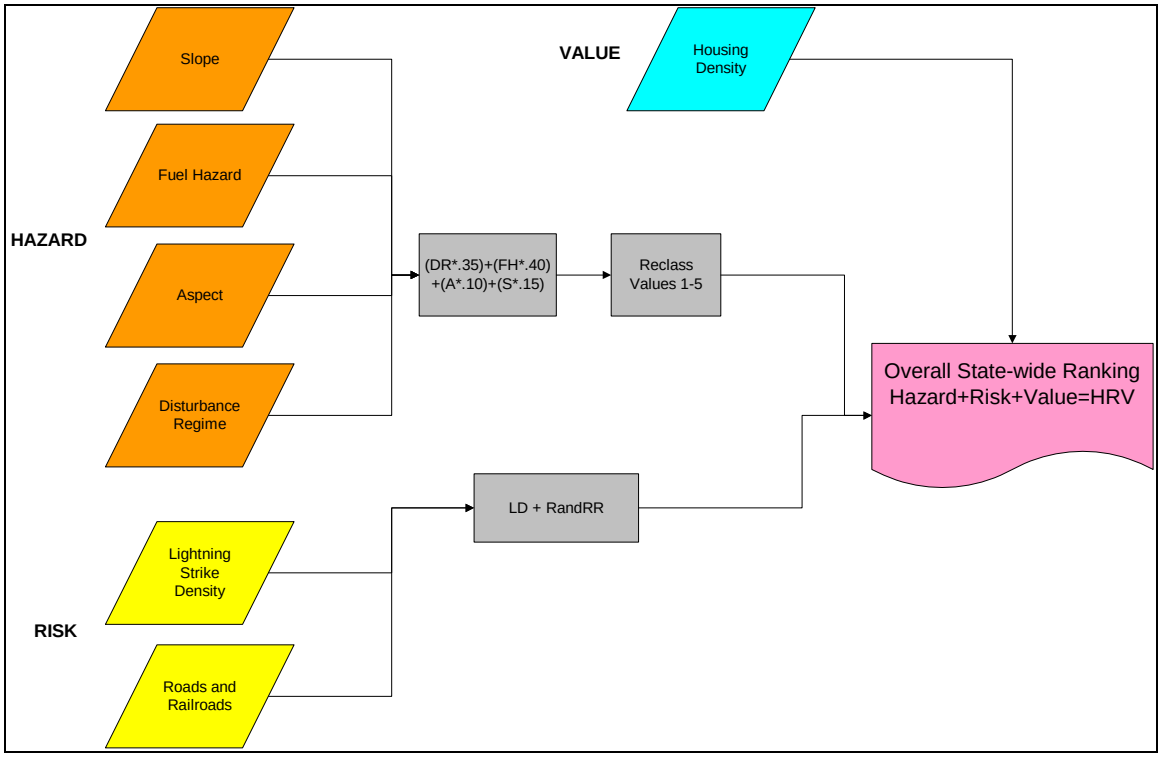
# Colorado Wildland Urban Interface Hazard Assessment Methodology

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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 lighting 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. Hazard = [Disturbance_Regime]*0.35 + [Fuel_Hazard]*0.40 + [Aspect]*0.10 + [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 University[2] 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 |