LANDFIRE Reference Database

The LANDFIRE Reference Database (LFRDB) includes vegetation and fuel data from approximately 800,000 geo-referenced sampling units throughout the United States. These data are amassed from numerous sources and in large part from existing information resources of outside entities, such as the USFS Forest Inventory and Analysis (FIA) Program, the USGS National Gap Analysis Program, and state natural heritage programs.

Vegetation data drawn from these sources and used by LANDFIRE include natural community occurrence records, estimates of canopy cover and height per plant taxon, and measurements (such as diameter, height, crown ratio, crown class, and density) of individual trees. Fuel data used include biomass estimates of downed woody material, percentage cover and height of shrub and herb layers, and canopy base height estimates. Digital photos of the sampled units are also archived, when available. Toney and others (2007) explain in detail how these types of field data, specifically those collected by FIA, have been acquired, incorporated into the LFRDB, and used in LANDFIRE. Several key attributes are systematically derived from the acquired data and included in the LFRDB. These attributes include existing and potential vegetation type in the form of NatureServe's Ecological Systems (Comer and others 2003; Toney and others 2007), uncompacted crown ratios (Toney and Reeves 2009), and several canopy fuel metrics (such as bulk density) derived from the FuelCalc program (Reinhardt and others 2006).

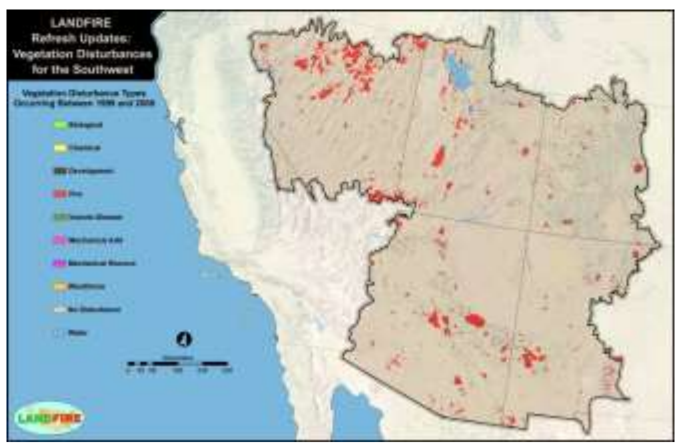
Records are carefully screened for information or spatial errors. Questionable data are either identified accordingly or removed from the LFRDB, depending on confidence in the assessment. Accepted data points are processed for associations with a number of ancillary datasets via a series of spatial overlays. These data-sets included a Landsat image suite, the National Land Cover Database (Homer and others 2004), the digital elevation model and derivatives (USGS 2005), soil depth and texture layers (for example, USDA NRCS 2005), and a set of 42 simulated biophysical gradient layers (such as evapotranspiration, soil temperature, and degree days). These biophysical gradient layers were generated using WX-BGC, an ecosystem simulator derived from BIOME-BGC (Running and Hunt 1993) and GMRS-BGC (Keane and others 2002). The extracted values from each of these overlays are archived in the LFRDB as predictor variables for the mapping process.

Public Events Geodatabase

This geodatabase is a collection of recent natural disturbance and land management activities used to update existing vegetation and fuel layers during the production of LANDFIRE 2008 Refresh (LF 1.1.0) and LANDFIRE 2010 (LF1.2.0) Program deliverables. Public versions of LANDFIRE reference database, which exclude proprietary and/or sensitive data, are available for download. Each LANDFIRE 2010 Public Events geodatabase includes three feature classes for each geographic area, namely Raw Events, Model Ready Events, and Exotics. The Public Raw and Model Ready Event feature classes include natural disturbance and vegetation/fuel treatment data. The Public Exotics feature class contains data on the occurrence of exotic or invasive plant species. In addition to the feature classes there is also a look up table for the source code (lutSource_Code), which is an attribute found in all three feature classes. The source code is a LANDFIRE internal code assigned to each data source. Consult the table “lutSource_Code” in the geodatabases for more information about the data sources included in, and excluded from, releases.

The data compiled in the three feature classes are collected from disparate sources including federal, state, and local, and private organizations. All data submitted to LANDFIRE are evaluated for inclusion into the LANDFIRE Events geodatabase. Acceptable Event data have the following minimum requirements to be included in the Events geodatabase: 1) the event must be represented by a polygon on the landscape and have a defined spatial coordinate system, 2) the event must have an acceptable event type (Appendix B) or exotics plant species and 3) the event must be attributed with year of occurrence or observation of 1999-2010.

Disturbance 1999-2010*



or current version

Disturbance products reflect change on the landscape caused by management activities and natural disturbance and are developed through a multistep process. Inputs to this process include; Landsat imagery and derived NBR (normalized burn ratio) data; polygon data developed by local agencies for the LF Events geodatabase effort; fire data obtained from MTBS (Monitoring Trends in Burn Severity), BARC (Burned Area Reflectance Classification), and RAVG (Rapid Assessment of Vegetation Condition after Wildfire) fire mapping efforts, PAD (Protected Area Database) data, and SmartFire ignition point buffer polygons (buffer distance dependent on sensor accuracy). LANDSAT imagery and derived NBR data are utilized for CONUS disturbance grid development. LF Event polygon data are provided to LANDFIRE by various local, regional, and national agencies and organizations. Disturbance type and year information is included as attributes for each polygon and transferred to the disturbance grids. Severity is determined by using dNBR (difference Normalized Burn Ratio) data classified into high, medium, and low severity levels based on dNBR standard deviation thresholds.

Vegetation Change Tracker (VCT) algorithms (Huang, et. al. 2008) were used to identify disturbances outside of LF Events for the LF2008 effort (years 1999-2008). Multi-Index Integrated Change Algorithm (MIICA) methods (Jin, et. al. 2013) were used to identify additional change in 2008 as well as disturbances in 2009 and 2010 for the LF2010 effort. Since disturbance type (i.e. causality) is not determined in the VCT or MIICA processes, a spatial analysis is done comparing the output to buffered (500 meter) LF Events, Protected Area Database GAP Status information (land use and management characteristics), and SmartFire ignition point buffer polygons. While not providing a precise type of disturbance, this analysis provides information useful for narrowing down the types of disturbance that could or could not typically occur. A disturbance grid is produced for each year 1999 to present. Each grid is attributed with year, disturbance type (if known, otherwise a description of possible types), severity, data sources, and confidence (type and severity).

Vegetation and Fuel Disturbance

Fuel Disturbance (FdistYEAR) are composites of the disturbance grids recoded by disturbance type, disturbance severity, and time since disturbance YEAR to meet LANDFIRE fuel mapping needs and serve as input to the LF Total Fuel Change Tool. FdistYEAR is a subset of the vdistYEAR and does not include chemical, biological, or development disturbances. Filtering to remove logically inconsistent disturbance/EVT combinations such as insect and disease within herbaceous landscapes was implemented. Fire occurrences take precedence, followed by the most recent disturbance.

Vegetation Disturbance (VdistYEAR) are composites of the disturbance grids recoded by disturbance type, disturbance severity, and time since disturbance YEAR to meet LANDFIRE vegetation transition modeling needs. Fire occurrences take precedence, followed by the most recent disturbance taking precedence.

Environmental Site Potential

The LANDFIRE Environmental Site Potential (ESP) layer represents the vegetation that could be supported at a given site based on the biophysical environment. This layer is used in LANDFIRE to inform the existing vegetation and fuel mapping processes. Map units are based on NatureServe's Ecological Systems classification, which is a nationally consistent set of mid-scale ecological units (Comer and others 2003). LANDFIRE's use of these classification units to describe environmental site potential differs from their intended use as units of existing vegetation. As used in LANDFIRE, map unit names represent the natural plant communities that would become established at late or climax stages of successional development in the absence of disturbance. They reflect the current climate and physical environment, as well as the competitive potential of native plant species. The LANDFIRE ESP concept is similar to that used in classifications of potential vegetation, including habitat types (Daubenmire 1968; Pfister and others 1977) and plant associations (Henderson and others 1989). The ESP layer is generated using a predictive modeling approach that relates spatially explicit layers representing biophysical gradients and topography to field training sites assigned to ESP map units. It is important to note that ESP is an abstract concept and represents neither current nor historical vegetation.

Biophysical Settings

The Biophysical Settings (BpS) layer represents the vegetation that may have been dominant on the landscape prior to Euro-American settlement and is based on both the current biophysical environment and an approximation of the historical disturbance regime. It is a refinement of the Environmental Site Potential layer; in this refinement, we attempt to incorporate current scientific knowledge regarding the functioning of ecological processes – such as fire – in the centuries preceding non-indigenous human influence. Map units are based on NatureServe's Ecological Systems classification, which is a nationally consistent set of mid-scale ecological units (Comer and others 2003). LANDFIRE's use of these classification units to describe biophysical settings differs from their intended use as units of existing vegetation. As used in LANDFIRE, map unit names represent the natural plant communities that may have been present during the reference period. Each BpS map unit is matched with a model of vegetation succession, and both serve as key inputs to the LANDSUM landscape succession model (Keane and others 2002). The LANDFIRE BpS concept is similar to the concept of potential natural vegetation groups used in mapping and modeling efforts related to fire regime condition class (Schmidt and others 2002; www.frcc.gov).

Existing Vegetation Type

The Existing Vegetation Type (EVT) layer represents the species composition currently present at a given site. LANDFIRE vegetation map units are derived from NatureServe's Ecological Systems classification, which is a nationally consistent set of mid-scale ecological units (Comer and others 2003). Existing vegetation is mapped through a predictive modeling approach using a combination of field reference information, Landsat imagery, and spatially explicit biophysical gradient data. Field data keyed to dominant vegetation type at the plot level were used as "training data" to drive the modeling process. Attribute information is provided that links the LANDFIRE EVT map units to existing classifications such as the National Vegetation Classification System and those of the Society of American Foresters and Society of Range Management.

Existing Vegetation Height

Existing Vegetation Height (EVH) represents the average height of the dominant vegetation for a 30-m grid cell. The EVH layer is generated using a predictive modeling approach that related Landsat imagery and spatially explicit biophysical gradients to calculated values of average dominant height from field training sites.

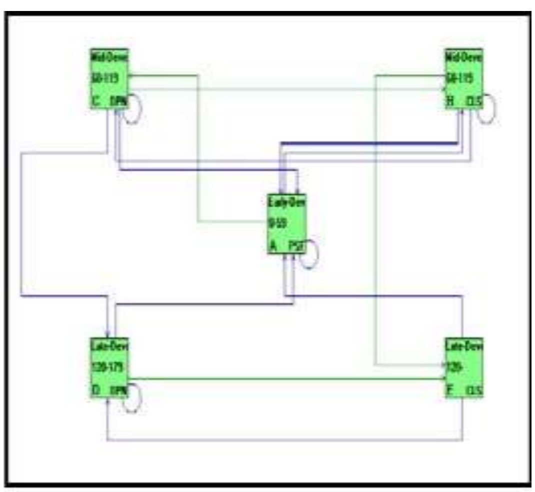
Existing Vegetation Cover

Existing Vegetation Cover (ECV) represents the vertically projected percent cover of the live canopy layer for a 30-m grid cell. The ECV layer is generated using a predictive modeling approach that related Landsat imagery and spatially explicit biophysical gradients to calculated values of average canopy cover from field training sites and digital orthophoto quadrangles.

Vegetation Dynamics Models

Vegetation dynamics models describe the vegetation dynamics and disturbance regimes of each biophysical setting (BpS).


LANDFIRE Biophysical Setting Model



Models consist of two parts: (1) a comprehensive model description and (2) a quantitative state-and-transition model developed using the software Vegetation Dynamics Development Tool (VDDT; ESSA Technologies Ltd. 2005). Descriptions explain the indicator species, geographic distribution, biophysical characteristics, succession stages, and disturbance regimes of each BpS. Descriptions also document the assumptions behind, the outstanding questions about, the contributors to, the resources used for, and the evolution of each model. To quantify the rates and pathways of succession and the frequencies and effects of disturbances, a state-and-transition model (Westoby and others 1989) is created for each BpS in VDDT. LANDFIRE vegetation models are created through a series of expert workshops attended by a variety of local and regional vegetation and fire ecologists, and the models then undergo a rigorous review process. While VDDT was used to develop the LANDFIRE BpS models, that software platform has evolved and is now called ST-Sim, available at www.apexrms.com.

13 Anderson Fire Behavior Fuel Models

Fire behavior fuel models represent distinct distributions of fuel loading found among surface fuel components (live and dead), size classes, and fuel types. The fuel models are described by the most common fire-carrying fuel type (grass, brush, timber litter, or slash), loading and surface area-to-volume ratio by size class and component, fuelbed depth, and moisture of extinction. These standard 13 Anderson Fire Behavior Fuel Models (FBFM13) serve as input to Rothermel's mathematical surface fire behavior and spread model (Rothermel 1972). The FBFM13 layer can serve as input to the FARSITE fire growth simulation model (Finney 1998) and FlamMap fire potential simulator (Stratton 2004). Further detail on these original fire behavior fuel models can be found in Anderson (1982) and Rothermel (1983).

40 Scott and Burgan Fire Behavior Fuel Models

This recently developed set of standard fire behavior fuel models represents more fuel models in every fuel type (grass, shrub, timber, and slash) than does Anderson's set of 13 fuel models. The main objective in creating the 40 Scott and Burgan Fire Behavior Fuel Models (FBFM40) is to increase the ability to illustrate the effects of fuel treatments using fire behavior modeling. The FBFM40 can serve as input to the FARSITE fire growth simulation model (Finney 1998), FlamMap fire potential simulator (Stratton 2004), BehavePlus fire behavior model (Andrews and others 2005), NEXUS crown fire potential model (Scott 2003), and FFE-FVS forest stand simulator (Reinhardt and Crookston 2003). Nomographs for estimating fire behavior using the new fuel models without the use of a computer are now available (through Rocky Mountain Research Station Publications). Further detail about these 40 fire behavior fuel models can be found in Scott and Burgan (2005).

Canadian Forest Fire Danger Rating System

These fuel types are defined "as an identifiable association of fuel elements of distinctive species, form, size, arrangement, and continuity that will exhibit characteristic fire behavior under defined burning conditions" (Pyne, Andrews, and Laven, 1996; Stocks and others 1989). The CFFDRS arranges fuel types into five major groups with 16 discrete fuel types that are qualitatively distinguished by variations in their forest floor and organic layer, their surface and ladder fuels, and their stand structure and composition. The Canadian Forest Fire Danger Rating System (CFFDR) is created for Alaska only. The CFFDRS assignments for Alaska are made by fire behavior and fuels experts based on Existing Vegetation Type (EVT) descriptions and representative photos.

Forest Canopy Bulk Density

Canopy Bulk Density (CBD) describes the density of available canopy fuel in a stand. It is defined as the mass of available canopy fuel per canopy volume unit. Geospatial data describing canopy bulk density supplies information for fire behavior models, such as FARSITE (Finney 1998), to determine the initiation and spread characteristics of crown fires across landscapes (VanWagner 1977, 1993). The CBD layer is generated using a predictive modeling approach that relates Landsat imagery and spatially explicit biophysical gradients to calculated values of CBD from field training sites. Because of model requirements, these data are provided for forested areas only. The units of measurement for the LANDFIRE CBD layer are kg m-3 * 100.

Forest Canopy Base Height

Canopy Base Height (CBH) describes the average height from the ground to a forest stand’s canopy bottom. Specifically, it is the lowest height in a stand at which there is a sufficient amount of forest canopy fuel to propagate fire vertically into the canopy. Geospatial data describing canopy base height provides information for fire behavior models, such as FARSITE (Finney 1998), to determine areas in which a surface fire is likely to transition to a crown fire (VanWagner 1977, 1993). The CBH layer is generated using a predictive modeling approach that relates Landsat imagery and spatially explicit biophysical gradients to calculated values of CBH from field training sites. Because of model requirements, these data are provided for forested areas only. The units of measurement for the LANDFIRE CBH layer are meters * 10.

Forest Canopy Height

Forest Canopy Height (CH) describes the average height of the top of the vegetated canopy. Geospatial data describing canopy height supplies information to fire behavior models, such as FARSITE (Finney 1998), to determine the probability of crown fire ignition, calculate wind reductions, and compute the volume of crown fuel (VanWagner 1977, 1993). The CH layer is generated using a predictive modeling approach that relates Landsat imagery and spatially explicit biophysical gradients to calculated values of average dominant height from field training sites. Because of model requirements, these data are provided for forested areas only. The units of measurement for the LANDFIRE CH layer are meters * 10.

Forest Canopy Cover

Forest Canopy Cover (CC) describes the percent cover of the tree canopy in a stand. Specifically, canopy cover describes the vertical projection of the tree canopy onto an imaginary horizontal surface representing the ground's surface. A spatially explicit map of CC supplies information to fire behavior models, such as FARSITE (Finney 1998), to determine surface fuel shading for calculating dead fuel moisture and for calculating wind reductions. The CC layer is generated using a predictive modeling approach that relates Landsat imagery and spatially explicit biophysical gradients to calculated values of average canopy cover from field training sites and digital orthophoto quadrangles. The units of measurement for the LANDFIRE CC layer are percent.

Landscape (.LCP) Files

The Landscape (.LCP) File is a multi-band raster format used by wildland fire behavior and fire effect simulation models such as FARSITE and FlamMap. The bands of an .LCP file store data describing terrain, tree canopy, and surface fuel. This .LCP file utilizes LANDFIRE data, including the optional crown fuel bands but currently not including the optional surface fuel bands. Users can specify Fire Behavior Fuel Model 13 or 40.

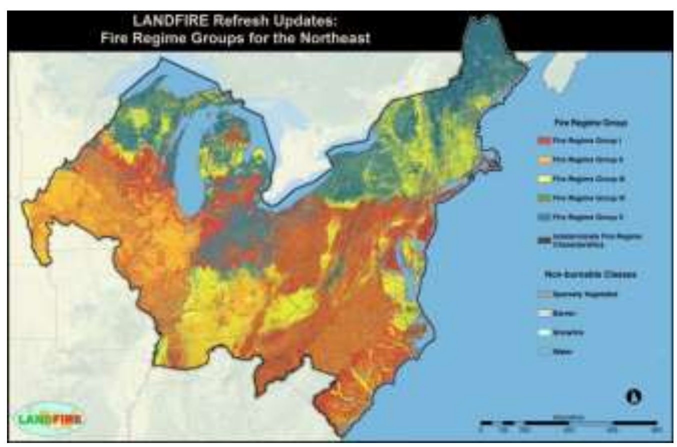
Fuel Loading Models

Fuel Loading Models (FLM) characterize fuel conditions and may be used to simulate wildland fire effects using applications such as FOFEM (Reinhardt and others 1997) and CONSUME (Ottmar and others 1993). FLM contain representative loading for each fuel component (for example, woody and non-woody) for typical vegetation classification systems. They characterize fuel loading across all vegetation and ecological types. These FLM are assigned to the LANDFIRE vegetation map unit classification systems. Geospatial representation of fire effects fuel models may be used to prioritize fuel treatment areas, evaluate fire hazard and potential status, and examine past, present, and future fuel loading characterizations.

Fuel Characteristics Classification System Fuelbeds

The Fuel Characteristic Classification System (FCCS) – developed by the USDA, Pacific Northwest Experiment Station, Pacific Wildland Fire Sciences Laboratory (PWFSL) in Seattle, WA – is a system for describing wildland fuels. Fire managers can use the FCCS to assign fuelbed characteristics for the purposes of predicting fuel consumption and smoke production through PWFSL's CONSUME software. Upon full implementation, the LANDFIRE team plans to work with FCCS staff to provide crosswalk assignments of FCCS fuelbed numbers to LANDFIRE existing vegetation layers.

Fire Regime Groups



The Fire Regime Groups (FRG) layer represents an integration of the spatial fire regime characteristics of frequency and severity simulated using the vegetation and disturbance dynamics model LANDSUM (Keane and others 2002). These groups are intended to characterize the presumed historical fire regimes within landscapes based on interactions between vegetation dynamics, fire spread, fire effects, and spatial context (Hann and others 2004). FRG definitions have been altered from previous applications (Hann & Bunnell 2001; Schmidt and others 2002; Wildland Fire Communicator's Guide) to best approximate the definitions outlined in the Interagency

Fire Regime Condition Class Guidebook (Hann and others 2004). These definitions were refined to create discrete, mutually exclusive criteria appropriate for use with LANDFIRE's fire frequency and severity data products.

Mean Fire Return Interval

The Mean Fire Return Interval (MFRI) layer quantifies the average period between fires under the presumed historical fire regime. This frequency is derived from vegetation and disturbance dynamics simulations using LANDSUM (Keane and others 2002, Hann and others 2004). The MFRI layer is intended to represent one component of the presumed historical fire regimes within landscapes based on interactions between vegetation dynamics, fire spread, fire effects, and spatial context.

Percent Low-severity Fire

The Percent of Low-severity Fire (PSL) layer quantifies the amount of mixed -severity fires relative to mixed- and replacement-severity fires under the presumed historical fire regime. Low severity is defined as less than 25 percent average top-kill within a typical fire perimeter for a given vegetation type (Hann and others 2004). This percent is derived from vegetation and disturbance dynamics simulations using LANDSUM (Keane and others 2002). The PLS layer is intended to represent one component of the presumed historical fire regimes within landscapes based on interactions between vegetation dynamics, fire spread, fire effects, and spatial context.

Percent Mixed-severity Fire

The Percent of Mixed-severity Fire (PMS) layer quantifies the amount of low-severity fires relative to low- and replacement-severity fires under the presumed historical fire regime. Mixed severity is defined as between 25 and 75 percent average top-kill within a typical fire perimeter for a given vegetation type (Hann and others 2004). This percent is derived from vegetation and disturbance dynamics simulations using LANDSUM (Keane and others 2002). The PMS layer is intended to represent one component of the presumed historical fire regimes within landscapes based on interactions between vegetation dynamics, fire spread, fire effects, and spatial context.

Percent Replacement-severity Fire

The Percent of Replacement-severity Fire (PRS) layer quantifies the amount of replacement-severity fires relative to low- and mixed-severity fires under the presumed historical fire regime. Replacement severity is defined as greater than 75 percent average top-kill within a typical fire perimeter for a given vegetation type (Hann and others 2004). This percent is derived from vegetation and disturbance dynamics simulations using LANDSUM (Keane and others 2002). The PRS layer is intended to represent one component of the presumed historical fire regimes within landscapes based on interactions between vegetation dynamics, fire spread, fire effects, and spatial context.

Succession Classes

Succession Classes (SClass) (termed vegetation-fuel classes in the Interagency Fire Regime Condition Class Guidebook version 1.0, Hann and others 2004) characterize current vegetation conditions with respect to the vegetation species composition, cover, and height ranges of successional states that occur within each biophysical setting. The historical reference conditions of these successional states are simulated using the vegetation and disturbance dynamics model LANDSUM (Keane and others 2002). The existing succession classes can also represent uncharacteristic vegetation components, such as exotic species, that are not found within the compositional or structural variability of successional states defined for a biophysical setting. The area contained in succession classes is compared to the simulated historical reference conditions to calculate measurements of vegetation departure, such as fire regime condition class. It is important to note that succession classes do not directly quantify fuel characteristics of the current vegetation, but rather represent vegetative states with unique succession or disturbance-related dynamics, such as structural development or fire frequency.

Vegetation Condition Class

Vegetation Condition Class (VCC) is a discrete metric that quantifies the amount that current vegetation has departed from the simulated historical vegetation reference conditions (Hann and Bunnell 2001; Hardy and others 2001; Hann and others 2004; Holsinger and others 2006). The three condition classes describe low departure (VCC 1), moderate departure (VCC 2), and high departure (VCC 3). VCC is calculated based on changes to species composition, structural stage, and canopy closure. LANDFIRE produces maps of VCC using methods derived from the Interagency Fire Regime Condition Class (FRCC) Guidebook (Hann and others 2004; Holsinger and others 2006). For a more detailed technical description, read Developing the LANDFIRE Fire Regime Data Products (Rollins and others 2007) available at www.landfire.gov. It is important to note that the LANDFIRE VCC layer represents the departure of current vegetation conditions from simulated historical reference conditions, which is only one component of the FRCC characterization outlined in Hann and others (2004). LANDFIRE simulates historical vegetation reference conditions using the vegetation and disturbance dynamics model LANDSUM (Keane and others 2002; Keane and others 2006; Pratt and others 2006). Current vegetation conditions are derived from a classification of LANDFIRE layers of existing vegetation type, cover, and height.

Vegetation Departure

The Vegetation Departure (VDEP) Index data product uses a range from 0 to 100 to depict the amount that current vegetation has departed from simulated historical vegetation reference conditions (Hann and Bunnell 2001; Hardy and others 2001; Hann and others 2004; Holsinger and others 2006). VDEP results from changes to species composition, structural stage, and canopy closure. LANDFIRE produces maps of VDEP using methods derived from the Interagency Fire Regime Condition Class (FRCC) Guidebook (Hann and others 2004; Holsinger and others 2006). For a more detailed technical description, read Developing the LANDFIRE Fire Regime Data Products (Rollins and others 2007) available at www.landfire.gov. It is important to note that the LANDFIRE VCC layer represents the departure of current vegetation conditions from simulated historical reference conditions, which is only one component of the FRCC characterization outlined in Hann and others (2004). LANDFIRE simulates historical vegetation reference conditions using the vegetation and disturbance dynamics model LANDSUM (Keane and others 2002; Keane and others 2006; Pratt and others 2006). Current vegetation conditions are derived from a classification of LANDFIRE layers of existing vegetation type, cover, and height.

Elevation

Elevation represents land height, in meters, above mean sea level. Elevation was derived from the National Elevation Dataset (NED). NED comprises merged 7.5 minute quadrangle topographic data resulting in a high quality, consistent elevation data set that spans the nation. Elevation unit measurements are meters above mean sea level.

Aspect

Aspect represents the azimuth of the sloped surfaces across a landscape. Aspect was derived from the National Elevation Dataset (NED). NED comprises merged 7.5 minute quadrangle topographic data resulting in a high quality, consistent elevation data set that spans the nation. Aspect unit measurements are degrees.

Slope

Slope represents the percent change of elevation over a specific area. Slope was derived from the National Elevation Dataset (NED). NED comprises merged 7.5 minute quadrangle topographic data resulting in a high quality, consistent elevation data set that spans the nation. Slope unit measurements are degrees.

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