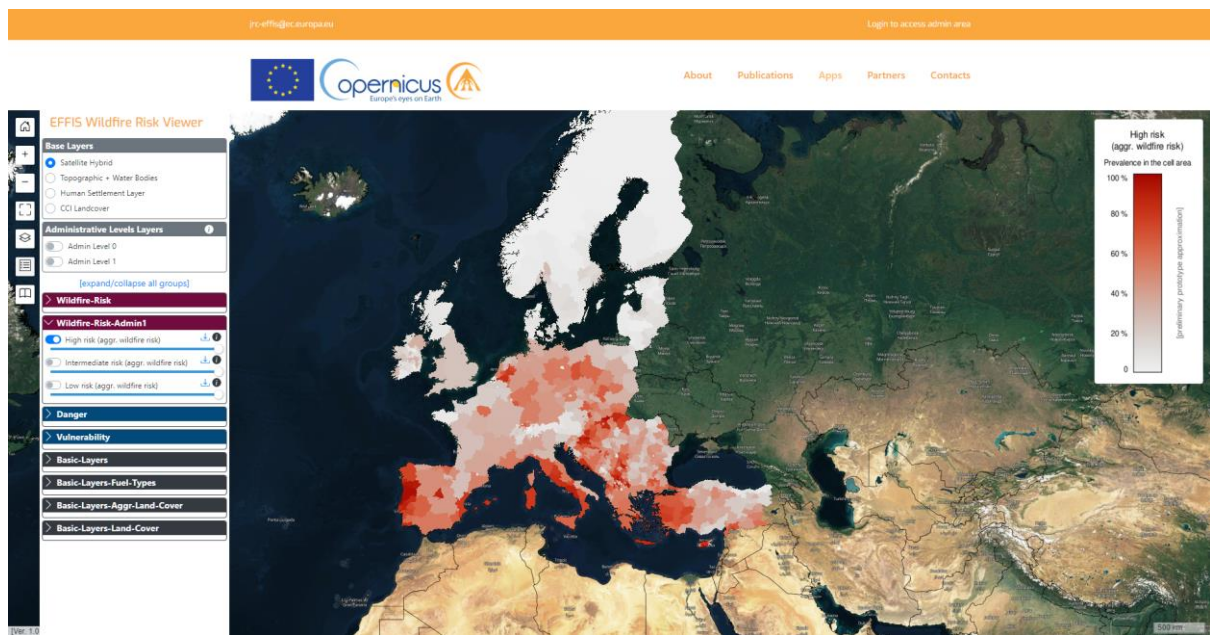


The European Forest Fire Information System (EFFIS) WildFire Risk Viewer

User's Guide

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Abstract

The pan-European Wildfire Risk Assessment (WRA) approach follows from a series of EU regulations that require the EC to have a wide overview of the wildfire risk in the European region, to support the actions of its Member States and to ensure compliance in the implementation of EU regulations related to wildfires. The process is closely linked with the Expert Group on Forest Fires (EGFF), composed of fire management representatives from 43 countries in the region and part of the European Forest Fire Information System (EFFIS) which was established jointly by the EC services (DG ENV and JRC) and the relevant fire services from the EU Member States, other non-EU European countries and Middle East and North African countries (Figure 1).

The main goal of the WRA is to describe the development of a pan-European wildfire risk based on the definition of risk adopted by the United Nations International Strategy for Disaster Reduction (UNISDR, 2009) which was also followed by the European Commission (EC) Joint Research Centre (JRC) reports (San-Miguel-Ayanz *et al.* 2017, 2019; Oom *et al.*, 2021) by presenting a first set of data that would enable the implementation of the proposed assessment. Defining a proper probability of wildfire occurrence/propagation would imply detailed information on local socio-economic, political, and behavioural aspects variable with space and time (as the vast majority of wildfires in Europe is due to human causes) for which no harmonised nor accurate information is available, nor reliable scientific knowledge is developed yet for them to be predictable. As a consequence, the harmonised WRA is based on a semi-quantitative approach where wildfire hazard is modelled as a simpler fuzzy possibility relying on robust (yet semi-quantitative) rank-based analysis. The harmonised WRA will support the inter-comparison of methods and needs among countries and be complementary to existing national WRA. Additionally, it can serve as a first approach to assess wildfire risk in those countries that have not yet performed a national WRA

An integrated framework of interconnected components associated with the fire process should support risk modelling to provide an integrated view of both fire likelihood and consequences. Figure 1 illustrates the WRA scheme here proposed, designed to be scale-independent and easily applicable to local, regional, and global scale. Two main groups of components are defined by considering the fire danger (or hazard) and the vulnerability on three categories: people, ecological, and economic values exposed in vulnerable areas.

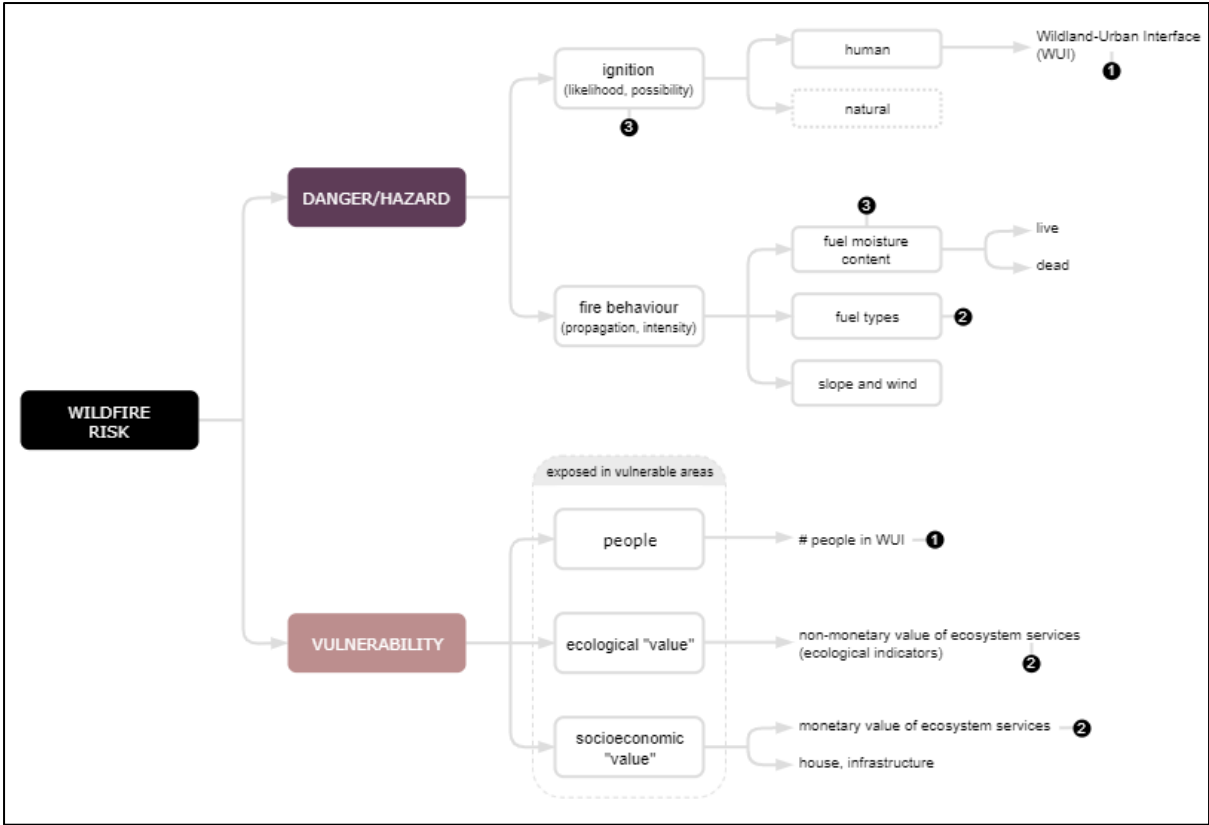



Figure 1. FIRE SCHEME

Overview









Figure 2. Map viewer (<https://effis.jrc.ec.europa.eu/apps/fire.risk.viewer/>)

Layers controls

On the left of the map are 7 windows containing map options/analysis tools. In all cases clicking on the info button  opens a new screen containing detailed information. Also there is a slider that will control the transparency of each layer (See **Additional information** session on this guide for full text of information on the layers).

Map Tools

A set of map tools are on the right side of the map image. The following table explains how the tools work.

Tool	Icon	Details
Open/close layers sidebar		Shows or hides the options bars on the left of the screen. Click once to hide, click again to show.
Reset map		Returns the map to the original extent covering Europe.
Zoom in/out		Click to increase or decrease resolution. The same effect can also be obtained using the roller button on the mouse.
Zoom to specific area		Click to put map on whole screen. Click again to restore to previous view. to highlight a specific area for the zoom.
Show legend		Opens a box on the screen with the legends for all the layers that are currently displayed.
Users Guide		Open a new page with the User's Guide document

Additional information

Original projection and spatial resolution

WCRP-European grid of the Coordinated Regional Climate Downscaling Experiment (CORDEX) by World Climate Research Programme (WCRP). Archived at <https://tinyurl.com/y85nxfdw>. The standard grid EUR-11 is used (grid cell resolution of approximately 0.11 degrees, or about 12.5 km).

Layers Description

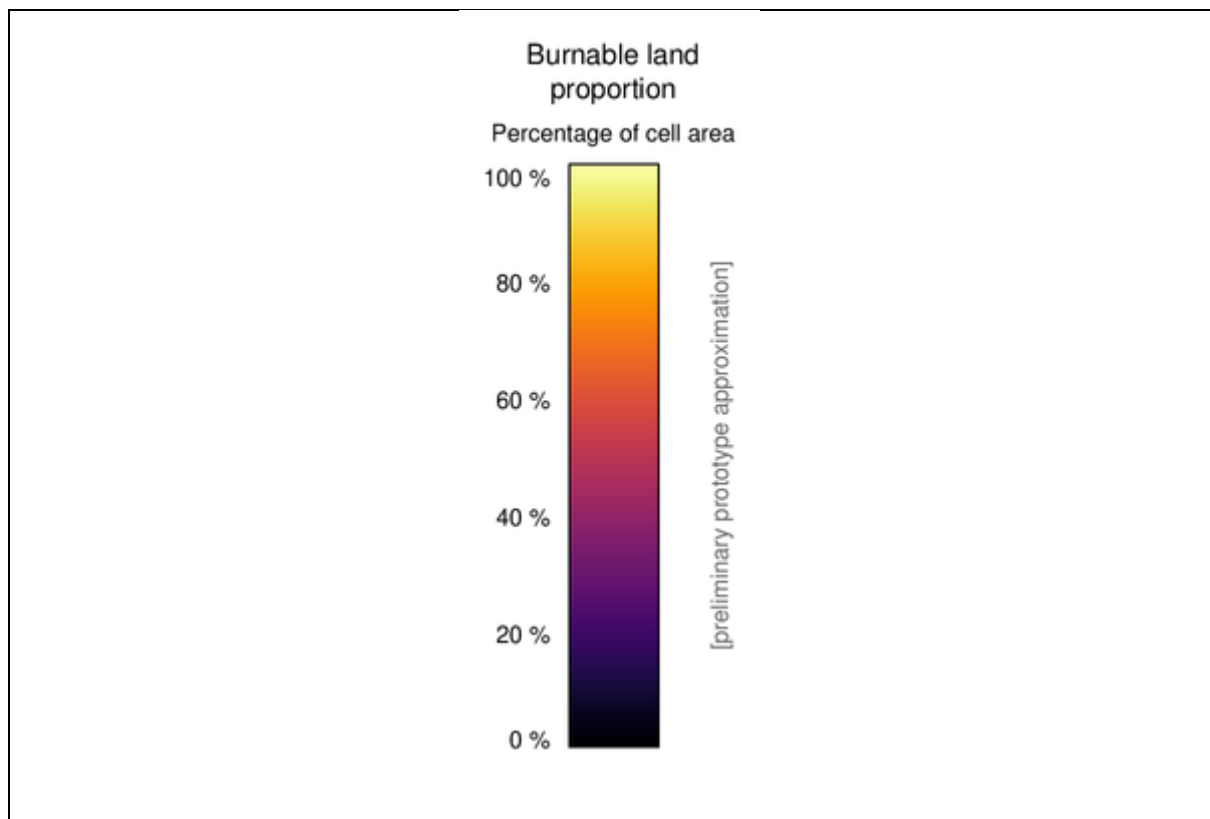
Layer name	Group	Units
Potential Burnable Land Proportion	Basic Layers	Percentage of cell area (%)
WUI proportion	Basic Layers	Percentage of cell area (%)
Protected area irreplaceability	Basic Layers	Percentile (%)
Protected area fraction	Basic Layers	Percentile (%)
Population density in vulnerable WUI	Basic Layers	People per Km ²
Total population density	Basic Layers	People per Km ²
Fuel types	Basic Layers	Percentage of cell area (%)
Aggregate land-cover	Basic Layers	Percentage of cell area (%)
Land-cover	Basic Layers	Percentage of cell area (%)
Danger by Weather	Danger	Percentile (%)
Danger by thermal anomalies	Danger	Percentile (%)
Population vulnerability	Vulnerability	Percentile (%)
Ecological vulnerability	Vulnerability	Percentile (%)
Economic vulnerability	Vulnerability	Percentile (%)
Ecological/economic vulnerability	Vulnerability	Percentile (%)
High risk (aggregated fire risk)	Wildfire-Risk	Prevalence in the cell area (%)
Intermediate risk (aggregated fire risk)	Wildfire-Risk	Prevalence in the cell area (%)
Low risk (aggregated fire risk)	Wildfire-Risk	Prevalence in the cell area (%)

Basic Layers

The image shows a user interface for a GIS application. On the left, a panel titled "Basic-Layers" contains six layers, each with a toggle switch, a download icon, and an info icon. On the right, two callout boxes are shown: one pointing to the info icon of the first layer, labeled "Info button", and another pointing to the transparency slider of the second layer, labeled "Transparency slider".

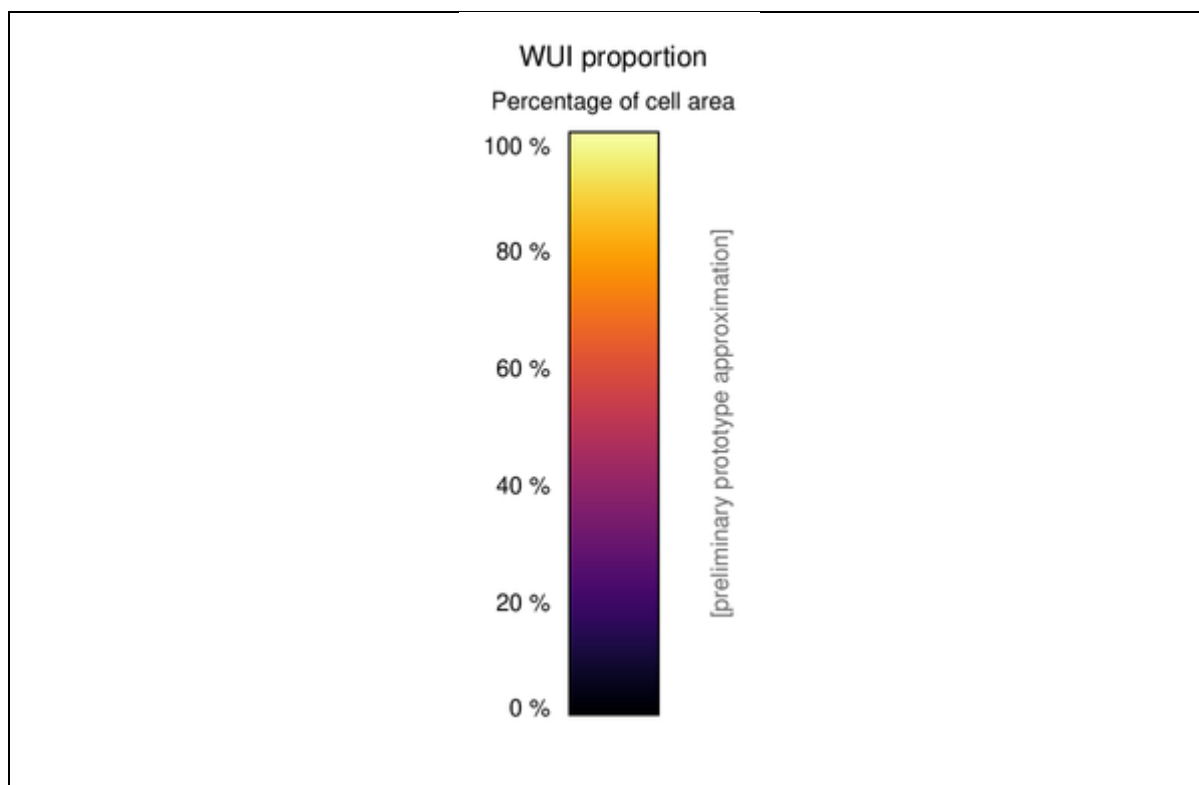
a) *Burnable land proportion*

Name
Burnable land proportion
Group
Basic Layers
Description
<p>The Burnable Land proportion mask refers to any type of vegetation fuel, so it includes wildland, but also cropland, or any other typology of land with vegetation components that could actually burn. This mask acts as a filter to avoid false alarms, i.e. to prevent that fire observations not corresponding to vegetation fires bias the final output. It was developed under the Global Wildfire Information System (https://gwis.jrc.ec.europa.eu/) framework, estimating on a high-spatial resolution the potential burnable area where vegetation fuels are found, irrespective of the particular fuel type. The GHSL built-up product (Pesaresi et al., 2013, 2016) was used directly together with the JRC's Global Water Layer (Pekel et al., 2016; https://global-surface-water.appspot.com/) and the Annual Maximum Normalized difference vegetation index (NDVI) value derived from Copernicus Sentinel imagery. The data processing was initially implemented at pixel level with spatial resolution of 30 meters, and then aggregated at the spatial resolution of the WCRP. A pixel was masked (considered as a non-burnable pixel) if occupied by GHSL built-up, or by water or if the maximum annual value of NDVI in the pixel was lower than 0.2 (assuming that such values correspond to bare soil) (Oom et al., 2021).</p>
Unit
Percentage of cell area (%)
Projection
<p>Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).</p>
Legend



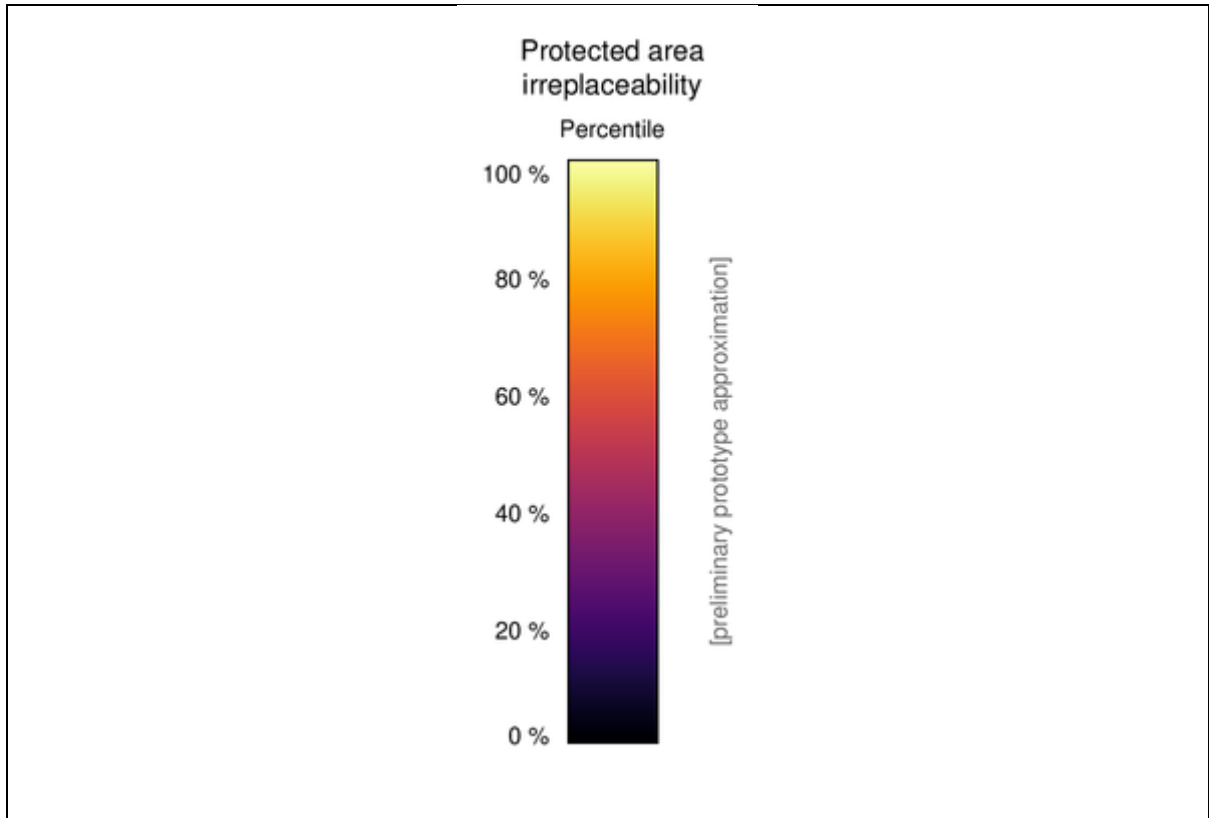
b) WUI proportion

Name
WUI proportion
Group
Basic Layers
Description
Proportion of land in the Wildland-Urban. In populated areas close to natural or semi-natural areas, the expansion of natural vegetation or settlements into the other class generates an interface designated as WUI (Costa et al., 2020).
Unit
Percentage of cell area (%)
Projection
Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).
Legend



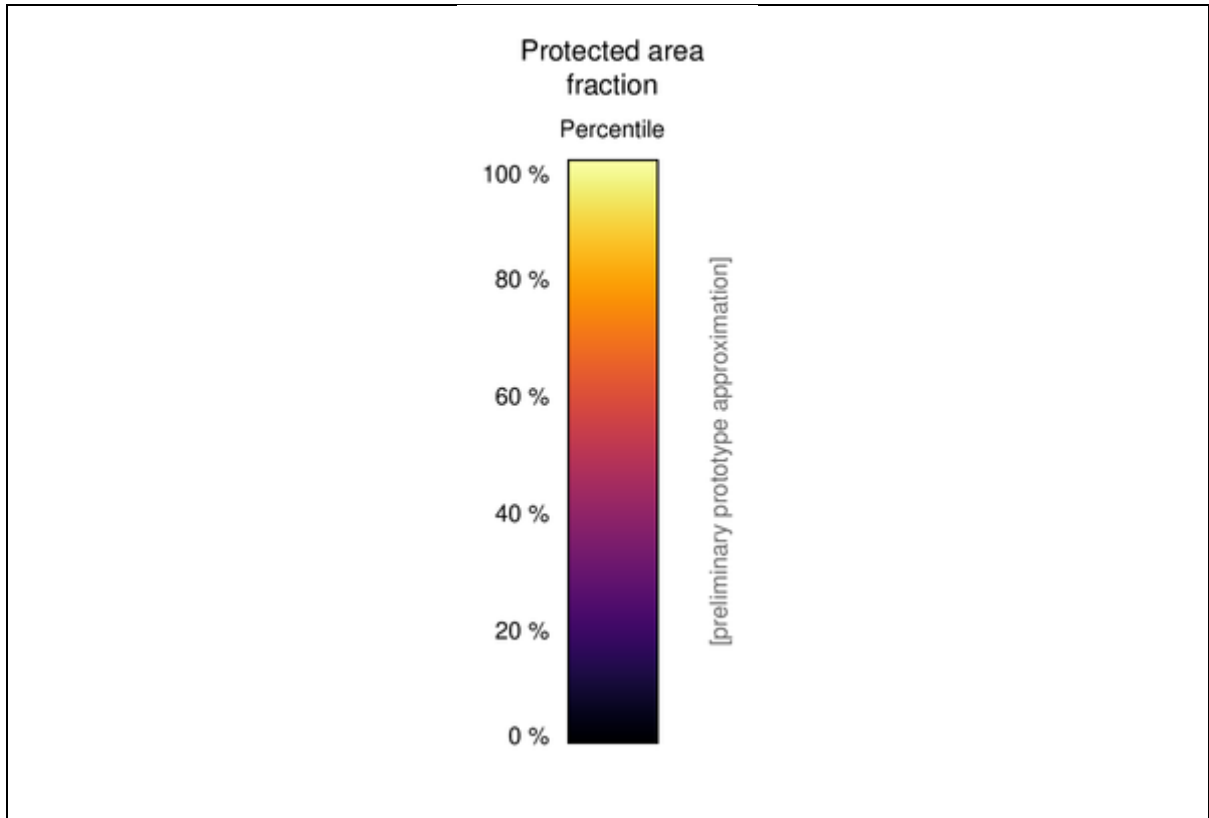
c) Protected area irreplaceability

Name
Protected area irreplaceability
Group
Basic Layers
Description
Ecological Irreplaceability score of the protected areas (IUCN Red List of Threatened Species: amphibians, mammals, birds from World Database on Protected Areas) (Le Saout et al., 2013)
Unit
Percentile (%)
Projection
Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).
Legend



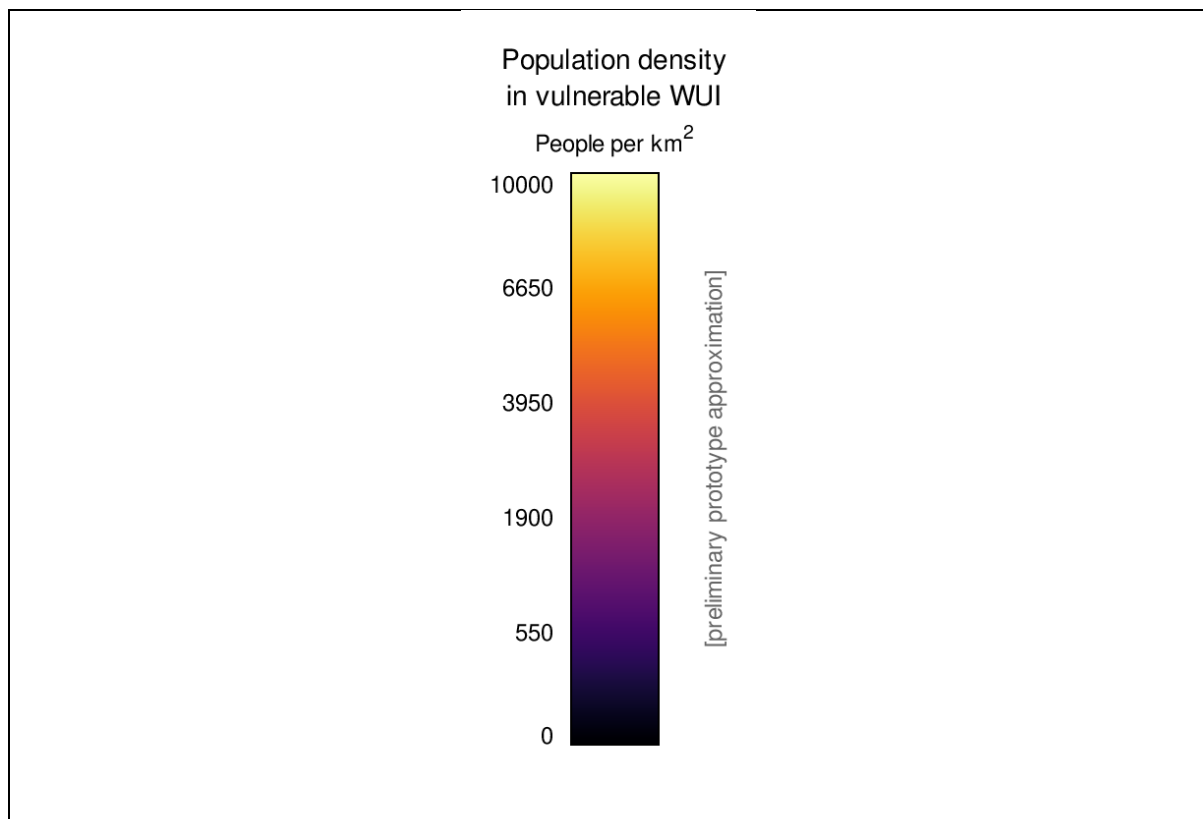
d) Protected area fraction

Name
Protected area fraction
Group
Basic Layers
Description
Percentile of protected areas with burnable fuel per each cell (World Database on Protected Areas)(UNEP-WCMC, 2019).
Unit
Percentile (%)
Projection
Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).
Legend



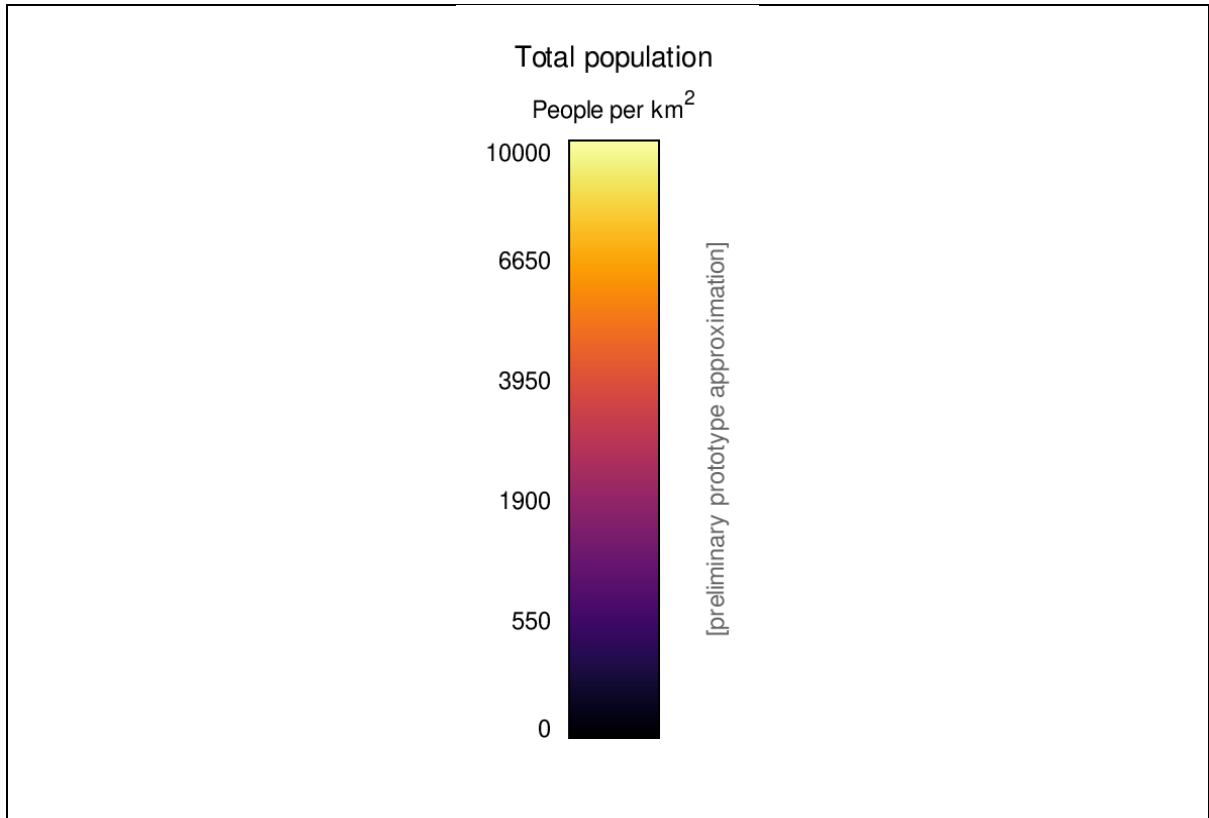
e) *Population density in vulnerable WUI*

Name
Population density in vulnerable WUI
Group
Basic Layers
Description
Population density (number of people per square kilometre) of the settlements exposed inside the vulnerable Wildland-Urban Interface (WUI)
Unit
People / km ²
Projection
Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).
Legend



f) Total population density

Name
Total population density
Group
Basic Layers
Description
Total population density (total number of people per square kilometre) inside and outside the settlements exposed in the vulnerable Wildland-Urban Interface
Unit
People / km ²
Projection
Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).
Legend



Danger

Danger by weather (FWI30-days) ↓ i
 Danger by wildfire thermal anomalie ↓ i

Info button
Download GeoTiff/CSV

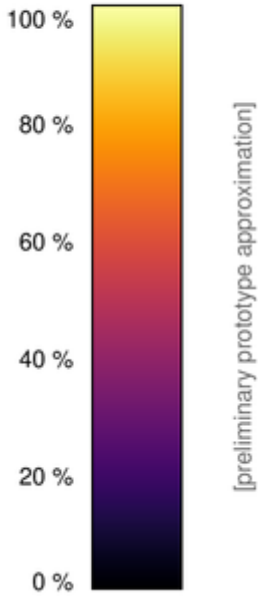
Transparency slider

a) *Danger by Weather*

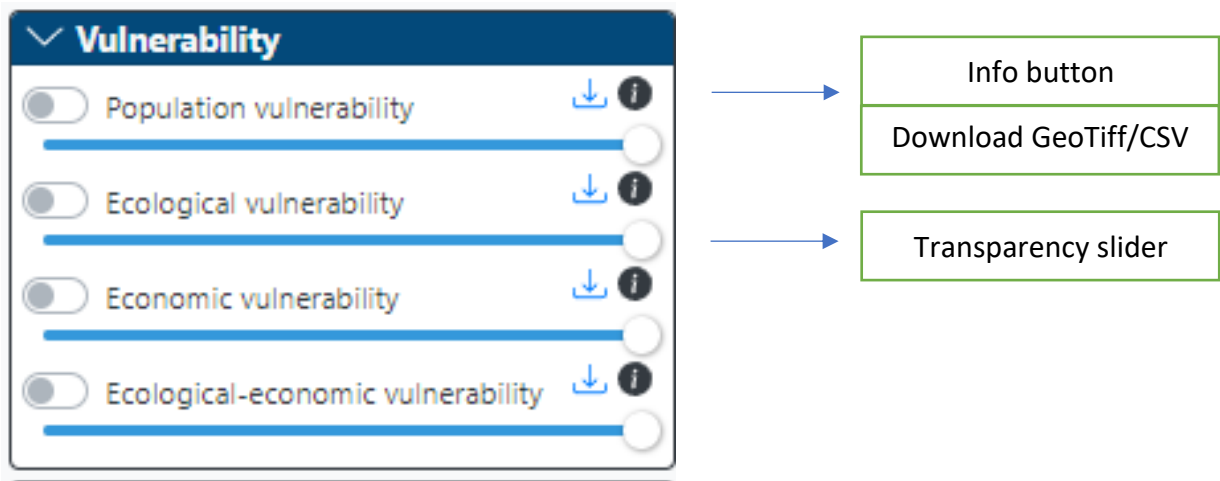
Name
Danger by weather
Group
Danger
Description
Number of days with high-to-extreme fire danger by weather (FWI \geq 30) (Van Wagner, 1987) - uncertainty aggregation: median value.
Unit
Percentile (%)
Projection
Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).
Legend
<p style="text-align: center;">Danger by weather (FWI30-days)</p> <p style="text-align: center;">Percentile</p> <p style="text-align: center;">100 %</p> <p style="text-align: center;">80 %</p> <p style="text-align: center;">60 %</p> <p style="text-align: center;">40 %</p> <p style="text-align: center;">20 %</p> <p style="text-align: center;">0 %</p> <p style="text-align: right;">[preliminary prototype approximation]</p>

b) Danger by fire thermal anomalies

Name

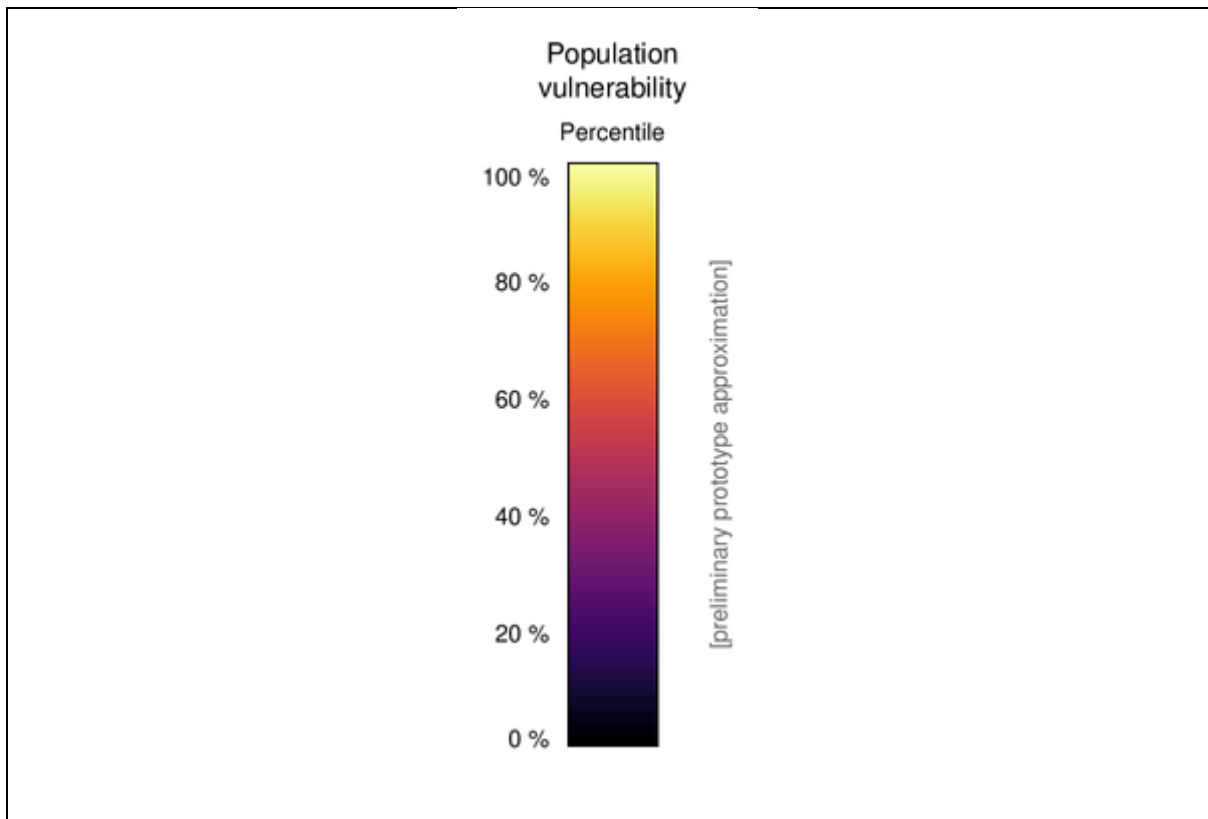
Danger by thermal anomalies
Group
Danger
Description
Fire danger by observed frequency of thermal anomalies (MODIS/VIIRS) (Giglio et al., 2018) from 2003 to 2019 - uncertainty aggregation: median value.
Unit
Percentile (%)
Projection
Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).
Legend
<p style="text-align: center;">Danger by weather (FWI30-days)</p> <p style="text-align: center;">Percentile</p>  <p style="text-align: center;">100 %</p> <p style="text-align: center;">80 %</p> <p style="text-align: center;">60 %</p> <p style="text-align: center;">40 %</p> <p style="text-align: center;">20 %</p> <p style="text-align: center;">0 %</p> <p style="text-align: right;">[preliminary prototype approximation]</p>

Vulnerability



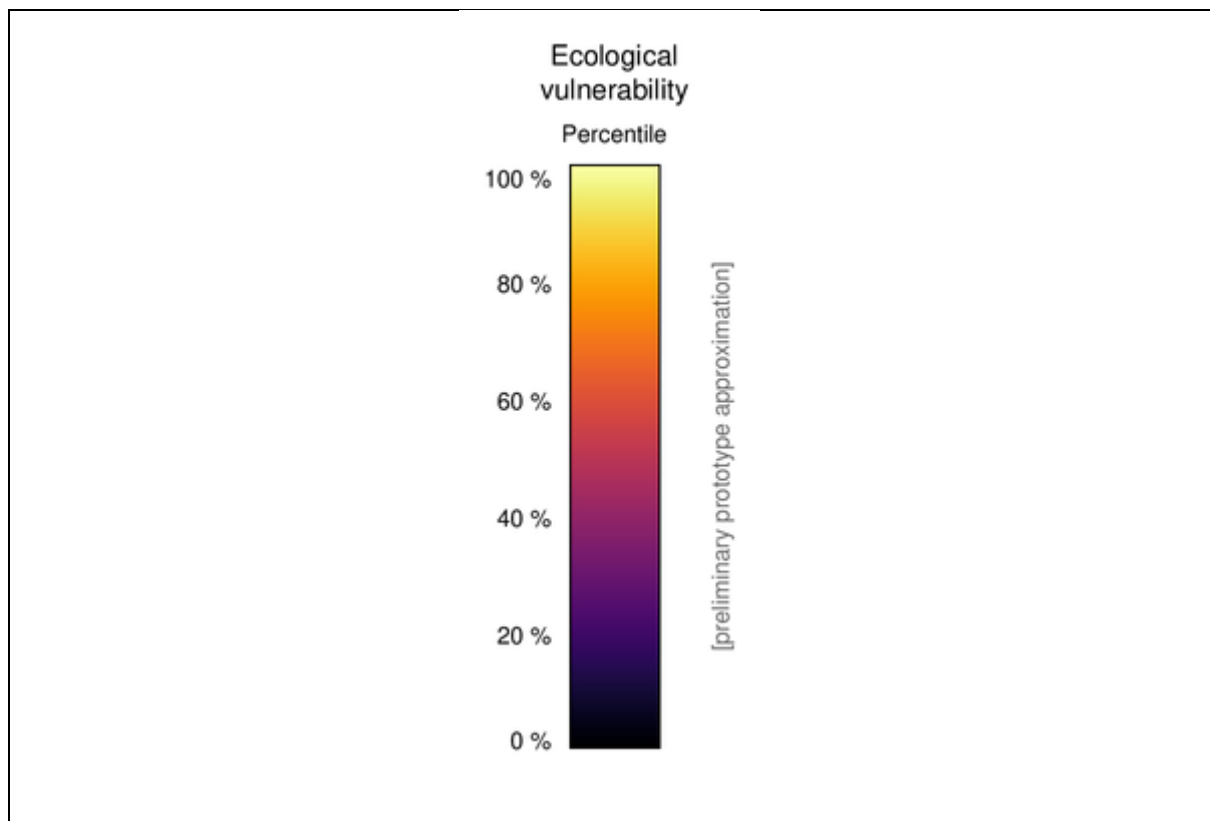
a) *Population vulnerability*

Name
Population vulnerability
Group
Vulnerability
Description
Aggregated index of population vulnerability. Based on population in the Wildland Urban Interface.
Unit
Percentile (%)
Projection
Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).
Legend



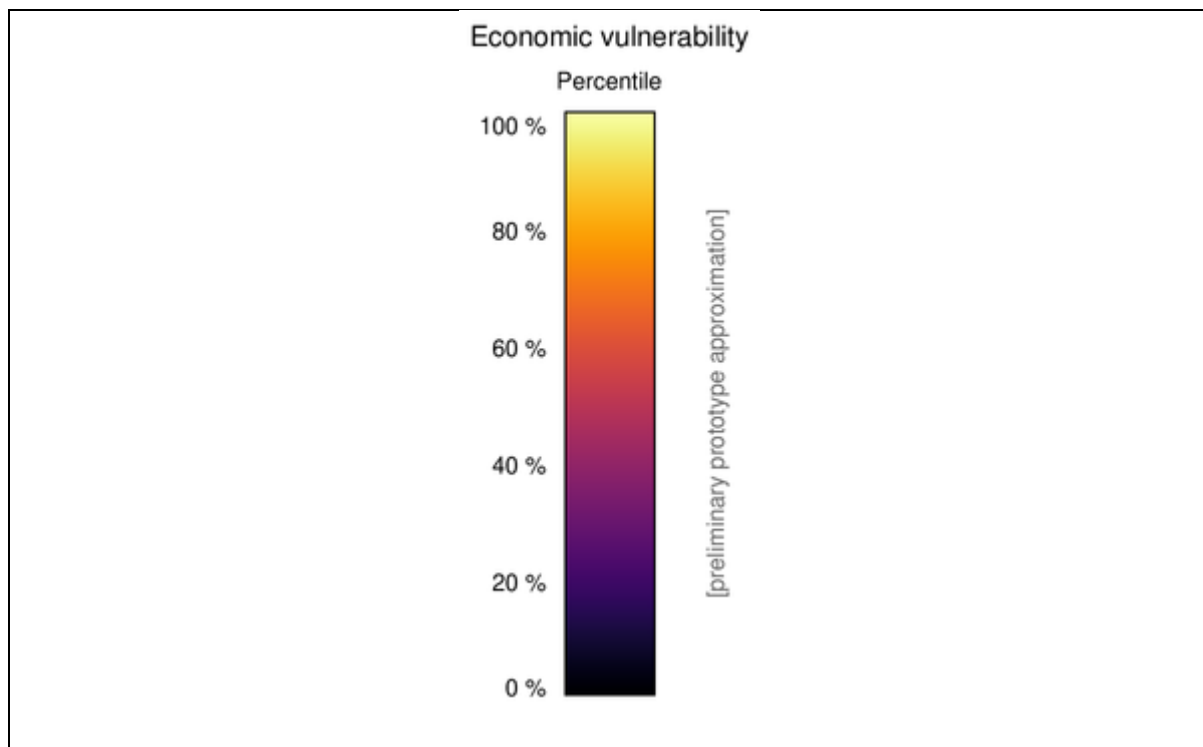
b) Ecological vulnerability

Name
Ecological vulnerability
Group
Vulnerability
Description
Aggregated index of ecological vulnerability. Based on the ecological “irreplaceability” score (IRR) of the local vegetation (weighted average IRR) and the protected area fraction (PAF) for each burnable grid cell. The IRR and PAF are joined as ecological exposure/vulnerability.
Unit
Percentile (%)
Projection
Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).
Legend



c) Economic vulnerability

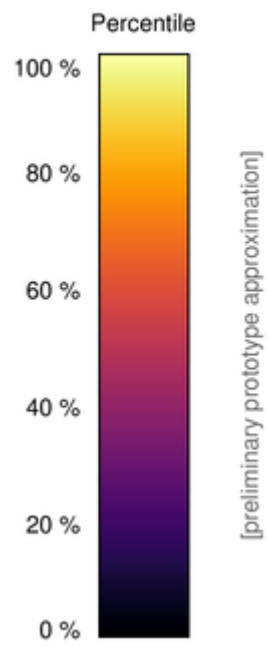
Name
Economic vulnerability
Group
Vulnerability
Description
Aggregated index of economic vulnerability. Based on the restoration cost for forest and agriculture areas, using the human settlements and infrastructure (European settlement layers).
Unit
Percentile (%)
Projection
Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).
Legend



d) Ecological-economic vulnerability

Name
Ecological - economic vulnerability
Group
Vulnerability
Description
Aggregated index of ecological and economic vulnerability.
Unit
Percentile (%)
Projection
Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).
Legend

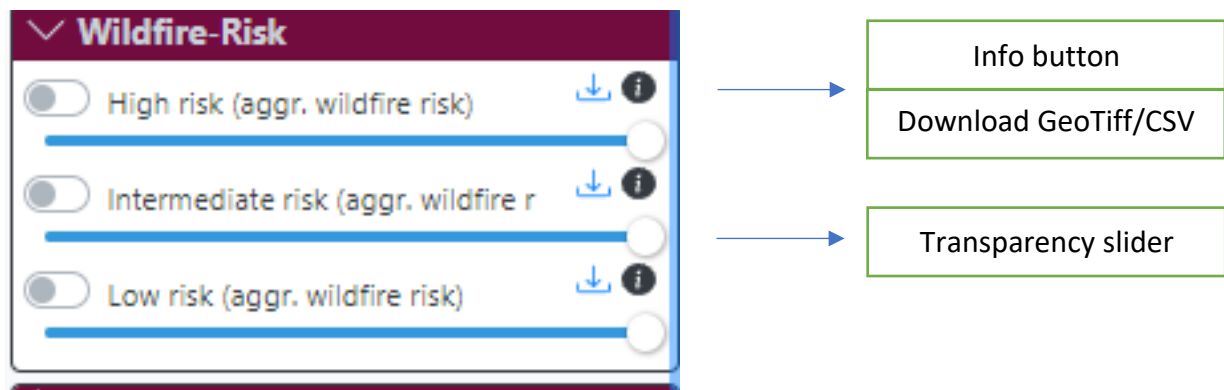
Ecological-economic vulnerability



Risk

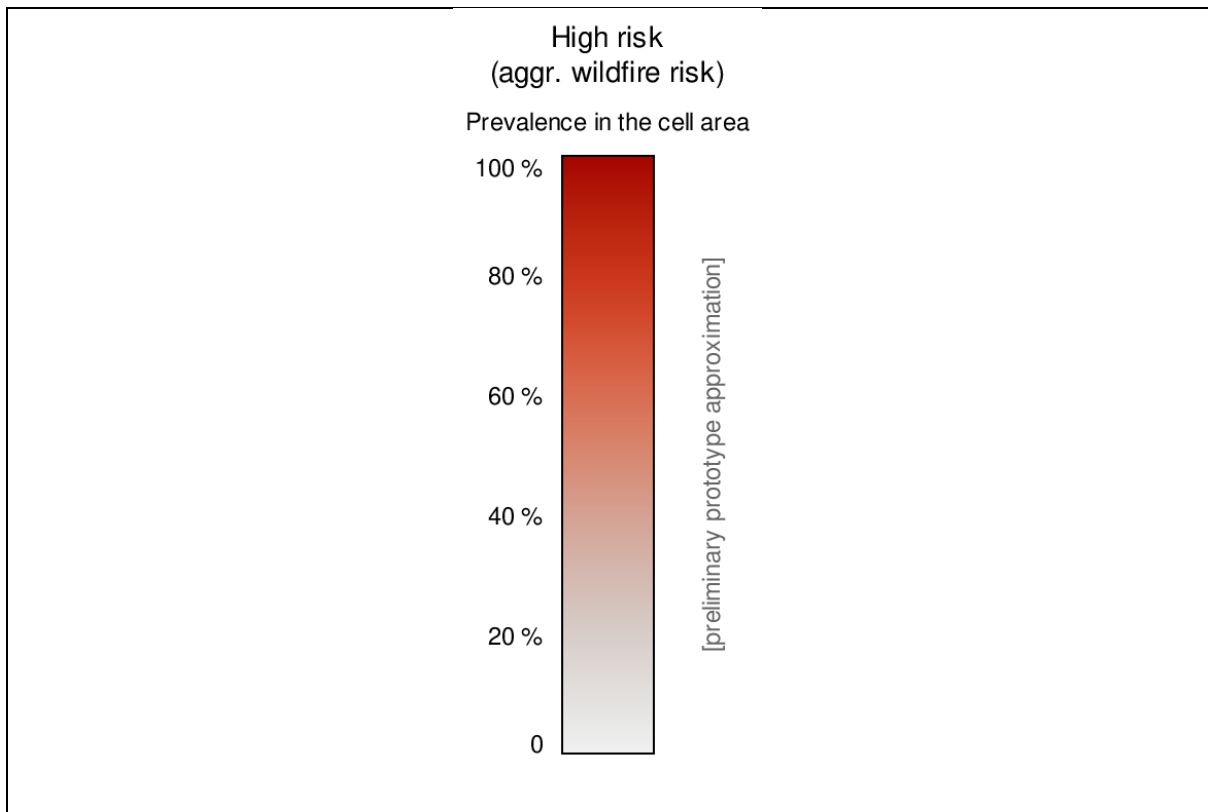
A *wildfire risk map* is then generated as an index to summarize the combined effect of wildfire danger and vulnerability (people, ecosystems and goods exposed in vulnerable areas). The format of the risk map allows risk classes (**low, medium and high risk**) to be identified, with a simple score ranging from 0 % to 100 %, as the percentage of the cell under that specific class.

High risk may be expected where high wildfire danger affects the most critical areas for people, and secondarily for the other ecological and socioeconomic aspects. The information is displayed at **pixel level**:



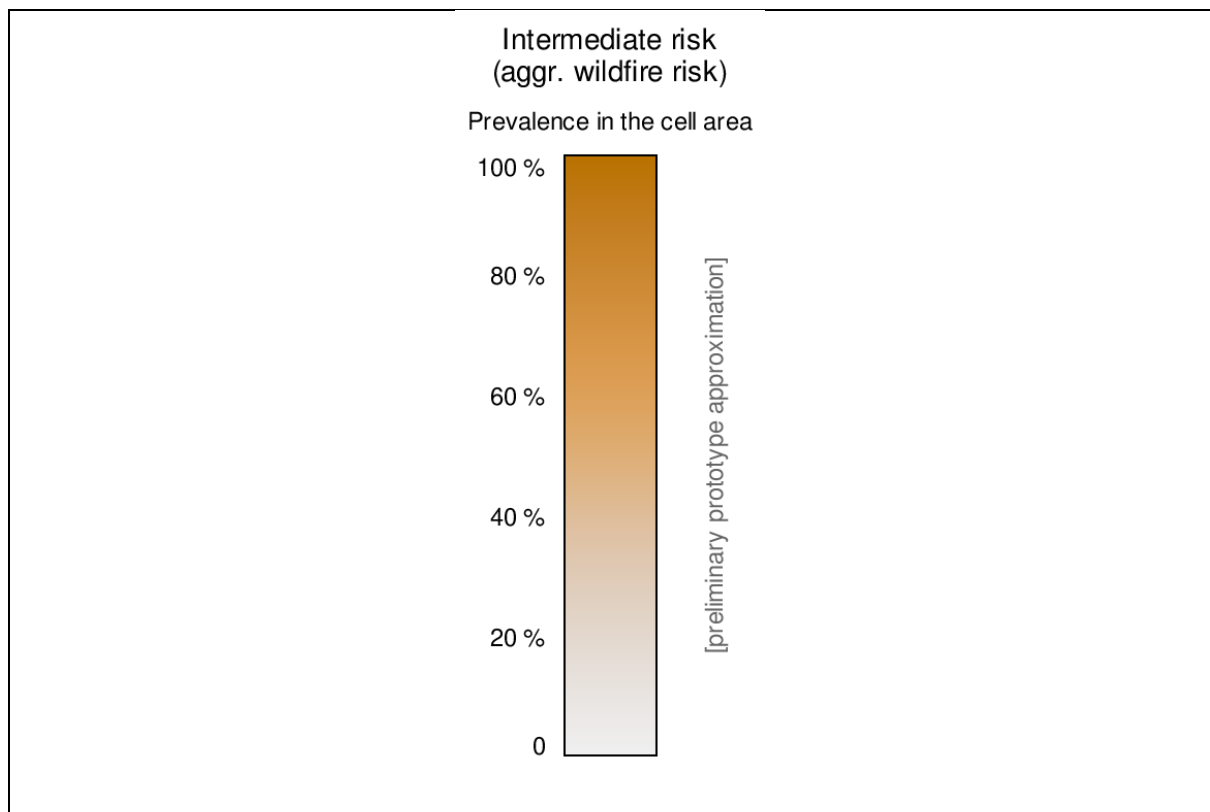
a) High risk

Name
High risk (aggregated wildfire risk)
Group
Wildfire-Risk
Description
Prevalence of the higher-risk class in the spatial cell (percentage), modelling wildfires and considering any other typology of vegetation fires only for the potential risk to become a wildfire
Unit
Prevalence in the cell area (%)
Projection
Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).
Legend



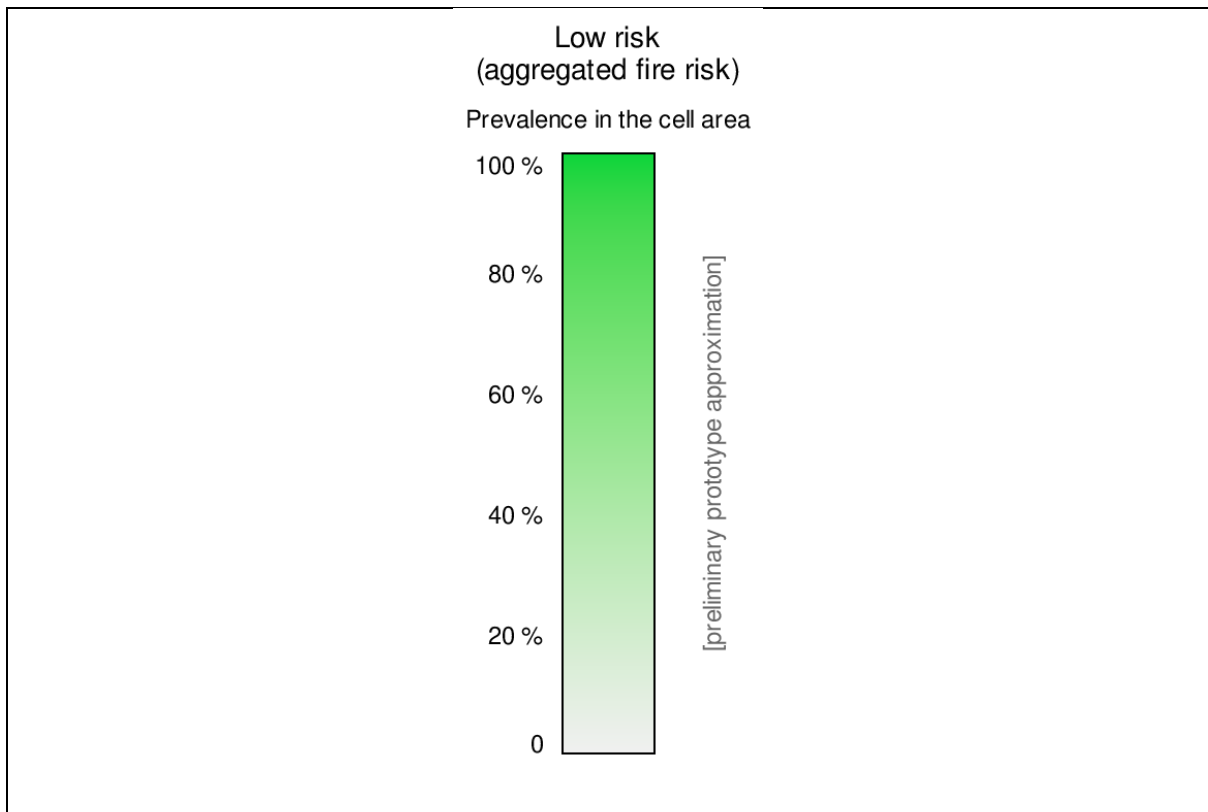
b) Intermediate risk

Name
Intermediate risk (aggregated wildfire risk)
Group
Wildfire-Risk
Description
Prevalence of the intermediate-risk class in the spatial cell (percentage), modelling wildfires and considering any other typology of vegetation fires only for the potential risk to become a wildfire
Unit
Prevalence in the cell area (%)
Projection
Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).
Legend



c) Low risk

Name
Low risk (aggregated wildfire risk)
Group
Wildfire-Risk
Description
Prevalence of the lower-risk class in the spatial cell (percentage), modelling wildfires and considering any other typology of vegetation fires only for the potential risk to become a wildfire
Unit
Prevalence in the cell area (%)
Projection
Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).
Legend

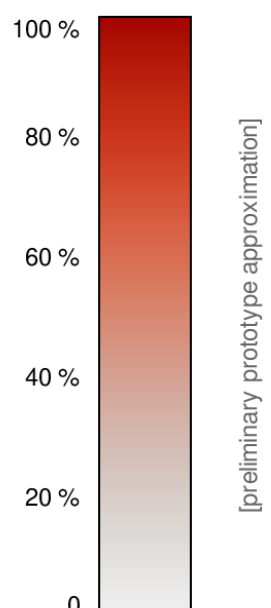


Admin1-Risk Indexes

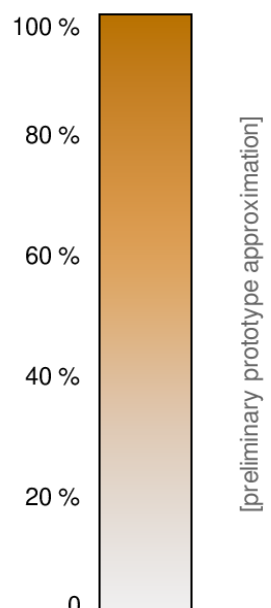
A *wildfire risk map* is then generated as an index to summarize the combined effect of wildfire danger and vulnerability (people, ecosystems and goods exposed in vulnerable areas). The format of the risk map allows risk classes **low, medium and high risk**) to be identified, with a simple score ranging from 0 % to 100 %, as the percentage of the cell under that specific class.

High risk may be expected where high wildfire danger affects the most critical areas for people, and secondarily for the other ecological and socioeconomic aspects. The information is displayed at **administrative level**:

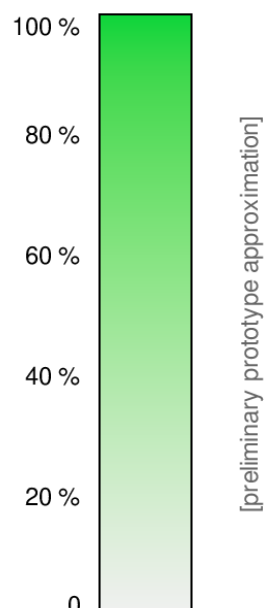
a) High risk

Name
High risk (aggregated wildfire risk)
Group
Wildfire-Risk-Admin1
Description
Aggregated wildfire risk index: prevalence of the higher-risk class in the spatial cell (percentage), modelling wildfires and considering any other typology of vegetation fires only for the potential risk to become a wildfire
Unit
Prevalence in the cell area (%)
Projection
Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).
Legend
<p style="text-align: center;">High risk (aggr. wildfire risk) Prevalence in the cell area</p>  <p style="text-align: center;">100 % 80 % 60 % 40 % 20 % 0</p> <p style="text-align: right;">[preliminary prototype approximation]</p>

b) *Intermediate risk*

Name
Intermediate risk (aggregated wildfire risk)
Group
Wildfire-Risk-Admin1
Description
Aggregated wildfire risk index: prevalence of the intermediate-risk class in the spatial cell (percentage), modelling wildfires and considering any other typology of vegetation fires only for the potential risk to become a wildfire
Unit
Prevalence in the cell area (%)
Projection
Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).
Legend
<p>Intermediate risk (aggr. wildfire risk)</p> <p>Prevalence in the cell area</p>  <p>[preliminary prototype approximation]</p>

a) Low risk

Name
Low risk (aggregated wildfire risk)
Group
Wildfire-Risk-Admin1
Description
Aggregated wildfire risk index: prevalence of the lower-risk class in the spatial cell (percentage), modelling wildfires and considering any other typology of vegetation fires only for the potential risk to become a wildfire
Unit
Prevalence in the cell area (%)
Projection
Native geospatial projection is EURO-CORDEX (https://euro-cordex.net). Available reprojection information for WGS84 and Lambert Azimuthal Equal-Area projection (ETRS89-LAEA).
Legend
<p style="text-align: center;">Low risk (aggregated fire risk) Prevalence in the cell area</p>  <p style="text-align: right;">[preliminary prototype approximation]</p>

Basic Layers- Fuel-Types

European Fuel Map classes: 10 categories of the NFFL or fire behavior models (Anderson, 1982). The last 3 categories of the NFFL models are not used in the European Fuel Map. The last class (other vegetation fuels) corresponds to the Potential burnable area proportion (i.e. % of burnable land) in the cell c : $PBAP_c$ minus the sum of all the other aggregated fuel types AFT^i_c :

Other vegetation fuels in the cell c (proportion), OVF_c

$$OVF_c = PBAP_c - \sum_i AFT^i_c$$

The image shows a user interface for 'Basic-Layers-Fuel-Types'. It features a list of 10 fuel types, each with a toggle switch, a download icon, and an info icon. The fuel types are:

- Fuel type 1: short grass
- Fuel type 2: grass/understory
- Fuel type 3: tall grass
- Fuel type 4: chaparral
- Fuel type 5: brush
- Fuel type 6: dormant brush
- Fuel type 7: southern rough
- Fuel type 8: closed timber litter
- Fuel type 9: hardwood litter
- Fuel type 10: timber (litter/und.)
- Other vegetation fuels

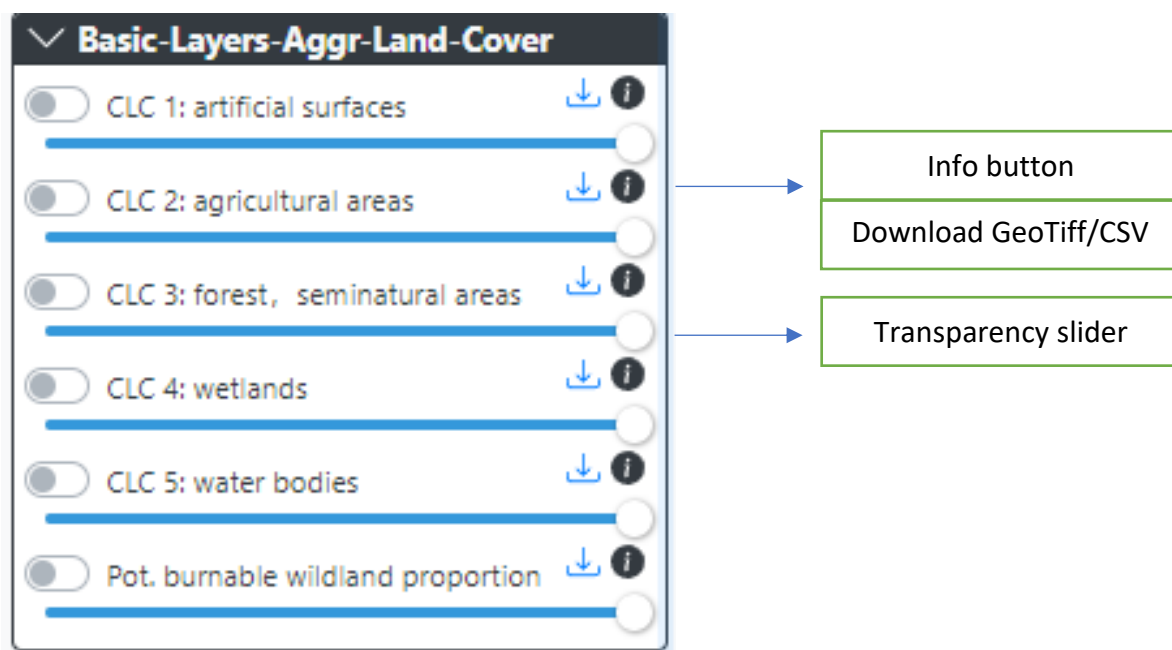
Callouts on the right side of the interface identify the 'Info button' and the 'Transparency slider'.

Fuel type	Description	Unit
Short grass	Pastures; sparse grasslands; temperate, Alpine and northern grasslands; coastal and inland halophytic vegetation and dunes	Percentage of cell area (%)
Grass and understory	Mediterranean grasslands and steppes; Mediterranean open shrublands (sclerophyllous); agroforestry areas	
Tall grass	Aquatic marshes	
Chaparral	Mediterranean shrublands (sclerophyllous) and shrublands in Mediterranean sclerophyllous forests; Mediterranean evergreen broadleaved forests	
Brush	Peat bogs; Mediterranean, temperate, Alpine and northern moors and heathlands; deciduous broadleaved shrublands (thermophilous); shrublands in thermophilous broadleaved forests, and in beech and mesophytic broadleaved forests; northern open shrublands in broadleaved forests; riparian vegetation	
Dormant bush	Wooded peatbogs; Alpine open shrublands (conifers)	
Southern rough	Shrublands in Mediterranean conifer forests (also montane ones), and in Alpine and northern conifer forests	
Closed timber litter	Mediterranean scale-needled open woodlands (juniperus, cupressus), and montane short needled conifer forest (firs, cedar); temperate conifer plantations; Alpine (fir, alpine spruce) and northern (spruce) short needled conifer forests	
Hardwood litter	Thermophilous (including mixed with conifers) and Mesophytic broadleaved forests; beech forest; mixed beech with conifers forest	
Timber (litter and understory)	Mediterranean long needled conifer forests (Mediterranean pines), including montane ones (black and scots pines); Alpine (pines) and northern (scots pine) long needled conifer forests; montane beech forest; white birch boreal forest; mixed forest: mesophytic broadleaved with conifers	
Other vegetation fuels	Burnable vegetation not categorised in the previous fuel types	

Corine Land Cover (CLC) was used as a first proxy to assess the vegetation classes most affected by fires. CLC, initiated by the European Union in 1985, consists of 44 land cover classes (Bossard et al., 2000) with a Minimum Mapping Unit (MMU) of 25 hectares (ha) and a minimum feature width of 100 m providing a harmonized description of the land use and land change (LULC) in Europe over the last 30 years). Validation assessments were performed for the changes between CLC2000 and CLC2006 (Buttner et al., 2011) achieving accuracies of around 85%.

The classes correspond to the Potential burnable area proportion (i.e. % of burnable land) in the cell c : $PBAP_c$ for five aggregated classes of CLC: Artificial surfaces, agricultural areas, forest and semi-natural areas, wetlands and water bodies.

The last class (Potential burnable wildland proportion) corresponds to the proportion of potentially burnable areas in the aggregated wildland classes of CLC (Forest and semi-natural areas, Wetlands and Water bodies).



Please see <https://land.copernicus.eu/user-corner/technical-library/clc-product-user-manual> annex I to have the full description of the aggregation schema.

Basic Layers- Land Cover

The image shows a user interface for the 'Basic Layers-Land-Cover' section. It features a list of 14 CLC classes, each with a toggle switch, a slider, and two buttons (download and info). The classes are:

- CLC 111: continuous urban fabric
- CLC 112: discontinuous urban fabric
- CLC 121: industrial, commercial unit
- CLC 122: road and rail networks
- CLC 123: port areas
- CLC 124: airports
- CLC 131: mineral extraction sites
- CLC 132: dump sites
- CLC 133: construction sites
- CLC 141: green urban areas
- CLC 142: sport, leisure facilities
- CLC 211: non-irrigated arable land
- CLC 212: permanently irrigated land

Callouts indicate the following features:

- Info button
- Download GeoTiff/CSV
- Transparency slider

Please see <https://land.copernicus.eu/user-corner/technical-library/clc-product-user-manual> annex I to have the full description of all the CLC classes.

Download data

Each layer can be downloaded clicking in the upper button



The file downloaded has the *var-name_of_the_layer.zip*. Each *zip* file contains three files:

1. *var-name_of_the_layer.tif* ----- Geotif file

Coordinate Reference System (CRS)	
Name	EPSG:3035 - ETRS89-extended / LAEA Europe
Units	meters
Method	Lambert Azimuthal Equal Area
Celestial body	Earth
Accuracy	Based on <i>European Terrestrial Reference System 1989 ensemble</i> (EPSG:6258), which has a limited accuracy of at best 0.1 meters .
Reference	Static (relies on a datum which is plate-fixed)

2. *README_var-name_of_the_layer.txt*

3. *var-name_of_the_layer.csv*

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