



# Residential Development Effects on Firefighting Costs in the Wildland-Urban Interface

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# Residential Development Effects on Firefighting Costs in the Wildland-Urban Interface

The cost of fighting wildland fires has increased dramatically over the last decade. Average expenditures from 2000 to 2013 were 150 percent higher than from 1985 to 1999 (NIFC 2014). By 2010, federal firefighting expenditures exceeded \$1 billion per year, representing nearly 50 percent of the U.S. Forest Service (USFS) budget and substantially reducing funding available for other forest management priorities (NIFC 2014). This increase in expenditures is partially attributed to growth in rural residential development in the wildland urban interface (WUI), where human development converges with wildland vegetation (OIG 2006).

New research suggests an important role that local governments could play in reducing the costs of fighting wildfires in the WUI. Towns and counties, through their influence on land use planning and policy, can shape the pattern of residential development to make fire fighting more efficient and less expensive (see Scofield 2014). Designing effective policies, however, requires a detailed understanding of exactly how development influences firefighting costs. This bulletin examines how different patterns of housing development in the WUI influence firefighting costs in the Rocky Mountain West and explores ways local governments could

increase firefighting efficiency through strategic land use planning.

## **GROWTH IN THE WILDLAND-URBAN INTERFACE AND FIREFIGHTING COSTS**

Exurban growth, characterized by large lot sizes and low housing densities, has accounted for much of the housing growth in the U.S. over the last several decades, and much of the exurban growth has occurred in the WUI. Between 1970 and 2000, total WUI area in the U.S. rose 52 percent (Theobald 2001). This development trend has been even more pronounced in the West, where for every 100 new homes built during the 1990s, 66 added to or created new WUI (Hammer et al. 2009). The Rocky Mountain region of Colorado, Montana, and Wyoming has over 200 million acres of WUI with 46 percent, 62 percent, and 80 percent of housing units in the WUI in the three states, respectively (Theobald and Romme 2007; Radeloff 2005).

WUI development increases the cost of fighting fires as firefighters shift their effort from fire containment to structure protection (Canton-Thompson et al. 2008). To protect homes, firefighters use aggressive full-suppression

Towns and counties, through their influence on land use planning and policy, can shape the pattern of residential development to make fire fighting more efficient and less expensive.

**Figure 1**

Isolated development often requires more firefighting resources than clustered development.



the location of homes relative to one another impacts the effectiveness of firefighting resources. There are two main types of firefighting resources: ground resources, such as hand crews and fire engines, and aerial resources, such as helicopters and air tankers. A single fire engine, for example, can protect multiple homes if they are located in close proximity to one another, whereas a separate engine would be required for each home that is dispersed on the landscape (Figure 1). At a larger spatial scale, clusters of homes concentrated in one area can be protected by a single aerial resource, such as an air tanker. If several clusters of homes are widely dispersed (Figure 2), however, multiple tanker drops may be required at an average cost in excess of \$20,000 each (NIFC 2012). Recent University of Wyoming research measured the relationships between development patterns, the

**Figure 2**

Developments that are widely dispersed on the landscape require more resources to protect (e.g., multiple air tanker drops) than if they were located closer to one another.



strategies that often involve costly resources, such as air tankers. Such strategies are implemented to protect homes regardless of economic cost-efficiency arguments. Previous research, for example, has shown fire managers are willing to spend \$10.3 million to protect \$1 million in home value (Calkin et al. 2012).

### WHY THE SPATIAL PATTERN OF DEVELOPMENT MATTERS

The spatial pattern of homes can have a large influence on firefighting expenditures because

effectiveness of firefighting resources, and the resulting suppression costs to quantify the hidden costs of dispersed residential development in the WUI (Scofield 2014).

### ECONOMIC ANALYSIS OF DEVELOPMENT PATTERN AND FIREFIGHTING EXPENDITURES

The analysis used data from a variety of federal agencies and parcel-level geospatial information on home locations for 291 wildfires in Colorado, Montana, and Wyoming from

2002 to 2011 (Scofield 2014). Residential development was characterized using a spatial index that accounted for two important spatial dimensions: 1) the relative density of homes within a development cluster, and 2) the relative proximity of separate clusters of homes. The index was defined on the basis of the characteristics of different firefighting resources. For example, homes were defined as clustered if they were within 100 meters of one another, which is the maximum distance over which a fire engine can be expected to protect multiple homes (Lampin-Maillet et al. 2010). Similarly, clusters of homes were considered to be dispersed if they were more than 2,000 meters apart, which was based on the hourly fire-line production of a bulldozer (the cheapest resource capable of protecting multiple home clusters simultaneously). The spatial index therefore captures the tradeoffs of using different types of firefighting resources (e.g., engine crews to protect densely clustered homes vs. air tankers to protect dispersed clusters or isolated homes). To isolate the influence of development pattern, the research also accounted for other drivers of firefighting expenditures (e.g., weather conditions and the fuel type available for each fire).

Results of the model showed that it is not simply the number of homes at risk that increases firefighting expenditures, but how homes are dispersed on the landscape. This

result contradicts the common belief that all new homes in the WUI lead to equal increases in firefighting expenditures. For example, one completely isolated home can increase expenditures by \$225,000 while a single home within a dense cluster can contribute as little as \$100 to overall firefighting expenditures (Figure 3). Similarly, fires burning in areas with highly dispersed development can cost as much as \$620,000 more than similar fires burning in areas with clustered development. Protecting a small number of dispersed homes can therefore be more expensive than protecting a high number of clustered homes. Conversely, fires with more homes at risk can actually be less expensive to fight than fires with fewer homes, as long as homes are sufficiently clustered.

### IMPLICATIONS FOR POLICY AND LAND-USE PLANNING

Despite existing policies to reduce fire in the WUI, ranging from defensible space ordinances to fire safety education, the cost of protecting homes from wildfires continues to rise (Haines et al. 2004). Local governments might provide the key to minimizing home loss and controlling firefighting costs. Completely restricting development is often not an option for local governments and is inconsistent with the private land ethos of the West; however, a better understanding of the relationship between development pattern and wildfire suppression costs provides a middle ground.

Fires with more homes at risk can actually be less expensive to fight than fires with fewer homes, as long as homes are sufficiently clustered.



**Figure 3**  
Isolated development (left) makes firefighting resources less efficient relative to clustered development (right), resulting in higher firefighting costs.

Land-use planners should consider the firefighting implications of different development patterns when planning for WUI development.

By influencing the pattern of new WUI development, policymakers can contribute to reducing wildfire suppression costs without restricting development altogether. For example, towns and counties could use development fees to encourage desired spatial arrangements of development (e.g., higher fees for dispersed, large-lot development). In the private sector, fire insurance programs with higher premiums for dispersed homes could create economic incentives to cluster development. While the

exact pattern of development capable of reducing firefighting expenditures will depend on local conditions (e.g., terrain and road access), land-use planners should consider the firefighting implications of different development patterns when planning for WUI development. Zoning regulations and incentive programs that guide, rather than simply restrict, development could strike a balance between private property rights and rural development while helping to control the growing costs of wildfire suppression.



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