The record for the other primary interface hazard, flammable vegetation, is not much better. Unlike flammable roofing, this hazard is generally confined to interface areas and its mitigation is much more limited.

In California, where vegetation clearance around wildland structures has been required for nearly 30 years, effective mitigation has been stymied by lack of code-enforcement resources, despite repeated disasters. Even when such code requirements are enforced, they tend to be applied only to wildland vegetation, while ignoring highly flammable landscape and ornamental vegetation such as juniper hedges and pine trees.

Mandating corrective actions through codes and ordinances is not the only approach to mitigating fire hazards. In fact, mandates might not always be the most appropriate strategy at the interface. For one thing, wildland fuels are more dynamic with respect to fuel loading and flammability than are structural fuels, and therefore less amenable to a standard "fix."

For another, mandates impose costs on those being regulated and are often resisted. With urban fire problems, such resistance is often countered with well-documented analysis of individual hazard-mitigation measures. Unfortunately, by comparison, there has been a striking lack of research and engineering applications to the exposure problems at the interface.

The other dominant hazard-mitigation strategy is the voluntary adoption of recommendations by those at risk. The use of voluntary measures for reducing the impact of high-rise fires has been largely limited to attempts to modify human behavior. Examples are recommendations for occupant use of stairways during evacuation, and fire alarm investigation and reporting procedures followed by building security personnel. But the vast majority of hazard-mitigation measures in high-rise buildings is provided by code enforcement and fire safety system engineering, not voluntary compliance.

Just the opposite is true with interface fire hazard mitigation. Other than fire suppression, recommendations are government's primary and often only response to the life and property losses suffered in interface fires. Such voluntary measures have been promulgated for nearly 30 years, yet interface fire losses continue to mount.

Contrasting attitudes

This dichotomy of hazard-mitigation strategies — mandatory regulations on the one hand and voluntary recommendations on the other — mirrors to some extent the two perceptions our society has of large fires. The deadly urban conflagrations, beginning with the Great Chicago Fire of 1871 and numerous high-rise conflagrations at the turn of the century, have been perceived as human-caused problems and thus as something that government should act on to prevent or control.

By contrast, wildland conflagrations from Peshtigo (1871) to Yellowstone (1988) have been perceived as natural disasters over which humans have little or no control.

Urban-wildland interface fires encompass attributes of both types of fire. One result is that there are mixed perceptions of the interface fire problem and confusion about mitigating the interface fire hazard.

On one side of the interface, society may view fire as an urban problem, and therefore not see the need for annually clearing grass and brush from around structures, since government is expected "to come put the fire out." On the other side of the interface, society may view fire as a natural disaster, an "Act of God" that is therefore beyond the pale of mere building codes.

To reconcile the contradictions inherent in this dichotomy, we recommend two models for approaching fire hazard mitigation at the interface. The first, which we call the "mandatory mitigation model," matches the perception of interface fire as an accidental and human-caused problem with a strategy that relies primarily on government mandates.

The second model, the "voluntary mitigation model," matches the perception of interface fire as a natural disaster with a strategy that relies primarily on voluntary measures and financial sanctions.

Mandatory mitigation

Throughout the 20th century, adoption and enforcement of fire safety and building codes have been driven by the perceived need to mitigate hazards identified following disastrous fires in factories, restaurants, theaters, schools, high-rises and other occupancies.

There are circumstances under which this model might also be the most viable approach to mitigating hazards at the fire interface. This is especially true where buildings are in such close proximity to each other that the actions (or lack of actions) taken at any one structure directly affect the survivability of closely adjacent structures.

A number of standards for protecting life and property from wildfire have previously been proposed.[8] Recognizing that specific standards need to be adapted to suit local circumstances, we endorse the basic framework of these proposals, all of which contain four elements.

1) Identify and map high-hazard interface fire areas. It almost goes without saying that identifying hazards is the first step toward mitigating them. In urban areas, identifying high-rise hazards is relatively straightforward. For example, buildings over a certain height might trigger additional hazard-mitigation measures.

Identifying interface fire hazards is far more complex, because such hazards are subject to dynamic variables such as weather and fuels, which can change yearly, seasonally or even hourly. Interface fire hazard-severity mapping has recently been mandated in California, and while such mapping is not easy, emerging technologies such as geographical information systems should facilitate the process. And there are

Making a case for 'the interface'

By Captain Ethan I. D. Foote and Division Chief Dana Cole, CDF

Numerous approaches to describing structure loss scenarios in wildfires have emerged over the past 20 years. All of them, however, describe the same fundamental problem of fire spreading from vegetation to buildings. It is in the fire service's best interest to settle on common terminology for this growing fire problem, so we all speak the same language among ourselves, to those in other disciplines and to the public.

The phrase C.P. Butler coined 20 years ago, the "fire interface," has withstood the test of time and deserves to be acknowledged as the basic term. "In its simplest terms," Butler wrote, "the fire interface is any point where the fuel feeding a wildfire changes from natural (wildland) fuel to man-made (urban) fuel.... The interface includes all conditions that may lead to fire spreading through natural vegetation into a building."[1]

This basic concept was later refined to describe three scenarios of building loss in vegetation fires.[2] The first is the "classic interface" scenario, in which a wildfire threatens a line of buildings along the fringe of a developed area, often extending into a city for many blocks. The second and perhaps more common scenario is the "mixed interface," in which rural homes scattered among expanses of vegetation are threatened by wildfire. The third scenario, the "occluded interface," typically occurs within an urban area where fire threatens to spread from an island of vegetation to surrounding structures.

While the scenarios differ, in each case the "fire interface" means the same thing: the boundary between two distinct fuel systems, one composed of combustible building materials, and the other composed of combustible vegetation. The key is that every building near flammable vegetation *has its own interface*, the boundary of which is crossed when a wildfire spreads to the building.

There are also other perspectives from which to view this problem. One is to focus on differences in development patterns and view groups of buildings as either lined up against an expanse of wildland vegetation, forming a "development interface," or scattered throughout a large area of natural vegetation with intermingled structures, forming a "development intermix."

Because of the differences in perception of the problem and the absence of any natural authority, names for this fire loss problem have proliferated. Examples include "exurban fire," "hillside/wildland intermix," "wildland-structural intermix" and "chaparral-urban interface."

Some of these terms are used to make important distinctions among wildfire scenarios. "Wildland-structural intermix," for example, is used to expound on differences in local planning issues and firefighting strategies between the "mixed" and "classic" interface situations.[3] The "chaparral-urban interface" definition has also been used to highlight issues vital to the distinctive fire/flood cycles of southern California "classic" interface fires.[4]

While it might be argued that some of these terms make important distinctions among types of fires, it is worth considering whether any purpose is served by categorizing each nuance of a common problem as a separate issue. FC

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2. J.B. Davis, "The Wildland-Urban Interface: What It Is, Where It Is and Its Fire Management Problems," in W.C. Fisher and S.F. Arno, "Protecting People and Homes from Wildfire in the Interior West: Proceedings of the Symposium and Workshop," GTR INT-251 (Ogden, Utah: USDA Forest Service, 1988), pp. 160–165. This refinement was first suggested by C.W. Philpot in 1986.
3. R.L. Irwin, "Local Planning Considerations for the Wildland-Structural Intermix in the Year 2000," in J.B. Davis and R.E. Martin, "Proceedings of the Symposium on Wildland Fire 2000," GTR PSW-101 (Berkeley, Calif.: USDA Forest Service, 1987), pp. 38–46.
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precedents: Other dynamic natural hazards such as floods have long been subject to hazard mapping.

2) Require mitigation of the urban fuel hazard at the interface. Jurisdictions should adopt enforceable construction standards which recognize that exterior flammability and ignition sources are as much a concern for interface structures as the threat of interior fires. Standards already exist in urban areas for protecting building exteriors from the hazard posed by fires in neighboring structures.[9] Such standards can be used as models for protecting structures from the exposure hazard posed by flammable vegetation.

3) Require hazard mitigation of natural (wildland) fuels at the interface. Vegetation fuels need to be cleared or modified in such a way as to minimize structure exposure hazard from advancing wildfire. This is the basis of the concept of "defensible space," which is meant to give firefighters a zone from which to defend life and property.

Analogous fuel loading restrictions are used to minimize the potential for fire departments becoming overwhelmed in high-rise fires. For example, new restrictions on the use of combustible interior finishes and contents in high-rises were widely adopted in the wake of hotel fires during the 1980s.

In each case, where fire threatens to spread from vegetation to homes and where fire threatens to spread from one floor of a high-rise to another, reducing the fire load is a major tool for mitigating the hazard.

4) Provide for a community infrastructure that reflects the additional hazards at the interface. Just as high-rises have extraordinary fire protection infrastructure needs, so do communities in high-hazard interface areas. Such communities need road networks that provide safe access for emergency responders while simultaneously allowing civilian evacuation; high-rises require smoke towers for emergency access and egress.

Interface communities need standards for signage on streets and buildings to facilitate locating a fire and to avoid delays in response; standards for multiple-story buildings include stairway identification signs.

And interface communities must provide for minimum emergency water supplies and pumping capabilities, just as required by high-rise fire safety standards.

Voluntary mitigation

It is not always feasible or desirable to accomplish the four hazard mitigation elements recommended above with governmental mandates. The extent of government regulation imposed on urban high-rises is not likely to be tolerated in rural communities, where wildfires might be perceived as random natural disasters on the order of tornadoes or blizzards. Government's role in mitigating losses from such disasters may be seen as limited at best, and therefore a viable strategy of voluntary measures should also be available.

Residents and communities are capable of mitigating interface fire hazards without mandates, but it is unlikely that most will do so unless the benefits are seen to outweigh the costs. Even areas with a high rate of voluntary compliance can be jeopardized by relatively few properties that pose an exposure fire threat to neighboring buildings.

To be effective, a voluntary strategy should incorporate land-use planning mechanisms, such as lot-size restrictions and building setbacks, that will allow property owners the latitude to mitigate natural fuel hazards themselves. The biggest challenge of this model could be to motivate interface residents to accept this responsibility, rather than assume that fire departments will always be available to put the fire out.


A CDF helicopter over the 1991 Oakland-Berkeley fire.

Financial incentives

Unfortunately, it is probably unrealistic to assume that millions of interface residents can be adequately informed about the risk and need for hazard mitigation. On the other hand, it might be feasible to get this message across to the much smaller number of people who establish insurance rates, loan terms and taxes.

In Europe, for example, the financial community traditionally supports the fire service in much stronger fire prevention measures than is the case in North America. As a result of these measures, the fire death rate is less than half that of North America, the number of structure fires per capita is far lower, and the threat of fire burning a structure from the exterior is almost nonexistent.

According to Philip Schaenman, president of TriData Corp., a Virginia fire consulting firm, "Many American homes, particularly those with wood shingle roofs and considerable open space, would simply not be insurable in Europe."[10]

We don't mean to advocate the kind of wholesale cancellation of homeowners' insurance policies that occurred recently when some major insurance carriers elected to abandon storm-prone areas in Hawaii, Florida and other Gulf Coast states in the wake of devastating hurricane losses. But we do believe it is in the interests of both the fire service and responsible interface residents that property-insurance rate structures reflect the true fire hazard severity of interface areas.

Just as life and auto insurers adjust rates for those who smoke or have poor driving records, so property insurers should take into consideration the degree of risk and extent of voluntary hazard mitigation at the interface. The "brush surcharge" used by some insurance companies in Southern California is a good example.

To be an effective market mechanism, insurance premiums must reflect the actual probability of structure loss. For example, one study of interface fires in southern California concluded that fire-resistant roofs and brush clearance for 100 feet around structures would reduce the average annual structure loss by a factor of 10.[11]

Construction and mortgage-lending standards can also be used as leverage to encourage appropriate fire protection measures on interface properties. Tax credits can be used to reward the adoption of fire safety standards, as has been done for years to promote energy-conservation measures.

Another tool that can achieve a better balance between risk and the costs of mitigation and protection is the creation of special assessment districts to support fire services and infrastructure improvements in high-risk areas. Such districts were created in Oakland and Berkeley following the 1991 fire.

Conclusion

Interface fires have the potential to overwhelm public fire protection capabilities, but the cost of these fires is not borne solely by the owners of burned structures. Insurance companies, lenders, the taxpaying public and firefighters are also hurt.

The lack of interface hazard mitigations exposes not only the subject property and neighboring properties to wildfire risk, it also makes firefighting more difficult, dangerous and costly. Unfortunately, the public often does not appreciate fire departments' limitations in responding to such fires.

The fire service can most effectively respond to the interface threat as it has responded to other potentially overwhelming hazards: by shifting the hazard-mitigation burden onto the parties who create the hazard. Those who profit from and enjoy the amenities of building and living at the interface must be willing to take responsibility for protecting life and property by funding additional mitigations, regardless of whether they are mandatory or voluntary.

The question of whether society should address the interface fire problem with expanded land-use control, code requirements or market mechanisms — or whether we will continue, in effect, to subsidize residential development in areas subject to predictable and avoidable natural fire hazards — might be beyond the scope of the fire service.

But whatever the answer, the public must understand that the fire service cannot mitigate the interface hazard alone. By the time fire breaches the interface and crosses from wildland to urban fuels, it might be too late. FC

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