Fire Hazard Model for Coconino County, Arizona

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Abstract: Fire is a major management issue in the southwestern United States. To quantify how fire risk changes during the year, three spatial models of fire risk for Coconino County, Northern Arizona were generated using a GIS. The models were generated using thematic data layers depicting vegetation, elevation, wind speed and direction, and precipitation for January (winter), June (summer), and July (the start of monsoon season). ArcGIS 9.0 was used to weight attributes in raster layers to reflect their influence on fire risk and to interpolate raster data layers from point data. Final models were generated using the raster calculator in the Spatial Analyst extension of ArcGIS 9.0. Ultimately, the unique combinations of variables resulted in three different models illustrating the change in fire risk during the year.

Coconino County, Arizona

Introduction: Rugged mountains, deep canyons, and forests characterize Coconino County in central Northern Arizona. Forests range from pine, fir, juniper, piñon, aspen to oak. Because of the dense forests covering much of the county, fire is a fact of life. Historically, humans have suppressed naturally occurring seasonal fires leaving behind dense fire prone forests. This situation begs several questions: Which parts of the county are at the biggest risk? Does risk vary from season to season? To answer these questions, I developed a Geographic Information System (GIS) model of fire risk.

A GIS uses maps to interpret the world around us. Tabular data representing each layer are depicted graphically on a "map". A GIS may resemble a paper map, but multiple "maps" called layers can be stacked on top of each other. These layers can be examined individually or in different combinations to create a dynamic map modeling a real life situation. By analyzing the relationships in individual layers and combinations of layers visually and mathematically, new relationships are determined.

Methods: Thematic layers depicting ground cover/vegetation (obtained from Southwest Regional Gap Analysis Project), wind speed and direction (point data were obtained from NOAA), elevation (obtained from GTOPO30), precipitation (obtained from the National Resources Conservation Service), and county lines (obtained from 2000 Census TIGER dataset) were projected to UTM using the North American Datum of 1983, Zone 12N. A landcover file from the Arizona Cartographer's Office was reclassified to reflect the fire risk of different ground cover classes: bare rock=0, agriculture/urban=1, grass=2, mixed tree and forb=3, and dense forests=4, where 0 is low risk and 4 is high risk. Because wind data was only available in point form, kriging (assuming the same pattern of variation can be observed at all points on the surface) was used to generate surface layers depicting wind speed and direction. Speed attributes were used to define the speed layer and direction attributes were used to define the direction layer. Slopes were analyzed using a DEM and calculating hillshade, slope and aspect. Slopes are deemed higher risk if they face the primary wind direction (southwest). All raster layers were clipped to Coconino County using TIGER data. Final layers were combined to produce the models generated using the *Raster Calculator* in *ArcGIS 9*. Slope direction, vegetation, and precipitation layers were all weighted equally. See Figure 1.

Thematic input layers combined to produce Combined Risk Models.

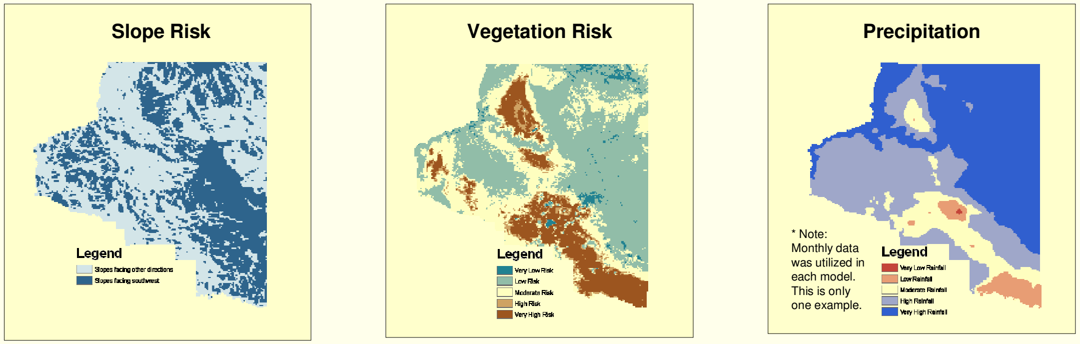

Figure 1: (A) Shows slopes facing into the prevailing wind direction. Slopes facing to the southwest are at higher risk. (B) Shows vegetation classified by risk value. (C) Shows amounts of rainfall throughout the county.

Discussion: Based on the GIS model output, the percentage of Coconino County above moderate fire risk in January is 24%, in June, 17%, and in July, 72%. Qualitatively, it is interesting to note the similarity between the models of January and July. These distribution similarities may be due to the similarity of precipitation amount and distribution during these months. The differences in risk are due to seasonal variations in conjunction with the interaction with the other layers. See Figure 2. This model could be used to predict fire risk in other places as well.

There were some variables that may have an affect on fire risk not taken into consideration. These variables were not considered because of lack of current and accurate data sets.

Monsoon Season: Lightning is more common in Monsoon season in the summer months (it usually starts in July). Precipitation patterns also change during this time, but there is not a specific start and end data and these patterns change from year to year.

Vegetation Density: Data at a fine enough scale was not available for the county. Instead, landcover and vegetation were classified as outlined in the methods section.

Yearly Precipitation: The amount of precipitation in all forms (ex. snow) per year in the county was not taken into account. Snow pack itself is an important factor influencing moisture in a given area.

Soil Moisture: different soils may retain water at different rates making the residual moisture different in different parts of the county. Soils which retain water well would be at a lower fire risk than soils that drain well.

Calculated Risk Models

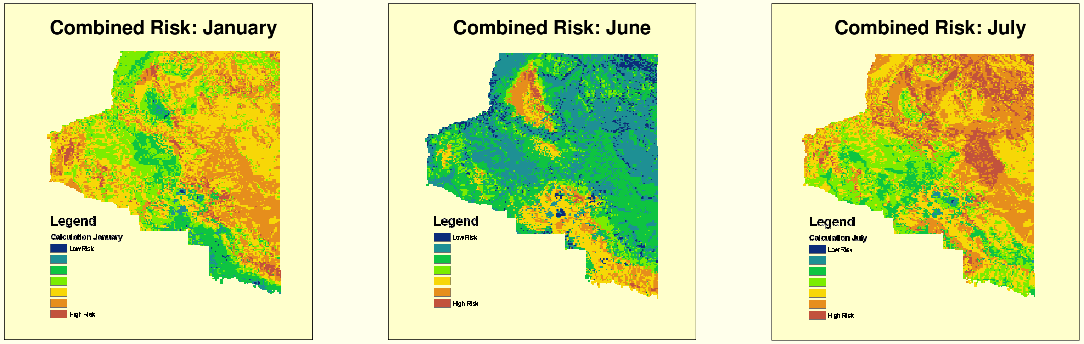

Figure 2: Combined Risk Models produced by adding thematic layers depicting vegetation risk, precipitation level, and slope risk: (A) January, (B) June, (C) July.

Managing Fire Risk: The seasonal fire risk models presented here are strong indicators that fire risk is present all year. In order to reduce the risk year round state and county governments are experimenting with the most effective ways to reduce fuel on public land, but the reducing fuel on private land is also important. Some easy simple ways to decrease fire risk near you home are raking leaves and needles away from buildings, keeping trees trimmed away from roofs, and stacking fire wood away from buildings.