

Glossary of wildfire hazard and risk

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Asset

A human-made object—a building, communication tower, etc.—of use or *value* to its owner. By contrast, *resources* are naturally occurring—wildlife habitat, forage, timber, etc. Assets and resources can be *damaged* by wildfire, resulting in reduction in value, or *loss*. Some resources increase in value after fire (a *benefit* of fire), but assets generally do not.

Benefit

An increase in the *value* of a *resource* or *asset* (although assets generally do not benefit from fire). The benefit to a resource may partially or wholly offset *loss* due to resource *damage*. The net effect of benefit and loss is called *net value change* (NVC) but has also been called *net loss* or net benefit.

Burn probability (BP)

The *probability* that a *wildfire* will burn a given point or area during a specified period of time. For wildfire management planning applications, burn probability is often reported on an annual basis—the probability of burning at any time during a single calendar year. Some planning applications report the *conditional burn probability* given that a fire occurs during a specified "problem fire" weather scenario. Wildfire incident management applications express burn probability for a much shorter time frame, typically one to four weeks. For practical purposes, wildfire simulation systems treat the burning of each pixel, the smallest landscape unit, as a point.

Conditional burn probability

Burn probability given a specific set of defining criteria. The specific criteria can be a weather scenario and a fixed, usually short period of active fire spread. Conditional burn probability is calculated for use in *hazard* and *threat* assessments that use FlamMap5 rather than FSim or FSPro. The *flame length probabilities* reported by FSim and FlamMap5 are conditional.

Conditional flame length (cFL)

The mean *flame length* at a specified point given the range of possible weather conditions and spread directions. CFL is often quantified as the mean flame length simulated with a Monte Carlo fire occurrence simulator but can also be estimated by properly weighting the simulated flame length across a range of weather conditions. Conditional flame length is one of two common measures of conditional wildfire intensity (the other is *mean fireline intensity*).

Conditional net value change (cNVC)

Conditional net value change is calculated as the sum-product of *flame-length probability* and *net value change* (to one or more *resources* or *assets*) over a range of *wildfire intensity* classes (usually flame length classes). *Burn probability* is not included in cNVC. If no beneficial effects are under consideration, cNVC can simply be called *conditional loss*. The terms "value change", "response" and "net response" are functional synonyms for net value change; all refer to the net effects of positive and negative changes on the value of a resource or asset.

Conditional wildfire intensity

The mean (central tendency) or typical *wildfire intensity* produced by the *fire environment* at a point on the landscape, incorporating non-heading spread directions and the full range of weather scenarios. Two measures of wildfire intensity are in common use—*flame length* and

fireline intensity. Flame length is used commonly in contemporary wildfire hazard and risk assessments. When using a Monte Carlo wildfire simulation system, *conditional flame length* (CFL) is the mean flame length of the iterations that burned a particular landscape pixel. The FSim wildfire simulation system also produces an output raster for *mean fireline intensity*—the mean fireline intensity of the iterations that burned each landscape pixel. Conditional wildfire intensity refers to the typical contemporary, not historical, wildfire intensity

Damage

An adverse physical change of an *asset* or *resource*. Damage is physical change, not the effect of that change on *value* (that is *loss*). The consumption of a building, death of desirable trees in a forest stand, and degradation of air quality are examples of damage a wildfire can cause. Damage can be direct or indirect. Examples of direct wildfire damage include tree mortality and consumption of buildings. Examples of indirect wildfire damages include reduction of forest productivity due to soil erosion and sedimentation of a reservoir.

Effects

The anticipated *benefits* and *losses* to *resources* and *assets*, typically quantified primarily as a function of *fire intensity*.

Effects analysis

The analysis of likely or anticipated response (*benefits* and *losses*) of *resources* and *assets* to wildfire, typically quantified as a function of fire intensity.

Ember load

The number or mass of embers per unit area. Ember load is quantified where embers land (after being lofted at another location).

Exceedance probability (EP)

The *probability* of exceeding a specified quantity of beneficial or adverse effect during a specified period of time. An EP curve is a graphical representation of EP over a range of possible quantities.

Expected loss

Expected value of loss due to wildfire, calculated as the product of *burn probability* and conditional loss if a fire were to occur. Expected loss considers only the adverse effects of a fire, whereas *expected net value change* also considers any potential offsetting beneficial effects, such as improvement in wildlife habitat.

Expected net value change (eNVC)

Expected net value change is calculated as the product of *burn probability* and *conditional net value change*. Expected net value change is a risk-neutral measure of the wildfire risk to resources and assets. If no beneficial effects are under consideration, expected net value change can simply be called *expected loss*. The terms value change, response and net response are functional synonyms for net value change; all refer to the net effects of positive and negative changes on the value of a resource or asset.

Expected value

Expected value is the probability-weighted mean outcome, a measure of the central tendency of outcomes. For example, if a system or simulation has a 90 percent *probability* of producing an outcome of 0, a 9 percent chance of an outcome of 10, and a one percent chance of an outcome of 1000, then the expected value is 10.9, as shown in the table below. Notice that 10.9 is not among the possible outcomes.

probability	outcome	Expected value
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0.90	0	0
0.09	10	0.9
0.01	1000	10
1.00		10.9

Exposure

The spatial coincidence of *wildfire hazard* (*likelihood* and *intensity*) with the location of a *resource* or *asset*. For example, a building (asset) in a flammable forest (hazard) is exposed to wildfire. Exposure can be intentional or incidental. A valuable but flammable forest is incidentally exposed to damage from wildfire, because the forest cannot be physically separated from the hazard. The construction of a residential building in the same flammable forest is intentional exposure to the same hazard.

Exposure analysis

An assessment of *wildfire hazard—likelihood* and *intensity*—where *resources* or *assets* are located.

Fire

A self-perpetuating process of combustion characterized by the emission of heat, usually accompanied by flame and smoke.

Fire modeling landscape

A *raster-format geospatial* characterization of fuel (surface fuel model, canopy base height, and canopy bulk density), vegetation (canopy cover and stand height) and topography (slope, aspect and elevation) needed to simulate potential fire behavior and fire growth across a landscape. For use in United States Forest Service spatial wildfire simulation systems (FlamMap, FARSITE, etc.), the fire modeling landscape must be in the form of an LCP file (Finney 1998).

Fire occurrence

An instance of a *wildfire* event; a *wildfire incident*. Fire occurrence can be characterized for a specified area during a specified period of time: frequency, density, start location, start date, fuel type, final size, management objective, and so on.

Fireline intensity (FLI)

The rate of heat release per unit length of flaming fire front, calculated as the product of heat content, fuel consumption during flaming front passage, and rate of spread.

Flame-length exceedance probability (FLEP)

The *conditional probability* of observing fire intensity above (exceeding) a specified flame length, given that a fire occurs.

Flame-length probability (FLP)

The *conditional probability* of observing *fire intensity* in a specified flame-length class, given that a fire occurs. The sum of FLP values at a point is therefore 1.

Frequency

The number of occurrences of an event per unit time.

Frequency density

The number of occurrences of an event per unit time and per unit area. For example fire-ignition frequency density is the number of fire ignitions per unit time per unit area (for example, ignitions per year per million acres).

Fuelscape

A *raster*-format geospatial characterization of ground, surface and canopy fuel across a landscape, typically consisting of one or more fuel characteristics data layers. For fire behavior modeling, a fuelscape consists of geospatial data layers representing surface fuel model, canopy base height and canopy bulk density. Fuelscape is functionally synonymous with *fire modeling landscape*. Other geospatial data layers required for geospatial fire modeling include topography characteristics (slope, aspect, elevation) and vegetation characteristics (forest canopy cover and height).

Geospatial

Of or pertaining to locations on the surface of the Earth.

Grid cell

A grid cell—also called a *pixel*—is the smallest addressable unit in a *raster* dataset.

Harm

Injury to a person. Harm is analogous to *damage*. Damage occurs to anthropogenic or natural objects—assets or resources—whereas harm occurs to persons.

Hazard

A physical situation with potential for harm to persons or damage to resources and assets. Wildfire hazard can be described qualitatively as a fire environment—fuel, weather, topography, and ignitions—with potential for causing harm or damage, or quantitatively by two characteristics: (1) the probability of a fire occurring at a specific point during a specified time period, and (2) the expected distribution of intensity given that the event does occur. Wildfire hazard at a given location on the landscape is quantified as: (1) burn probability and (2) conditional wildfire intensity given that a fire does occur. Those two characteristics can be combined into a single spatially resolved measure of wildfire hazard: integrated wildfire hazard. It is important to note that since the definition of risk in the wildfire context is expanded to include beneficial as well as negative effects, the consideration of wildfire likelihood and intensity (in other words, hazard) should be expanded as well.

Highly valued resource or asset (HVRA)

A *resource* or *asset* that is “likely to warrant protection if found to be at risk”. Low-value *assets* like outbuildings are often left unanalyzed so that efforts can be focused on the more highly valued resources and assets.

Ignition density

Number of wildfire ignitions per unit area.

Ignition density grid

Raster-format *geospatial* data representing the number of *wildfire* ignitions per unit area.

Ignition frequency

Number of *wildfire* ignitions per unit time.

Ignition frequency density

The number of *wildfire* ignitions per unit time and per unit area.

Ignition probability

The probability of an ignition occurring during the specified time period, usually one day or one year, expressed as a fraction (0-1) or a percentage (0-100).

Integrated wildfire hazard

Integrated wildfire hazard combines the two components of *wildfire hazard*—*burn probability* and *conditional wildfire intensity*—into a single characteristic that can be mapped. Integrated wildfire hazard is the product of burn probability and conditional wildfire intensity; it is expressed as either as the expected flame length or as the expected fireline intensity, depending upon which is used to characterize wildfire intensity.

Intensity

The rate of energy release of a *natural phenomenon*. Intensity is generally considered to be the primary effects-causing characteristic of a *wildfire* and other natural phenomena. Hurricane and tornado intensity is measured by wind speed. Wildfire intensity is measured as *fireline intensity* or *flame length*.

Likelihood

Non-technical synonym for *probability*.

Loss

The reduction in *value* of a *resource* or *asset*.

Natural hazard

A hazardous natural phenomenon; a peril arising from a source that occurs naturally (as opposed to a technological hazard such as a nuclear meltdown). “Natural peril” is a better term.

Net value change

The net effect of both damaging and beneficial effects on the *value* of a *resource* or *asset*, whether it increases or decreases. Negative numbers for net value change indicate a *net loss*; positive numbers indicate a *net benefit*.

Peril

A source of risk. Wildfire is a peril; so are hurricanes, earthquakes, and tornadoes. Also: technological phenomena like icy roads or a nuclear accident.

Pixel

A pixel—for picture element—is also called a *grid cell*. It is the smallest addressable unit in a *raster* dataset.

Probability

The *likelihood* that an event will occur during a specified period of time, typically defined as the relative frequency of an event; the ratio of the number of cases that represent the event to the total number of cases.

Resource

A resource is something found in nature and necessary or useful to people—wildlife habitat, forage, timber, etc. By contrast, *assets* are anthropogenic objects—buildings, communication towers, roads, etc.—of *value* to its owner. Assets and resources can be *damaged* by wildfire, resulting in *loss of value*. Some resources increase in value after fire (a *benefit* of fire), but assets generally do not.

Risk

Generally, risk is the potential for realization of adverse or beneficial consequences to HVRAs. Although there exists no single, best measure of risk, in this risk assessment framework we quantify the potential for effects as the expected value of the probability of an event occurring multiplied by the magnitude of the effect, given that an event has occurred.

Risk assessment

An appraisal of the interaction of *wildfire hazard* and the *vulnerability of resources and assets* in a defined area. Components of wildfire hazard include the *probability* of burning and the *intensity* given that a burn occurs. Components of HVRA vulnerability include *exposure* and *susceptibility*.

Risk compensation

An adjustment in behavior (usually *exposure*) in response to a change in other risk factors (*hazard or susceptibility*). *aka* risk homeostasis.

Risk management

“Risk Management is the identification, assessment, and prioritization of risks followed by coordinated and economical application of resources to minimize, monitor, and control the probability and/or impact of unfortunate events” (Hubbard 2009, p. 10)

Risk source

The propensity for a location to produce (be a source of) *risk to assets or resources*. Risk source refers to locations where damaging wildfires originate, even if the damage occurs elsewhere.

Risk transmission

A situation in which the adverse effects of a natural hazard occur some distance from where the event initiates.

Susceptibility

The propensity of an asset or resource to experience an effect as a result of burning at a given level of wildfire intensity. An asset or resource that is easily damaged by a low-intensity wildfire is susceptible, whereas one that is difficult to damage even with a high-intensity wildfire is resistant. Modifications to a building (changing to a fire-resistant roof covering, screening vents, etc.) make it less susceptible to fire damage. The term susceptibility is used for the propensity to experience either an increase or decrease in value.

Threat

The *expected value of loss*; nearly synonymous with risk but specifically excludes any potential for beneficial fire effects.

Uncertainty

Imperfect information or a lack of knowledge. Uncertainty can manifest in many forms, and in risk analyses often relates to understanding of the *probabilities* of events. Uncertainty can also relate more to knowledge gaps, linguistic confusion, or unknown preferences.

Value

The worth or importance of an *asset or resource*.

Value change

The change in *value* of a *resource or asset* arising from an event such as *wildfire*. Some resources or assets experience offsetting beneficial and adverse effects, so the term *net value change* is often used to acknowledge that these offsetting effects have been accounted.

Vulnerability

The combination of *exposure* and *susceptibility* of a *resource or asset* to a *peril*.

Wildland fire

A *fire* burning in vegetation. Also called landscape fire or land-cover fire. A wildland fire can be planned or unplanned. A planned wildland fire is a prescribed fire or controlled burn. An unplanned wildland fire is a *wildfire*.

Wildfire

An unplanned *wildland fire*. Wildfires arise from ignitions due to natural causes (primarily lightning) or from anthropogenic causes.

Wildfire intensity

The rate of energy release of a *wildfire* at a point on its perimeter, typically measured as *flame length (FL)* or *fireline intensity (FLI)*.



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