Identifying High Wildfire Risk Areas in Ravalli County, Montana

Background

- I have personal experience with fighting wildfires in the Bitterroot National Forest.
- I am interested in fire modeling to see how accurate it really is.
- There are many tools and data available to measure risk of wildfires.

Process for Fire Risk Modeling Ravalli County

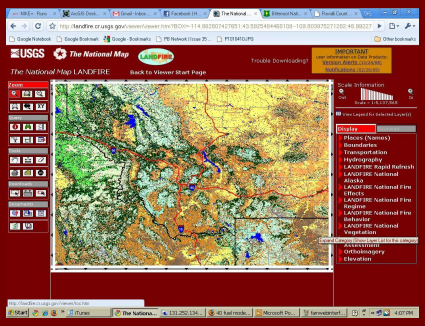
1. Obtain spatial and non-spatial data needed for developing the risk assessment for the 1996 fire season.
2. Generate fire behavior models using surface data.
3. Create density raster data sets for 2000 population and historical fire occurrences from 1986-1996.
4. Determine weights of components and create the risk assessment.
5. Evaluate the accuracy, roughly by site, for fire occurrences during a later active fire season: 2000.

Step One: Obtain Spatial and Non-Spatial Data

- Data
  - LANDFIRE system for spatial surface data
  - FAMWEB system for non-spatial weather and fuel moisture data
  - USFS Bitterroot NF GIS web portal for historical fire occurrences: http://www.fs.fed.us/r1/bitterroot/maps/gis_data.shtml
  - Ravalli County GIS web portal for population data: http://www.ravallicounty.mt.gov/gis/data.cfm

Step One: Obtain Spatial and Non-Spatial Data (cont.)

- Landfire System used to acquire the following:
  - 40 Fuel Model Classification (Scott and Burgan 2005)
  - Slope, Aspect, Elevation
  - Canopy Base Height, Canopy Bulk Density, Canopy Cover, and Canopy Height



Step One: Obtain Spatial and Non-Spatial Data (cont.)

- FAMWEB site used to obtain non-spatial data for weather and fuel moistures
  - Parameters used for study: Darby Ranger District, Bitterrroot NF, June 1st-September 31, 1996
  - Data used to generate fuel moisture file

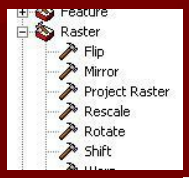
242403	SOUTH SAWMILL	4	WLSTDNV1\242403.TXT	WX242403.FWX	1982-2008
242501	POPLAR	4	WLSTDNV1\242501.TXT	WX242501.FWX	2000-2008
242901	DARBY	2	WLSTDNV1\242901.TXT	WX242901.FWX	1954-2008
242902	DEER MT	4	WLSTDNV1\242902.TXT	WX242902.FWX	1954-2008
242903		7	WLSTDNV1\242903.TXT	WX242903.FWX	1960-1984

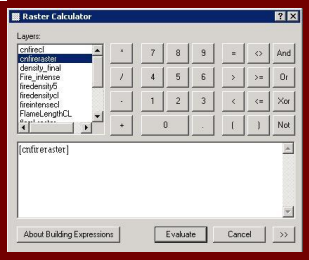
Step Two: Enter Data into Available Tools for Fire Analysis and Modeling

- Tools Used:
  - FARSITE: A spatial and temporal fire behavior model program. Used to generate fuel moisture and landscape files.
  - FireFamilyPlus: A system for summarizing and analyzing daily weather observations and computing fire danger indices based on the National Fire Danger Rating System
  - FLAMMAP: Produces spatial lanscape maps for fire behavior predictions for a single set of weather inputs. (point in time)

Step Two: Enter Data into Available Tools for Fire Analysis and Modeling (cont.)

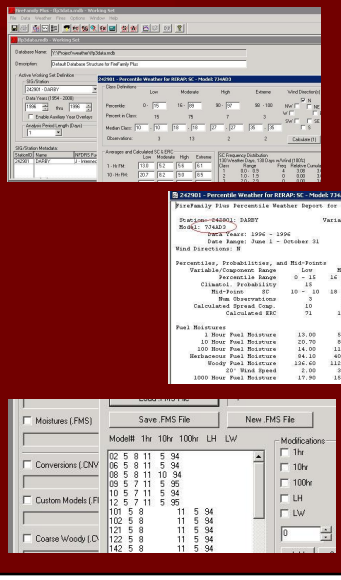
- Used the Project Raster Tool to change the projection of all LANDFIRE surface files to UTM coordinates.
- Used the Raster Calculator to set surface files to the same extent and cell size
- Used the Raster to ASCII Tool to convert surface rasters to ASCII format
- All required for input into FLAMMAP software





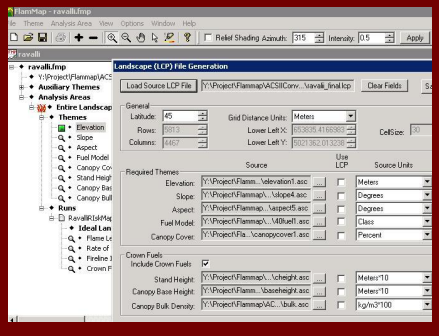
Step Two: Enter Data into Available Tools for Fire Analysis and Modeling (cont.)

- Create .FMS file (fuel moisture file) also required for FLAMMAP prediction map
  - Input Darby Ranger District station information from FAMWEB into FireFamilyPlus and set the time period.
  - Run Percentile Weather Summary Report to get 90th percentile weather conditions for each of the 40 fuel models. This was tough because the station data was a different fuel modeling standard (NFDRS). This is the most extreme weather for this time interval.
  - Use FARSITE to create the .FMS file using the numbers generated in the FFP report.

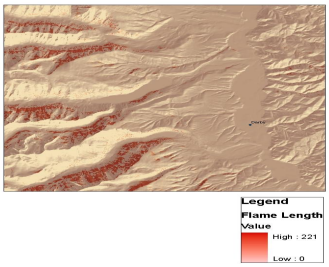


Step Two: Enter Data into Available Tools for Fire Analysis and Modeling (cont.)

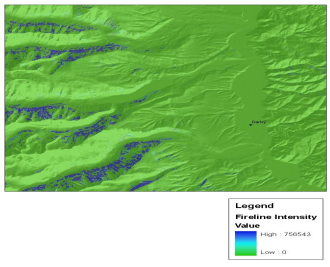
- Enter in all collected data into FLAMMAP to produce weather and fuel condition maps for June 1-October 31, 1996
- Generate fire behavior maps for further evaluation:
  - Flame Length
  - Rate of Spread
  - Crown Fire Activity
  - Fireline Intensity



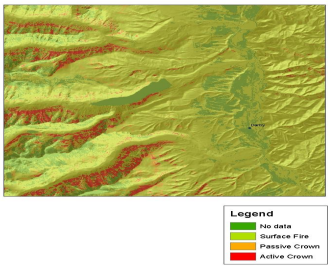
Flame Length (feet)



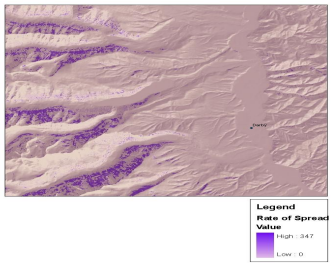
Fireline Intensity (BTU/ft per min)



Crown Fire

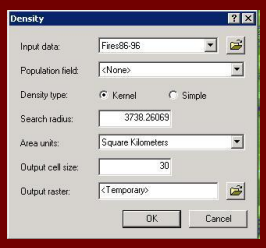


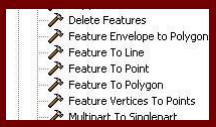
Rate of Spread (feet per minute)



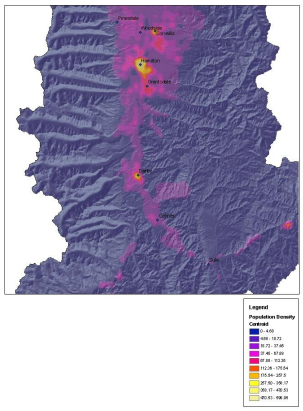
Step Three: Create Fire Occurrence and Population Density Maps

- Used the Density Tool in Spatial Analyst on Bitterroot NF historical point shapefile for fire occurrences during 1986-1996 using a 5 miles search radius.
- Used the Feature to Point Tool to transform parcel data into points based on the polygon centroid, then used the Density Tool in Spatial Analyst on these points using a 5 mile search radius.

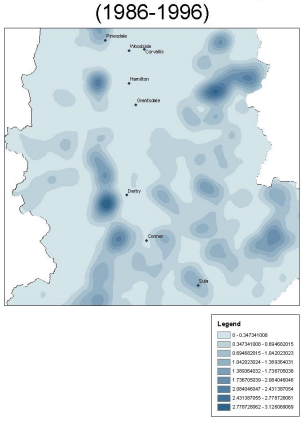




Population Density



Fire Occurrences Density
(1986-1996)



Step Four: Determine Weights of Raster Data Maps

- Used the Reclassify Tool to transform all raster data sets into levels of risk
- Used a publication by two environmental consultants who created a community wildfire protection plan for Torrence County, NM. "Community Wildfire Protection Plans: Modeling LANDFIRE, GIS, and Community Values" Heather Timmons and Joseph Fluder-SWCA Environmental Consultants 2003.
- Although these risk assessment inputs and weights are not for Ravalli County, it saved me from picking arbitrary classifications for this project.
- I removed proximity to fire stations from their study and added 10% weight to Crown Fire Activity map.

Inputs for Reclassification and Weighted Overlay

- Used Weighted Overlay Tool in Spatial Analyst

Layer	Source	Year	Weight (%)	Ranks
Flame Length	LANDFIRE: Elevation, Aspect, Slope, Scott and Burgan (2005) 40 Fuel Model, Forest Canopy Base Height, Forest Canopy Bulk Density, Forest Canopy Cover, Forest Canopy Height	2007	20	1: 0–4 feet 2: 4–8 feet 3: 8–12 feet 4: Greater than 12 feet
	Mountainair RAW Stations (Weather)	1992–2006		
Fire Occurrence	New Mexico State Forestry	1987–2007	15	1: No fires/mile squared 2: 0.0–0.2 fire/mile squared 3: 0.2–1.0 fire/mile squared 4: Greater than 1 fire/mile squared
Rate of Spread	LANDFIRE: Elevation, Aspect, Slope, Scott and Burgan (2005) 40 Fuel Model, Forest Canopy Base Height, Forest Canopy Bulk Density, Forest Canopy Cover, Forest Canopy Height	2007	15	1: 0–5 feet/minute 2: 5–15 feet/minute 3: 15–40 feet/minute 4: Greater than 40 feet/minute
	Mountainair RAW Stations (Weather)	1992–2006		
Crown Fire Activity	LANDFIRE: Elevation, Aspect, Slope, Scott and Burgan (2005) 40 Fuel Model, Forest Canopy Base Height, Forest Canopy Bulk Density, Forest Canopy Cover, Forest Canopy Height	2007	15	1: No data
	Mountainair RAW Stations (Weather)	1992–2006		2: Surface fire 3: Passive crown fire 4: active crown fire
Population Density	U.S. 2000 Census Block Population	2000	15	1: 0–5 people/mile squared 2: 5–80 people/mile squared 3: 80–525 people/mile squared 4: Greater than 525 people/mile squared
Fireline Intensity	LANDFIRE: Elevation, Aspect, Slope, Scott and Burgan (2005) 40 Fuel Model, Forest Canopy Base Height, Forest Canopy Bulk Density, Forest Canopy Cover, Forest Canopy Height	2007	10	1: 0–100 BTU/feet/sec 2: 100–500 BTU/feet/sec 3: 500–1,000 BTU/feet/sec 4: Greater than 1,000 BTU/feet/sec
	Mountainair RAW Stations (Weather)	1992–2006		

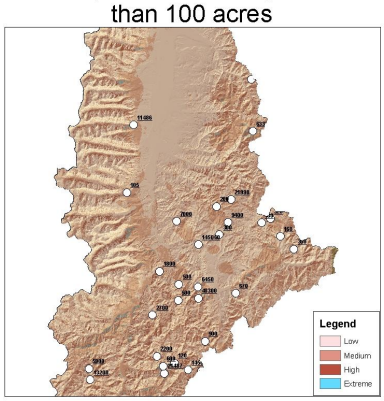
Step Five: Evaluate Accuracy

- Select by Attribute on USFS Bitterroot fire starts point shapefile for the year 2000 and greater than 100 acres. Very spotty data with missing fire names and acreage.

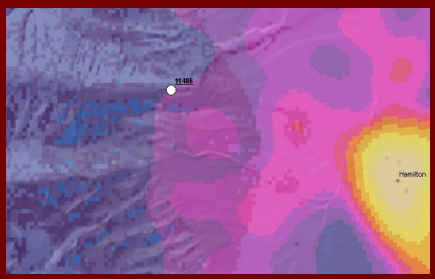
2000		USF0103			
2000		USF0103200500	MT. George	29	8
2000		USF0103200500	Cedar Barefoot	29	7
2000			Wapiti, Lookout??		
2000			Wapiti ??		
2000		USF0103200500	Wilkhead	7	8
2000		USF0103200500	White Cap Lake	11	8
2000		USF0103			
2000		USF0103200500	Watch it	23	8
2000					
2000		USF0103200500	Burnt Strip Mountain	9	8
2000		USF0103200500	Fire Mountain	1	8
2000		USF0103200500	Green Spot	18	8
2000			Spot Mountain	8	8
2000		USF0103200500	Pyramid Peak	9	8
2000		USF0103200500	Beaver Jack	1	8

Weighted Results with Y2K season large fires

Risk Assessment Map for year 1996 with year 2000 fires greater than 100 acres



Risk results for Darby, Hamilton, and Sula



If I had more time….and lessons learned

- It would have been interesting to see if it was possible to do some spatial interpolation on fuel model densities and create a probability surface for how the fuel loading could potentially be disbursed throughout parts of the forest. Not sure how much observed data there is out there for this though.
- Data for fire starts and perimeter fire mapping is very poor. It would have made my study more exploratory. If it was more complete I probably would have done some more computed analysis to evaluate the accuracy of the risk assessment.
- Would have used the 13 fuel model standard to save time cross-referencing it with the NDFRS standard in FFP.
- Should have used the Model Builder in ArcCatalog from the very beginning to increase efficiency.

References

- "Community Wildfire Protection Plans: Modeling LANDFIRE, GIS, and Community Values" Heather Timmons and Joseph Fluder-SWCA Environmental Consultants 2003.
- "Aids to Determining Fuel Models for Estimating Fire Behavior" Hal E. Anderson, 1982. For cross referencing fuel models.
- User Guides for FireFamilyPlus, FARSITE, and FLAMMAP
- Data acquired from LANDFIRE, USFS, Ravalli County, and FAMWEB

Questions?