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A COUPLED MODEL APPROACH FOR ASSESSING FIRE HAZARD AT POINT REYES NATIONAL SEASHORE: FLAMMAP AND GIS

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1. INTRODUCTION

Traditionally, most of the prescribed burning at Point Reyes National Seashore was implemented to manage shrub and grass fuel types. The objectives of the prescribed burns were to decrease hazardous fuel loads and manage historical landscapes by maintaining the diversity of species through fire, similar to the practices of indigenous people of coastal California.

As Point Reyes is challenged with more diverse issues surrounding fuels and fire management, the desire to manage forested landscapes with moderate to high levels of timber fuels has become a necessity. The reduction of dangerous crown fire potential is directly linked to managing surface fuel loads. Furthermore, the wildland urban interface (WUI) is an important factor in determining the necessity to manage timber fuel types. High values at risk adjacent to National Park Service property boundaries reside near timber fuels. These types of challenges are increasing the need for Point Reyes to manage timber fuel types rather than solely grass and shrub fuel types.

The Firtop prescribed burn is the first large-scale timber fuels project conducted by Point Reyes National Seashore. Consequently, a thorough analysis of the potential fire behavior for this burn is important in gaining the cooperation of the surrounding community and staff at Point Reyes.

A fire hazard analysis used in conjunction with potential fire behavior output from FlamMap (Finney, 2003) were used to locate areas of extreme fire hazard. Using the two models together helped validate the areas that were considered potential problem areas for fire hazard.

A fire hazard analysis combines the effects of slope, aspect, and fuel model to derive the potential for an area to burn using a Geographical Information System (GIS). Local knowledge of fire behavior and fuel types combined with outputs from Nexus (Scott and Reinhardt, 2001) were used to crosswalk the combination of fuels, slope, and aspect to fire hazard (Table 1).

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The GIS assisted in spatially locating areas where fuels, aspect, and slope could produce dangerous fire behavior given extreme wind and weather scenarios.

FlamMap (Finney, 2003) is a fire prediction model used to predict potential fire behavior using a GIS. Data such as fuels, weather, wind, fuel moisture, canopy, slope, elevation, and aspect are combined to predict potential fire behavior. Outputs such as flame length and fire intensity can be used to assess areas of greatest concern for extreme fire behavior.

In the following analysis, outputs from a mechanistic fire behavior model, FlamMap, was compared to a GIS fire hazard model to locate areas of overlapping extreme fire hazard. Results from this analysis will be helpful for fire managers to locate areas of potentially hazardous fire behavior during extreme weather scenarios. Furthermore, these results are helpful for developing a better understanding of the potential for a treatment area to burn in a worst case scenario.

Figure1. Location of Point Reyes National Seashore in Northern California

2. METHODS

The GIS fire hazard analysis combined fuels, aspect, and slope. Slope was divided into 3 classes representing moderate to steep slopes, respectively: 0-20%, 21-40%, and >40%. Aspect was divided into 2 classes: south and southwest facing; and north, west, and east. Aspect is the direction a slope faces and is measured 0 to 360 degrees. South and southwest facing slopes reside between 135 – 195 degrees. All other slopes reside between 0-134 degrees or 196-360 degrees. Fuel models were derived from data obtained from 1,691 field plots that measured vegetation and cover attributes. Field data were combined with an existing vegetation map and designated to the 13 standard fuel models (Anderson, 1982) with the expertise of personnel familiar with fire behavior for Marin county. All data were queried and combined using ESRI's ArcGis 8.3 spatial analyst raster calculator.

The combination of fuels, aspect, and slope that was cross-walked to fire hazard was facilitated using Nexus. Wind and weather data for the 97th percentile were obtained from a collection of remote automated weather stations (RAWS) in the Marin county area (Table 2). These data were used to derive fuel moisture, wind, and weather inputs in both FlamMap and Nexus. Wind and weather data of the 97th percentile were used in this simulation because those data correspond to the 1995 Vision Fire that burned more than 8,800 acres at Point Reyes. Those data were used in FlamMap to condition the dead fuel moisture to realistic values for this region.

99th percentile fire hazard			
Slope (%)	**Aspect**	**Fuel Models**	**Fire Hazard**
0-10	N, E, W, S	8	Moderate
21-40	N, E, W, S	8	Moderate
>40	N, E, W, S	8	Moderate
0-10	N, E, W, S	10,11	Very High
21-40	N, E, W, S	10,11	Very High
>40	N, E, W	10,11	Very High
0-10	N, E, W, S	1,5,6	Extreme
21-40	N, E, W, S	1,5,6	Extreme
>40	N, E, W, S	1,5,6	Extreme
>40	S	10,11	Extreme

Table1. Cross walk to GIS model of fire hazard.

Variable Name	97th percentile
wind (mph)	14
1h fuel moisture (%)	4
10h fuel moisture (%)	6
100h fuel moisture (%)	12
live fuel moisture (%)	60
precip (1/10 in.)	0
min-rh (%)	13
max-rh (%)	40
max-t (degrees C)	35
min-t (degrees C)	15

Table 2. 97th percentile wind and weather.

Slope, aspect, elevation, canopy cover, and fuels were combined in Farsite v4.0.1 (Finney, 2002) to create the landscape file necessary for FlamMap. Foliar moisture content was set to 100% while wind was set to 14mph from the northeast.

The fire hazard analysis was spatially compared to the FlamMap simulations to observe if extreme hazard from the GIS fire hazard corresponded with the extreme fire hazard from FlamMap. Extreme fire intensities were defined in this experiment as greater than or equal to 3464.14kW/m (1000 Btu/ft/sec) and flame lengths greater than or equal to 3.35 meters (11 feet).

3. RESULTS AND DISCUSSION

The GIS model showed 385.14 hectares of extreme fire hazard compared to the outputs from FlamMap, which showed 75.97 hectares of extreme fire hazard. Both models shared 71.56 hectares of similar spatial extreme fire hazard (Figure 2). The extreme fire hazards overlapped in areas of shrub and timber fuels. The larger area for extreme fire hazard shown in the GIS model is due to the inclusion of fuel model 1 in the definition of extreme. Output from Nexus showed that under 97th percentile conditions and 1 hour fuel moistures of 4%, this fuel type would exhibit flame lengths greater than 3.35 meters (11 feet) and fire intensities greater than 3464.14 kW/m (1000 Btu/ft/sec). Under extreme conditions, it is possible that this fuel type would realistically exhibit fire behavior that was far beyond the capabilities of a direct attack suppression tactic.

The greatest fire hazard occurred on the shrub dominated, steep, southwest facing slopes that transition to the Pacific Ocean. These fuels are exposed to fog for most of the summer months, which keeps the live fuel moisture consistently higher than other shrub dominated landscapes in California. Consequently, only on rare northern wind events coupled with drought to produce 60% live fuel moistures, would this area realistically present an extreme fire hazard.

Only a small portion of the GIS extreme fire hazard is present in the Firtop proposed burn perimeter, and this area was entirely composed of fuel model 1 or short grasses. This fuel type would not exhibit extreme fire behavior with the type of weather conditions under which a prescribed burn would be implemented. The outputs from FlamMap displayed no areas that would present extreme fire behavior within the Firtop prescribed burn unit. According to the results of both models, a prescribed burn that was kept in prescription would not present a fire hazard from surface fuels.

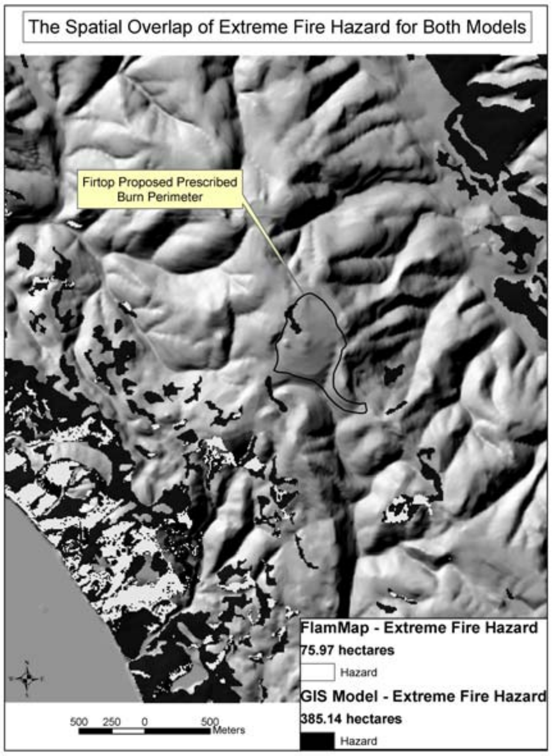

Figure 2. FlamMap and GIS Model Extreme Fire Hazard Comparison. 71.56 hectares of overlap are shown above.

4. CONCLUSION

This type of analysis is helpful in ascertaining locations of extreme fire hazard. Applying a two-model approach is helpful to validate both models. The GIS model allows for some subjectivity in the crosswalk of aspect, slope, and fuel model to extreme hazard. The knowledge of local fire behavior is helpful at this step to validate model outputs from Nexus. This combination of local fire behavior knowledge and the GIS model results in a more reliable product .The limitations of the GIS model are important variables such as wind, weather, cover, etc. are not taken into account. Applying a mechanistic model such as FlamMap is more encompassing, because it does apply the variables listed above to produce fire behavior outputs. Furthermore, less subjectivity is involved in the inputs. Both models have value and used in conjunction with one another, may provide a very thorough assessment of potential areas for extreme fire hazard.

These models were derived using very extreme weather and wind data. It is important to note that prescribed fires would never be implemented under these conditions. A comparison of these models using 50^{th} and 75^{th} percentile wind and weather data would more accurately represent the types of weather conditions under which Point Reyes might perform the Firtop prescribed burn. Further analyses of crown fuels and crown fire potential would be helpful in fine-tuning this analysis. In forested landscapes an assessment of potential crown fire is important in ascertaining fire hazard.

5. REFERENCES

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