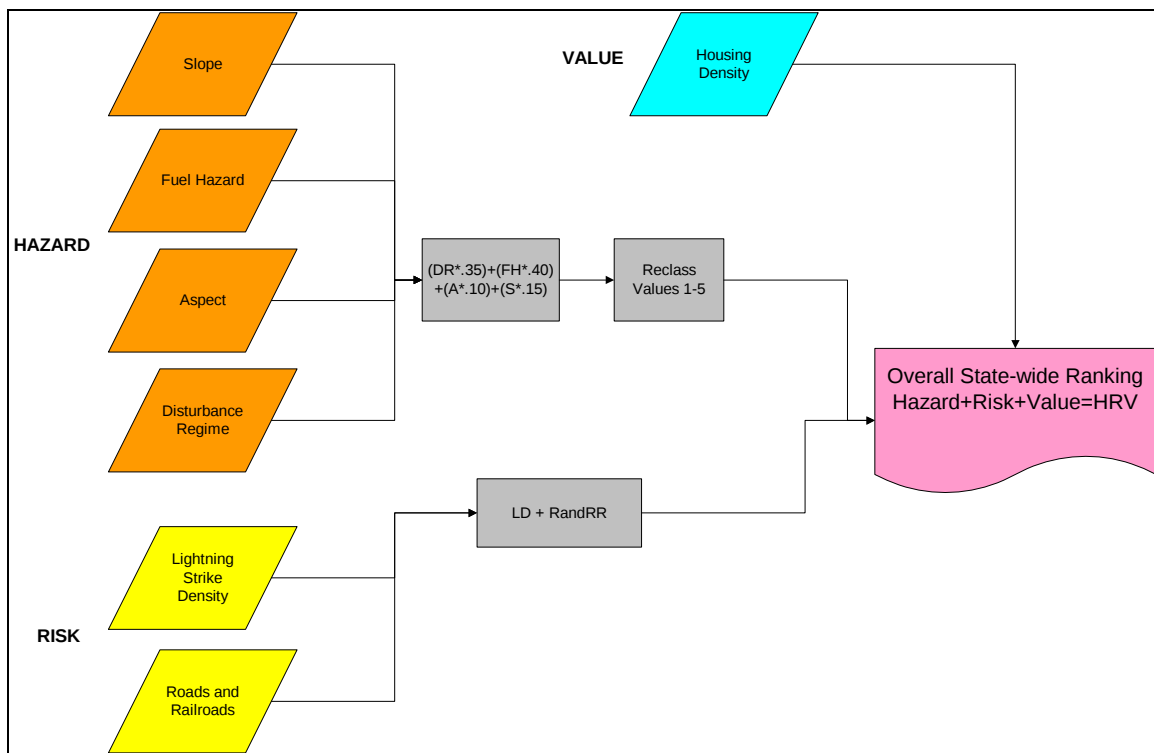


Colorado Wildland Urban Interface Hazard Assessment Methodology



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Background

Geographic Information Systems (GIS) is a tool that allows for comparison and analysis of geographic phenomenon. Differing sets of data can be compared based on their spatial location information. In the mid-nineties, GIS was recognized as an ideal tool to use in determining wildfire hazard, by comparing values such as slope, vegetation, housing density, ignition history, and aspect throughout Colorado. GIS provided the tools to implement a state-wide analysis that was previously extremely difficult.

The Front Range Redzone Project was one of the first attempts to map the fire hazard along Colorado's Front Range, incorporating slope, aspect, and fuels. The project centered on the areas of highest housing density – the urban and suburban areas along the Front Range. This project started the Redzone concept in Colorado and provided a great educational tool to convey wildland fire danger. Due to the success of the Front Range Redzone project the scope was expanded to include the remaining forested lands in Colorado. This state level project was called the Midlevel Assessment. The Midlevel Assessment took a more detailed look at the state and included more accurate information on fuels, population growth, and distribution. Even this more detailed information lacked the resolution to accurately map population densities in the western portion of Colorado. Some portions of the Midlevel Assessment are used in this mapping effort, specifically the values for slope, aspect, and vegetation.

The Colorado Wildland Urban Interface Hazard Assessment builds on the work of earlier hazard methodologies and provides new and updated data to further enhance accuracy and scale. A better, more accurate housing density surface was created to assist in ranking the Wildland Urban Interface hazard. This assessment also includes all of the counties in Colorado, including the eastern plains counties, which were previously omitted. The final outputs are a Risk, Hazard, and Value (RHV) map displaying areas of concern that are at risk of catastrophic wildland fire.

This project is a joint effort of CSFS, USFS, BLM, NPS, and other interested parties.



Approach

The Colorado Wildland Urban Interface Hazard Assessment uses three main layers to determine fire danger, Risk, Hazard, and Values. The following lists include the data used to create each of the three layers.

1. Risk – Probability of Ignition
 - a. Lightning Strike density
 - b. Road buffer – 100 meter buffer of roads and railroads in Colorado.
2. Hazard – Vegetative and topological features affecting intensity and rate of spread
 - a. Slope
 - b. Aspect
 - c. Fuels – Interpreted from CDOW GAP Vegetation information.
3. Values – Natural or man-made components of the ecosystem on which a value can be placed.
 - a. Housing Density – Life and property
4. Non-flammable areas Mask – a mask was created to aid in the analysis for areas that will not carry fire such as rock and water areas. Urban areas were included in these non-flammable areas if there was not a significant source of vegetation to carry the fire. These areas show in the final assessment as a zero value for fire hazard.

Scale

The Colorado Wildland Urban Interface Hazard Assessment is meant to be used as a tool to compare fire hazard in various areas in Colorado and within counties. The data is not meant to be used to determine fire hazard at the subdivision or parcel level scale. The assessment data and process steps are provided to allow counties or subdivisions to substitute better, higher resolution data for comparing portions of small areas of counties, subdivisions, or individual parcels.

Process Outputs

One of the objectives to creating a Statewide Wildfire Hazard Assessment is to assist in prioritizing and planning mitigation projects. The other is to update the Redzone maps which have proved to be a useful communications tool.

The following maps are the Process Outputs and represent the combination of the Risk, Hazard, and Values layers:

Risk + Hazard + Value (housing density) = RHD

Redzone Map = buffered high values from the assessment showing high hazard areas.

GIS Process Steps

Data layers were collected or contracted for all of the layers stated above. Use National Elevation Dataset for the creation of the base 30 meter DEM layer. Create all grids based on this DEM layer with the same cell size and extent. Change any NO Data values to 0. The steps are as follows:

1. Risk

- a. Lightning Strike – Determines areas of high lightning strike occurrence and corresponding rise in ignition potential. Only the positive polarity strikes are used to create the density surface.¹ Source: BLM lightning strike data. Create density surface and classify to:

Reclass Value	Density
4	High
3	Medium
2	Low
1	Very Low

- b. Roads – Buffer existing roads by 100m and reclass the buffer areas to 1, all other areas will receive a value of 0.
- c. Add the Lightning Strike and Roads grids together for the Risk Grid.

2. Hazard

- a. Create Slope from 30m USGS DEM and reclassify the grid as described in NFPA 299, 1991, (slope in percent):

Slope %	Rating	Reclass Value
0 – 5	Mild	1
6 – 20	Moderate	2
21 – 40	Steep	3
41+	Extreme	4

- b. Create Aspect from 30m USGS DEM and reclassify the grid as described in NFPA 299, 1991, (aspect in degrees):

Aspect°	Reclass Value
0-160 or 200-360	1
160-165 or 195-200	2
165-175 or 185-195	3
175-185	4

¹ Correlation between positive polarity strikes and wildfire ignition: “ArcGIS Extensions – Identifying Areas of High Risk to Wildfires” ESRI, 2002. “Lightning Ignition Efficiency” notes from John Calkins, ESRI, 2002. “Lightning Detection and Operation Systems in North America” Peter Brookhouse, Australian Brushfire Conference, 1999.

- c. GAP Vegetation codes were reviewed by CSFS, USFS, and BLM employees and ranked based on Fuel Hazard and Disturbance Regime. Fuel hazard represents a qualitative ranking based on flammability during an average burning day. Disturbance regime is also a qualitative ranking based on the average length of the return interval.
 - i. Fuel Hazard – create grid for vegetation hazard rating and reclassify based on CDOW GAP VEG primary codes. Ratings based on values derived in Colorado Red Zone Analysis, “Colorado Fire Protection Assessment Report”, “Colorado Mid-Level Wildfire Hazard Assessment Report”, and CSFS District Forester evaluations (see Appendix A for codes). Fuel hazard represents a qualitative ranking based on flammability during an average burn day.
 - ii. Disturbance Regime – CDOW GAP Vegetation Primary codes reclassified based on methodology used in the Colorado Red Zone Analysis, “Colorado Fire Protection Assessment Report”, “Colorado Mid-Level Wildfire Hazard Assessment Report”, and input from CSFS District Foresters (see Appendix A for codes). Disturbance regime is also a qualitative ranking based on the average length of the return interval.
- d. $\text{Hazard} = [\text{Disturbance_Regime}] * 0.35 + [\text{Fuel_Hazard}] * 0.40 + [\text{Aspect}] * 0.10 + [\text{Slope}] * 0.15$
- e. Classify Hazard grid to five equal intervals and reclass to values 1 (low) – 5 (high).

3. Values

- a. Housing Density, Life and Property – Source: Dr. Dave Theobald, Colorado State University² and Dr. Brian Muller, University of Colorado Denver. Data was created using a combination of parcel data, well head location data, and Census information. Projections were also made for housing densities in 2010 and 2020 to allow for future risk projections.
 - i. Create a density surface and classify as follows:

Houses per Acre	Reclass Value	Density Class
0 – 0.004	0	Public or Vacant
0.004 – 0.025	3	Ranchette
0.025 – 0.1	4	Low
0.1 – 0.5	5	Medium
0.5 – 1	4	High
1 - 9999	2	Urban

4. Non-flammable areas Mask – a mask was created to aid in the analysis for areas that will not carry fire such as rock and water areas. Urban areas were included in

² See Appendix B – “Mapping Housing Density for Prioritization of Urban/Forest Wildfire Hazards in Colorado”, David M. Theobald and Mary Kneeland.

these non-flammable areas if there was not a significant source of vegetation to carry the fire. These areas show in the final assessment as a zero value for fire hazard. Values for the mask were derived from the DOW GAP vegetation information and used for Front Range urban areas. These areas were used to create “holes” in the state coverage masking out non-flammable areas.

5. Combination of Hazard, Risk, and Value Layers – Grids were added together to create the final HRV grid showing areas in the state at high risk to catastrophic wildland fire in the interface. Values ranged from 2-15 and were coded for best display.

Appendix A – CDOW GAP Vegetation codes for Fuel Hazard and Disturbance Regime

PRIMARY	Description	Fuel Rank	Hazard	Disturbance Rank	Disturbance Regime
11001	Human Settlement type	0	none	0	n/a
21001	Dryland Crops type	1	low	4	short
21002	Irrigated Crop type	1	low	4	short
21003	Orchard/Horticulture type	1	low	4	short
21004	Confined Livestock Feeding type	0	none	0	n/a
31010	Tall-grass Prairie type	2	moderate	4	short
31013	Sand Dune Grassland Complex type	1	low	4	short
31020	Mid-grass Prairie type	2	moderate	4	short
31030	Short-grass Prairie type	1	low	4	short
31040	Foothill and Mountain Grasslands	1	low	4	short
32001	Mesic Upland Shrub type	2	moderate	4	short
32002	Xeric Upland Shrub type	2	moderate	4	short
32003	Deciduous oak type	4	very high	4	short
32005	Bitterbrush Shrub Steppe	2	moderate	4	short
32006	Mountain Big Sagebrush type	2	moderate	4	short
32007	Wyoming big sagebrush steppe type	2	moderate	4	short
32009	Big Sagebrush Shrubland type	2	moderate	4	short
32010	Desert Shrub type	1	low	4	short
32011	Saltbush Fans and Flats type	1	low	4	short
32012	Greasewood Fans and Flats type	2	moderate	4	short
32013	Sand Dune Complex Shrub type	1	low	4	short
32030	Disturbed Shrubland	1	low	4	short
41001	Aspen forest type	1	low	3	medium
42001	Spruce-fir type	3	high	1	very long
42002	Spruce-fir clearcut type	2	moderate	2	long
42003	Douglas fir Type	3	high	3	medium
42004	Lodgepole pine Type	3	high	2	long
42007	Lodgepole pine clearcut type	2	moderate	2	long
42009	Limber pine type	2	moderate	3	medium
42010	Ponderosa pine type	3	high	4	short
42011	Blue spruce type	2	moderate	2	long
42012	White fir type	3	high	3	medium
42015	Juniper woodland type	3	high	3	medium
42016	Pinyon/Juniper woodland type	4	very high	3	medium
42017	Rocky Mountain Bristlecone pine type	1	low	1	very long
42018	Mixed Conifer type	3	high	3	medium
43000	Mixed Forest type	2	moderate	4	short
52001	Open Water type	0	none	0	n/a
61001	Forest dominated wetland/riparian ty	1	low	3	medium
62001	Shrub-dominated Wetland/Riparian typ	2	moderate	4	short
62002	Graminoid-and forb-dominated wetland	1	low	4	short
70000	Barren land	0	none	0	n/a
71001	Unvegetated Playa type	0	none	0	n/a
71002	Bare soil (Non-playa)	0	none	0	n/a
73000	Sandy Areas other than beaches (Dune	0	none	0	n/a
74001	Exposed Rock type	0	none	0	n/a

75001	Mining Operations	0	none	0	n/a
81001	Prostrate shrub tundra type	1	low	2	long
82001	Meadow Tundra Type (Above Upper Tree	1	low	1	very long
82002	Subalpine meadow type	1	low	3	medium
83000	Bare Tundra	1	low	1	very long
85000	Mixed Tundra	1	low	2	long