Assessing the Effectiveness of Fire Management in the Wildland Urban Interface

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Background & Significance

While fires are a natural and necessary part of many healthy ecosystems, they can also be a destructive force when they impact human communities. Due to fire suppression, human disturbance, invasive pests, and climatic changes, fires in many areas now burn hotter and larger than they would have historically.

California has the largest area of wildland urban interface (WUI), the area where homes and associated structures are built among forests, shrubs, or grasslands. In Santa Barbara County in particular, there is a substantial amount of highly flammable vegetation along with WUI development, making the implementation of fire management initiatives imperative. Along with identifying proper management strategies, understanding the sociopolitical and biophysical conditions that contribute to the success of fire management programs is a task of equally critical importance.


FACT:

Between 2004 and 2013, California experienced
37,432 fires
1.6 million acres burned
$4 billion lost from fires

City of Santa Barbara's Wildland Fire Suppression Assessment District

In 2006, Santa Barbara residents in the foothill (light green) and extreme foothill (dark green) zones voted in favor of a special assessment district (outlined in maroon) to mitigate the risks from wildland fire. The City of Santa Barbara Fire Department created a **one-of-its-kind** Wildland Fire Suppression Assessment District (District) that provides residents with additional fire protection benefits. Residents of the District pay a yearly fee of approximately $75 in exchange for services such as debris chipping, defensible space inspections, roadside clearance, and vegetation management. All homes benefitting from the District fall within areas of high fire hazard.
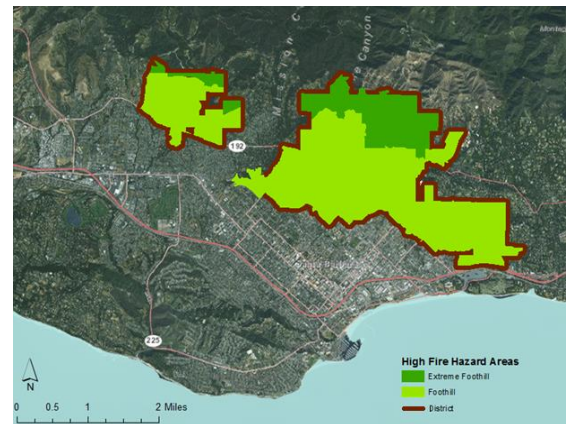
Project Objectives

Ten years after the District's inception, the Fire Department is interested in a comprehensive evaluation of the District and its efforts towards reducing threat from wildfire. In response, this thesis project looked at several aspects of the District to determine its effectiveness.

1 Determine the overall attitudes of residents towards the District and their use of its services

2 Assess the effectiveness of fuel removal treatments conducted by SB City Fire Department

3 Identify other cities that may benefit from a similar fire management special assessment district
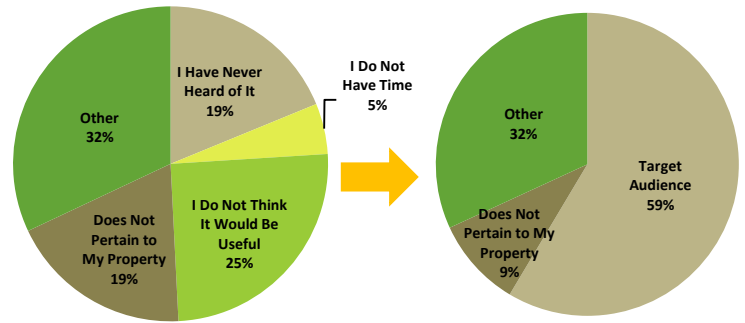
Determining Residents' Opinions

Results from our survey showed that only 38% of residents have ever requested a defensible space inspection. To better understand why residents do not use this service, we evaluated their responses.

The first pie chart on the right represents the response distribution for the reasons why residents have never used the defensible space inspections. "Other" was the most frequent response, and included residents who were unsure how to schedule an inspection, were afraid of the word "inspection", and have procrastinated.

Why Have You Never Used the Defensible Space Inspection?

Since defensible space is one of the top indicators for whether or not a home will survive a fire, we were concerned that 25% of respondents don't think this service would be useful. We combined these responses with all respondents who have never heard of it, those who don't have time, and half of those who say it does not pertain to their property (because there is likely a lack of understanding) to come up with a target audience that could benefit from strategic communication outreach from the Fire Department to increase awareness of the service benefits.

Fire Risk Perception in High Fire Hazard Areas
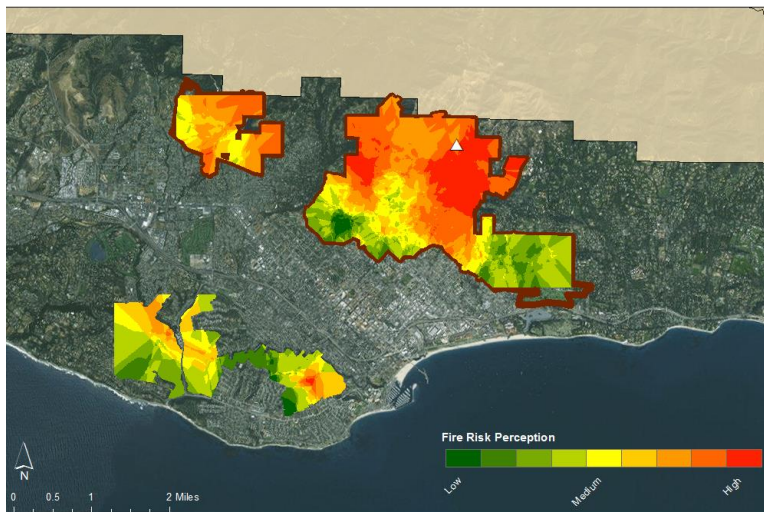
To determine the collective risk perception for geographic areas in the foothill and extreme foothill zones, as well as the coastal zones of the high fire hazard areas, we used interpolation of survey responses. To do this, we used the perceived fire risk responses, including non-respondents, to perform the Kriging method of interpolation in ArcGIS.

On the map, perceived fire risk ranges on the spectrum from very high (red) to low (green). As one might expect, the Kriging analysis showed that areas near the Los Padres National Forest (beige shaded area), the Tea Fire ignition location (white triangle), and areas near densely vegetated canyons all have higher perceived risk estimates.

Note: all residents surveyed live in *high fire hazard zones*, so all shaded areas on the map should actually be red, representing high fire risk.

Findings & Recommendations

1. **Improved strategic communication**
   We recommend increased strategic communication efforts for the target residents to increase awareness and encourage use of the District's services. A social media audit showed that the Fire Department's social media accounts could be used more effectively to reach out and share information to residents. In particular, we believe that the Fire Department should create a YouTube channel featuring tutorials and instructional videos.

2. **Service renaming**
   Residents feel that the terminology "defensible space *inspections*" is intimidating because it has a negative connotation. We suggest that the Fire Department consider using a friendlier term such as "defensible space *consultation*".

3. **Adjusted scheduling availability**
   To accommodate residents who are not available during the 9-5 Monday-Friday work schedule, we recommend that the Fire Department consider adjusting the scheduling times of the services provided.

Assessing Vegetation Management Effectiveness

Before

After

One of the large-scale services provided by the Fire Department is vegetation management in areas with unique hazards such as heavy, flammable vegetation, lack of access due to topography and roads, and/or firefighter safety. These selected areas are known as Vegetation Management Units (VMUs). In most cases, the Fire Department removes between 1/2 and 2/3 of the vegetation found in these high fire hazard areas; the pictures above represent a VMU before and after 2/3 vegetation removal.

To assess the effectiveness of the vegetation management program to reduce fire risk, we used a fire behavior modeling software called BehavePlus. We modeled five representative VMUs pre- and post-treatment and under two different wind conditions. Pre-treatment modeling refers to assessing fire behavior under no vegetation management, while post-treatment measures fire metrics based on recorded vegetation removal by the Fire Department. The first wind scenario represents "standard" wind speeds of 6 mph. The second scenario represents the more extreme Sundowner wind conditions that can be observed during the summer months and can reach speeds up to 60 mph.

Relationship Between Fire Risk and Fuel Removal
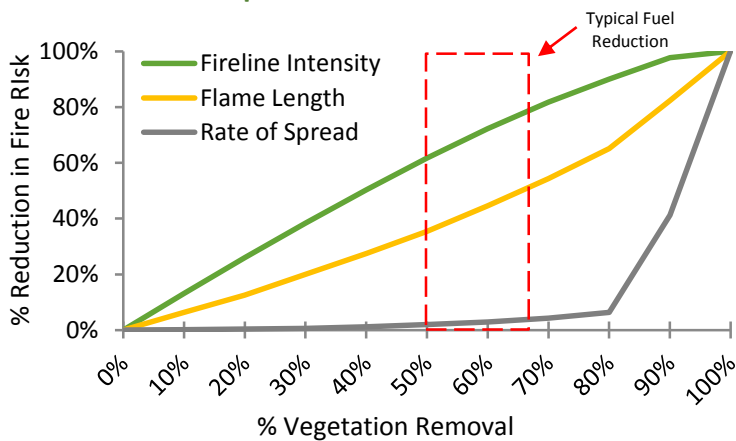
The three fire metrics of interest for this project include fireline intensity, flame length, and rate of spread. These metrics react differently to the amount of vegetation removed. Fireline intensity and flame length show gradual decreases in fire risk as the percentage of vegetation is removed. Rate of spread has a drastically different pattern, where management seems to have little impact until roughly 85% of vegetation is removed. Such a large removal could be both impractical ecologically and aesthetically, unless placed in certain strategic locations where response time is especially slow.

Flame Length (ft) Comparisons

6 mph (Standard winds)		60 mph (Sundowner winds)	
pre	post	pre	post
17.5	8.6	50.2	17.2

Vegetation management reduces flame length even under Sundowner conditions. Vegetation removal returns flame length under Sundowner conditions to baseline conditions pre-treatment, making firefighting efforts less challenging.

Findings & Recommendations

The linearity of response to vegetation removal indicates that more removal is better. In chaparral ecosystems, rate of spread is not affected until approximately 85% of fuel is removed. This highlights the importance of a quick response time by the fire department.

Finding Other Suitable Cities

City Suitability

Low
High
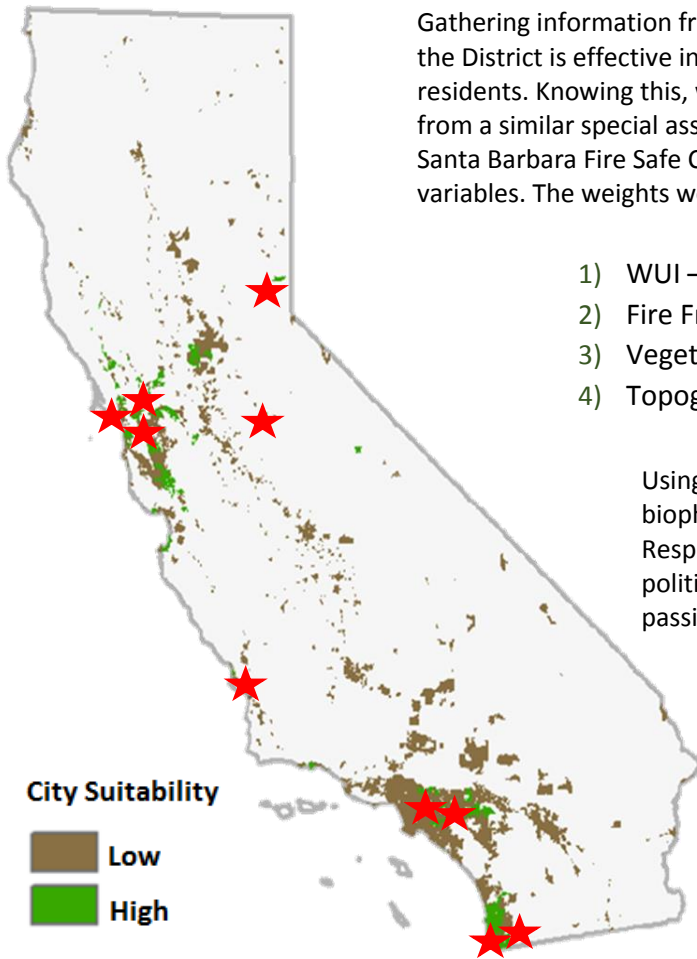
Gathering information from the survey and fire modeling, we have determined that the District is effective in reducing fire risk and has a high rate of acceptance by residents. Knowing this, we aimed to find other cities in California that could benefit from a similar special assessment program. To do so, we surveyed experts from the Santa Barbara Fire Safe Council to determine the weighted importance of 4 indicator variables. The weights were found using pairwise comparisons of each variable:

1) WUI – cities that fall within the wildland urban interface
2) Fire Frequency- cities with higher wildfire events
3) Vegetation – cities with flammable vegetation
4) Topography – cities with steep slopes and deep canyons

Using these weights, we assessed cities across the state to find a biophysical suitability score for each city that fell under Local Responsibility Areas. Cities were then filtered by income and political party to determine cities with optimal feasibility for passing a special assessment district.

Top 10 most suitable cities	
1. Truckee	6. Fremont
2. Mill Valley	7. San Diego
3. Sonora	8. Chula Vista
4. Diamond Bar	9. Riverside
5. San Luis Obispo	10. Oakland

Findings & Recommendations

A number of cities could benefit from a similar special assessment district. Entire cities with a smaller populous such as Mill Valley or Truckee could implement a city-wide program. For larger cities such as San Diego or Chula Vista, certain communities and neighborhoods within the city could develop assessment districts based on need, similar to the implementation in the City of Santa Barbara. In the context of climate change, drought, and uncertainty moving forward, it is imperative to protect California's citizens and unique ecosystems. The more communities that are prepared, the better off California will be as a whole.

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