

Fire Risk and Residential Development: A GIS Analysis¹

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Abstract: Population growth is rapid in rural areas in California. This growth into the wildland-urban interface makes fire protection and suppression more difficult. Fire managers have opportunities to reduce fire danger by improving housing development patterns; however, the overall density and placement of houses is usually set by criteria other than fire danger. By identifying and mapping historical and current housing development patterns, managers can begin to examine difficulties of fire protection, such as road access and crew response time, and to identify fire hazard zones. Proposed development patterns can then be examined for potential fire risks, and recommendations made based on these estimated risks. The effects of various factors assumed to correlate with rapid residential construction in Nevada County, California, were described. Geographic Information Systems (GIS) methods were used to analyze overall housing location patterns and to determine improved methods to reduce fire risks in the wildland-urban interface. Preliminary results indicate that populations are densest in chaparral vegetation types with very high and moderate fire risk.

Rapid population growth into the wildland-urban interface causes difficulty for fire protection and suppression, such as inadequate road access, distance to water and roads, and slow fire crew response time. By identifying the current arrangement of houses on the landscape, fire managers can estimate potential fire risks to housing developments. The use of Geographic Information Systems (GIS) in mapping wildland fire risk and population growth is promising (Chou and others 1990, Salazar and others 1990). A GIS processes spatial information and is designed for data management, mapping, and spatial and nonspatial analysis (Berry 1987).

Fire risk maps were produced with a GIS by combining basic environmental factors such as vegetation type and slope. A GIS was used to categorize fire risk within Nevada County, California. Using geographic mapping tools and demographic information, a GIS executed scenarios describing estimated population density in each fire risk area and predicted future developments at risk in very high and high fire danger areas. This paper addresses the use of GIS technology to describe and assess housing locations at risk to fire in rural and wildland-urban interface areas, in Nevada County, California.

GIS and Fire Risk Analysis

Nevada County in the north central Sierra Nevada was California's fifth most rapidly growing county between 1980 and 1990, with most of the population growth in wildland areas (California Department of Forestry and Fire Protection 1988a).

¹Presented at the Symposium on Social Aspects and Recreation Research, February 19-22, 1992, Ontario, California.

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This growth is highly dispersed, with 85 percent of the population living in unincorporated areas, and with extensive commuting to jobs outside the county (Bradshaw 1987). Many of the residents live in areas where vegetation type and slope contribute to high fire risks. Due to incomplete and complex environmental and demographic information, the extent of the risk is not understood.

A GIS was used to map the approximate location of residential structures based on parcel information in the County Assessor's files. These data include the size of each parcel, whether buildings are on the parcel, and the dominant use and the assessed value of the buildings. Within the county, the data on individual parcels are aggregated into about 50 books, most with 30-70 pages. Mapped locations of the pages from the assessor's files were overlaid on geographical features of the county within the GIS, to provide detailed information on the extent of development in remote areas. As well, within the rural areas we described the extent to which parcels have been developed, the acreage involved, and the proximity of developed parcels to major highways.

The state fire risk maps are inadequate for developing a concept of reduced fire risk for development because they are based on elevation only. We generated a fire risk map, using a GIS, based on vegetation types and slope. The major vegetation types in Nevada County are conifers, hardwoods, shrubs, and chaparral. The majority of the population is in the south central area of the county, therefore, this is the area of greatest importance for fire planning.

Vegetation in south central Nevada County consists of chaparral and hardwoods, both types susceptible to very high and high fire risks. For purposes of modeling fire risk, particularly when referring to structures, the fire risks are grouped into the following four broad categories: very high, high, moderate, and low (table 1). (California Department of Forestry and Fire Protection 1988b, p. 15-55).

Results

The GIS was queried to select rural, nonrural and wildland-urban interface categories that fall into the previously designated very high, high, moderate, and low fire categories derived from the GIS data layers.

Preliminary results from the queries indicate that populations are densest in the chaparral vegetation type at slopes between 20 and 40 percent, where the fire risk is very high. Additional populated areas are in hardwood vegetation type at slopes less than 20 percent, where fire risk is moderate. Therefore, in relation to fire risk, housing developments are best located in low to moderate fire risk areas in the hardwood and

shrub vegetation types at slopes between 10 and 20 percent, in central and north central locations in the county. Additional fire suppression planning in areas of increased road access, proximity to water, and additional fire crews, must be implemented if developments occur in other areas where fire risk is very high and high.

Summary

GIS applications are useful to policymakers and fire managers who desire improved understanding of the difficulties of managing growth in the wildland-urban interface. While it is not possible to prohibit all growth in very high fire risk areas, it is possible for both land owners and public officials to know and understand the hazards associated with extensive low density housing development in hardwood and chaparral areas.

Within the very high fire risk areas, additional fire safety, fire zoning, and fire suppression measures can be taken to assure that people can safely evacuate areas during fires and suppression efforts can be better planned. In addition, information and prevention campaigns can be more effectively targeted to areas of very high fire risk. If the extent of development in these areas is better understood, loss of life and property can be reduced.

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Table 1—*Fire risk associated with slope and vegetation types*

Slope (pct)	Conifers	Hardwoods	Shrubs	Chaparral
>40	High	Moderate	High	Very high
>20-<40	Moderate	Moderate	High	Very high
>10-<20	Moderate	Low	Moderate	Moderate
<10	Low	Low	Low	Moderate

Source: Chase 1992