ESA Climate Change Initiative – Fire_cci
D3.3.5 Product User Guide – Sentinel-1 South America (PUG-S1SA)

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Summary

This document is Product User Guide for the Sentinel-1 Burned Area product for a Large Demonstrator Area in South America, version 1.0, of the Fire_cci project.

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Prepared	UAH UAH	Miguel A. Belenguer-Plomer M. Lucrecia Pettinari	08/07/2019
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1. General overview

This document contains practical information on how to use the FireCCIS1SA10 product of the Fire_cci project, which is based on the C-SAR Instrument on board the ESA Sentinel-1 (S1) satellite.

1.1. Introduction

The FireCCIS1SA10 product comprises maps of burned area from a Large Demonstrator Area in tropical South America (Figure 1). It was developed and tailored for its use by climate, vegetation and atmospheric modellers, as well as by fire researchers or fire managers interested in spatially detailed burned patterns.

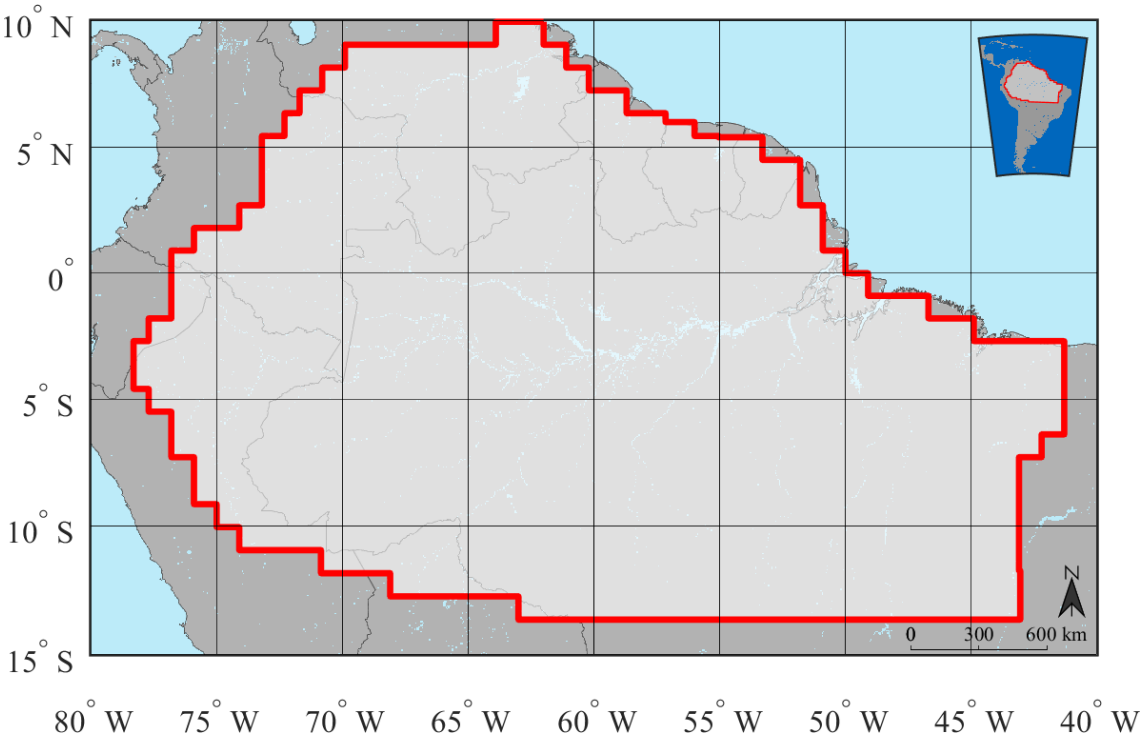

Figure 1: Region of the Amazon where the FireCCIS1SA10 product was generated.

1.2. Available data and key features of the S1 SAR images

The input images for the FireCCIS1SA10 product were Ground Range Detected (GRD) dual-polarized (vertical-vertical VV, and vertical-horizontal VH polarizations) SAR images acquired by the Sentinel-1 A/B satellites in interferometric wide (IW) swath mode. Since the observation scenario of Sentinel-1 for Amazon in 2017 did not provide images every 6 days, the algorithm was designed to work with a lower temporal resolution.

The pre-processing was carried out with Orfeo ToolBox (OTB), developed by the Centre for the Study of the Biosphere from Space (CESBIO). The pre-processing steps included data download (ascending and descending passes), calibration to gamma nought and multi-look to the desired spatial resolution. The geocoding steps include orthorectification to the desired spatial resolution, subset Sentinel-1 data to the current processing tile as well as slice assembly for data acquired from the same orbital path but provided within different slices. The last step of the OTB chain is multi-temporal filtering

of the products according to satellite pass. The BA algorithm used for producing the final Fire_cci BA product is described in the Algorithm Theoretical Basis Document (Tanase and Belenguer-Plomer, 2018) and in Belenguer-Plomer et al. (2019).

2. Pixel BA product

The FireCCIS1SA10 product is a GeoTIFF file with three layers indicating the date of detection (Figure 2), the confidence level and the land cover in the pixel detected as burned (see Section 2.6 for further detail).

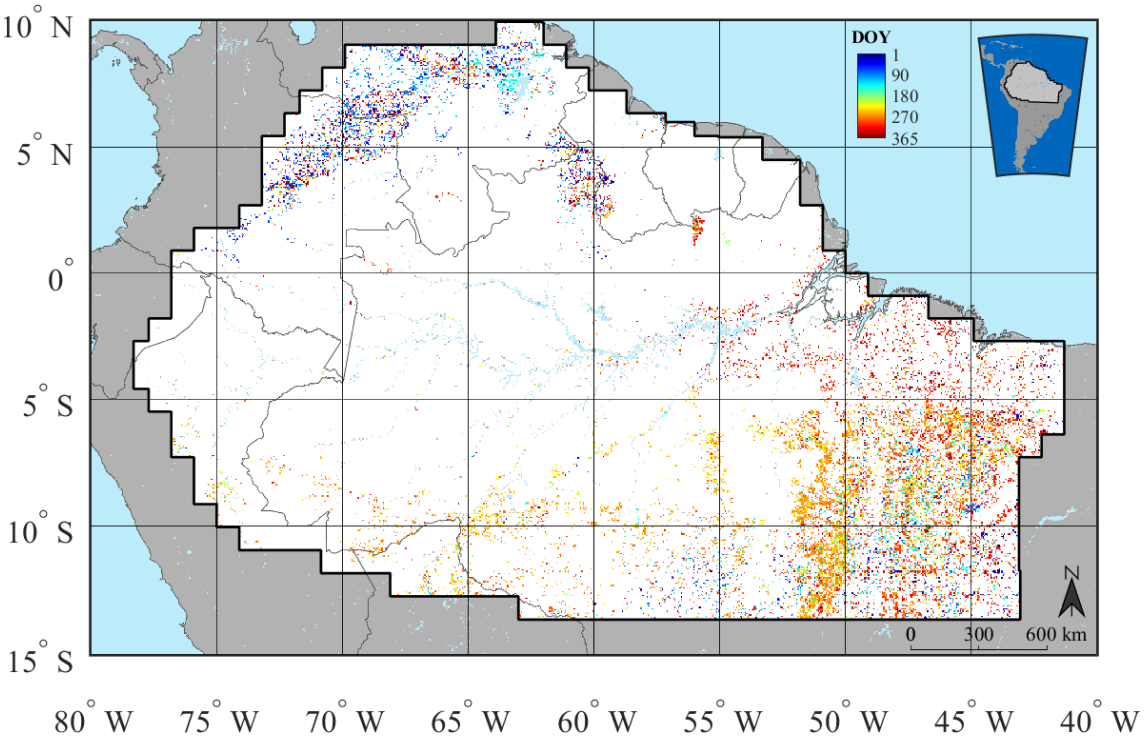

Figure 2: Day of detection for all the subsets in 2017, derived from the pixel product.

2.1. Temporal compositing

The pixel products are released as monthly composites so they can encompass those pixels that burn more than once during a calendar year.

2.2. Spatial Resolution

The Spatial resolution of this BA product is 0.000359326 degrees (approximately 40 m at the Equator). The pixel spacing was reduced from 20 m (Sentinel-1 resolution in range) to a 40 m since this presented a better trade-off between computing time and accuracy.

2.3. Product projection system

The Coordinate Reference System (CRS) used for the BA products is a geographic coordinate system (GCS) based on the World Geodetic System 84 (WGS84) reference ellipsoid and using a Plate Carrée projection with geographical coordinates of equal pixel size. The coordinates are specified in decimal degrees. Information on product projection, ellipsoid and pixel size is included in the GeoTIFF file header, so every pixel in the file

can be geographically referenced without the need of adding specific pixel indicators of geographical position.

2.4. Subsets

The BA product is distributed in 5x5 degree tiles, each one a non-overlapping region, covering the Amazon rain forest. Figure 3 shows the extent of these tiles.

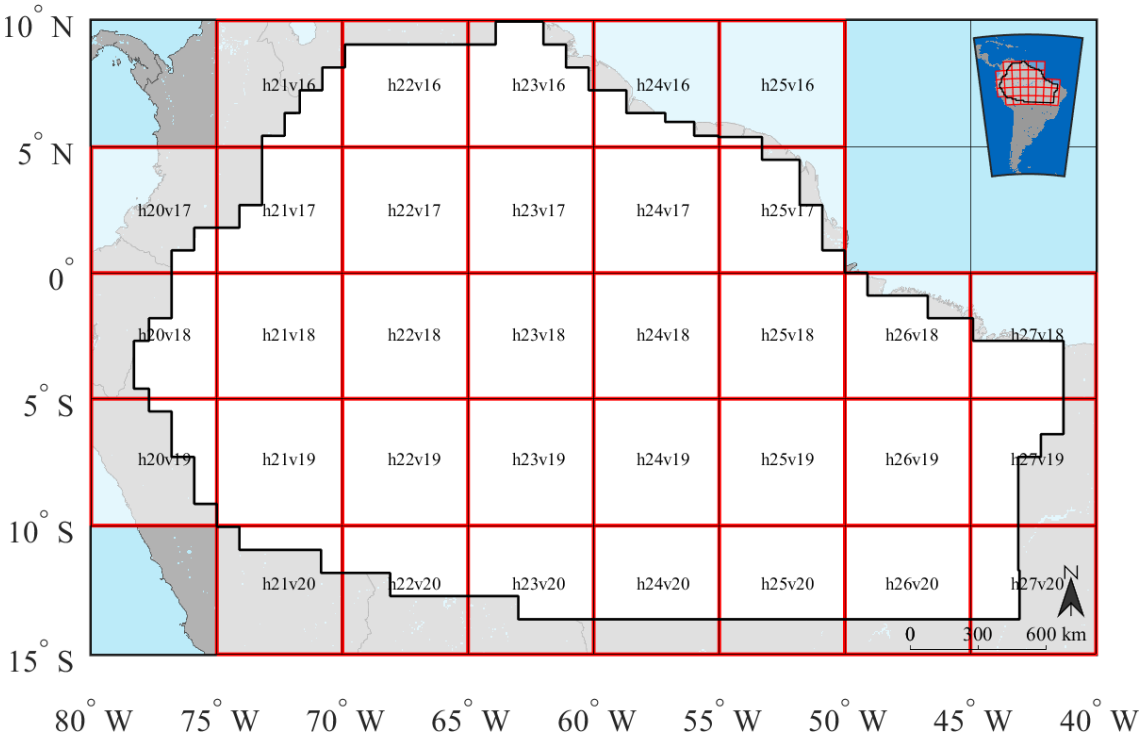

Figure 3: Geographical distribution of subsets of the FireCCIS1SA10 product.

2.5. Product file naming conventions

The files for each sensor and month are named as follows:

<Indicative_Date>-ESACCI-L3S_FIRE-BA-<Indicative_Sensor> -<Additional_ Segregator>-fv<File_Version>-<Layer>.tif

<Indicative_Date>

The identifying date for this data set:

Format is YYYYMMDD, where YYYY is the four-digit year; MM is the two-digit month from 01 to 12 and DD is the two-digit day of the month from 01 to 31. For monthly products DD=01.

< **Indicative Sensor**>
For version 1.0 of the product, the sensor is SAR.

<Additional_Segregator>

This is AREA_<TILE_NUMBER> being the tile number the subset index described in Section 2.4.

<**File_Version**>

File version number in the form n{1,}[.n{1,}] (That is 1 or more digits followed by optional . and another 1 or more digits). The most recent version is fv1.0.

<Layer>

As each layer is provided as an individual GeoTIFF file, the code of each layer is:

- JD: layer 1, corresponding to the Julian day, or day of the year of detection of the BA.
- CL: layer 2, corresponding to the confidence level
- LC: layer 3, corresponding to the land cover

Example:

20170101-ESACCI-L3S_FIRE-BA-SAR-AREA_h20v17-fv1.0-JD.tif

2.6. Pixel attributes

The following sub-sections describe each of the layers of the pixel product, including the name of the attributes in the GeoTIFF file, the units of the attributes and the data type, and some information useful for the correct use of the product. They also include examples of the pixel product layers.

2.6.1. Layer 1: Date of the first detection

Layer	Attribute	Units	Data Type	Notes
1 (JD)	Date of the first detection	Day of the year, from 1 to 366	Integer	Possible values: • 0 (zero): when the pixel is not burned. • 1 to 366: day of the first detection when the pixel is burned. • -1: when the pixel is not observed in the month. • -2: used for pixels that are not burnable: water bodies, bare areas, urban areas, permanent snow and ice.

When the pixel is characterized as burned, it is assumed that the complete pixel was burned, as for all BA products.

The date of the burned pixel (usually also called day of the year or Julian day) may not be coincident with the actual burning date, and it could correspond to several days afterwards, depending on image availability

An example of this layer corresponding to September 2017 is shown in Figure 4.

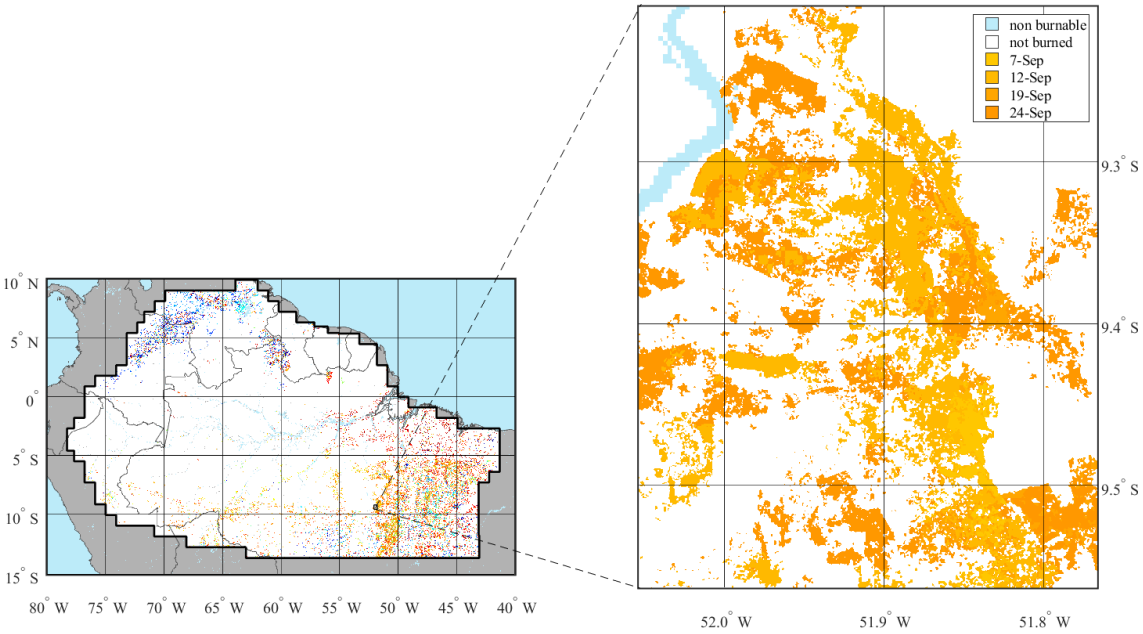

Figure 4: Example of the Date of the first detection in September 2017

2.6.2. Layer 2: Confidence level

Layer	Attribute	Units	Data Type	Notes
2 (CL)	Confidence level	0 to 100	Integer	Probability of detecting a pixel as burned. Possible values: - 0 (zero): when the pixel is not observed in the month, or it is not burnable. - 1: value assigned when the pixel was observed, but it was classified as not burned. - 2 to 100: Probability values. The closer to 100, the higher the confidence that the pixel is actually burned.

The confidence level was based on the statistical similarity of temporal radar indices between each pixel with the mean of burned regions of interest of the same land cover type observed. The original probability values were rescaled, in order to provide values easier to understand by users. The technical details are explained in Tanase and Belenguer-Plomer (2018).

An example of this layer corresponding to September 2017 is shown in Figure 5.

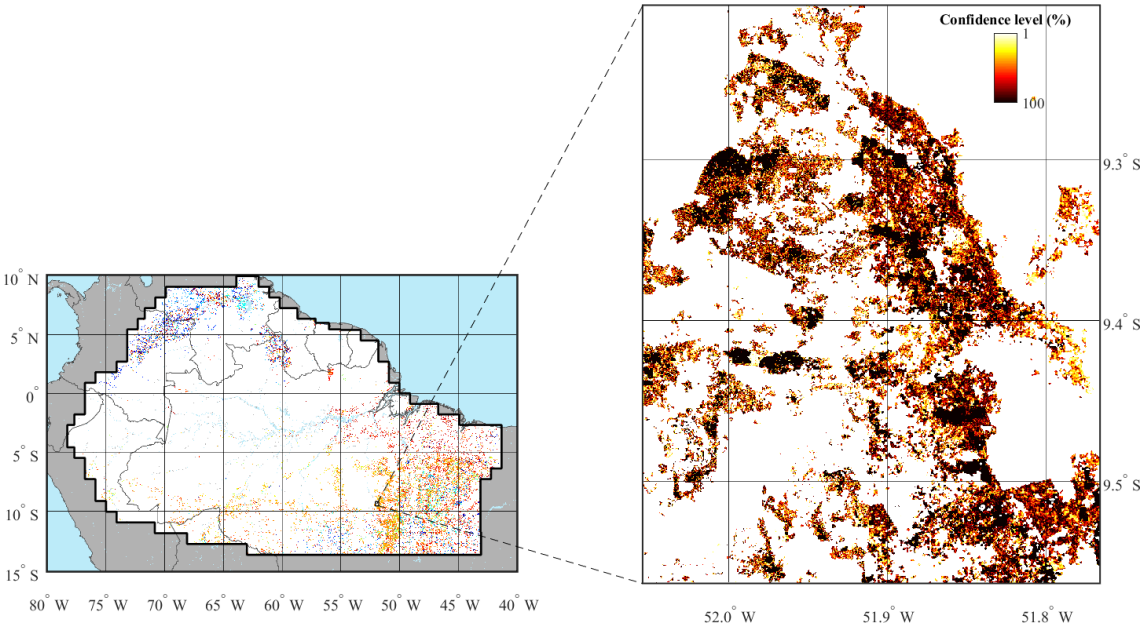

Figure 5: Example of the Confidence Level layer in September 2017

2.6.3. Layer 3: Land cover of burned pixels

Layer	Attribute	Units	Data Type	Notes
3 (LC)	Land cover of burned pixels	0 to N	Byte	Possible values: • 0 (zero): when the pixel is not burned in the month, either because it was observed and not classified as burned, or because it is non burnable or was not observed. • 10 to 180: land cover code when the pixel is burned (codes listed in Annex 1). Land cover of the pixel detected as burned, extracted from the Land Cover CCI maps (see Section 2.8).

It is assumed that there is only one land cover within the pixel, as in most land cover maps. This is a reasonable estimation for homogenous land cover areas, but it may imply errors for heterogeneous landscapes. The basic land cover map is the CCI Land Cover map (see Section 2.7). Obviously, errors included in this map also affect the information contained in the BA product and hence the calculation of emissions using land cover based emissions factors would be affected. The resolution of the land cover map is much coarser than the BA, and was resampled from its original spatial resolution (approx. 300 m at the Equator) to the resolution of the pixel product.

An example of this layer corresponding to September 2017 is shown in Figure 6.

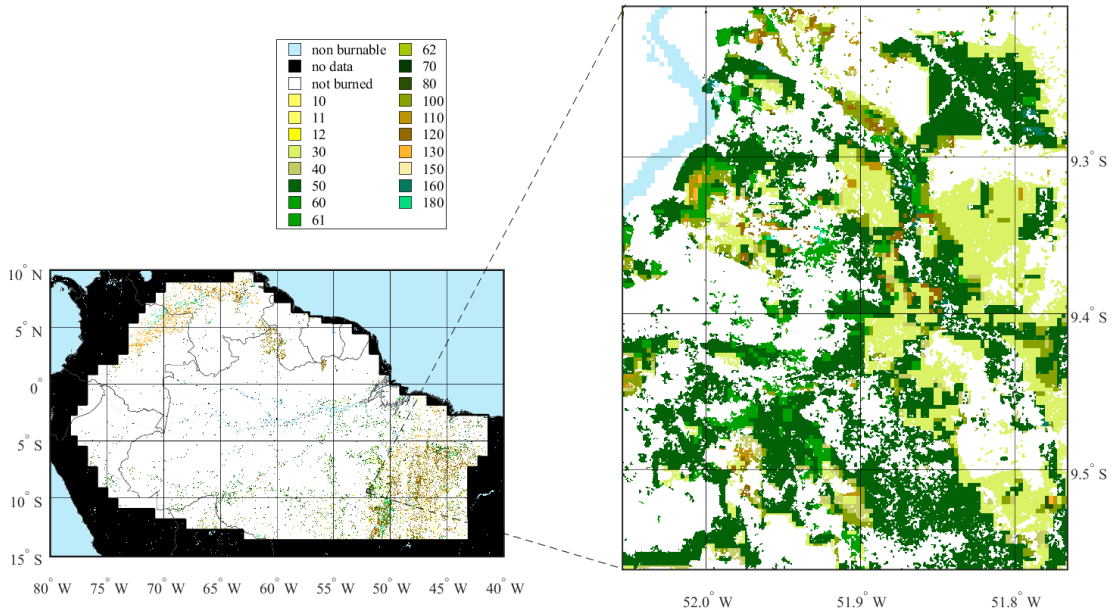

Figure 6: Example of the Land Cover of burned pixels layer for Amazon 2017. The description of the land cover categories is in Annex 1.

2.7. Land Cover information

The land cover information was selected to provide information about the pre-fire land cover category, and for this reason the reference land cover used is the closest available product prior to the year being processed. The land cover assigned to the pixel detected as burned was extracted from the LC_cci product (ESA 2017) to assure consistency with other variables within the CCI programme.

For the FireCCIS1SA10 products, the LC_cci v2.0.7 was used (ESA 2017). This product offers annual land cover files that cover the period 1992 – 2015. For the burned area product of 2017 the last available year of land cover data (2015) was used.

The land cover categories included in the BA product are listed in Annex 1.

2.8. File metadata

For each BA file product, an additional xml file with the same name is created. This file holds the metadata information following the ISO 19115 standard. The description of the populated fields is included in Annex 2.

3. Product assessment

The algorithm used to generate this pixel product was preliminary assessed using a sample set of 44 areas selected in different locations, in a similar way as in Padilla et al. (2014). The overall omission and commission errors (OE and CE) were 36% and 37% respectively (methods and results explained in Fernandez-Carrillo et al. (2018)).

4. Data dissemination

The FireCCIS1SA10 product is freely available from the Fire_cci website: https://www.esa-fire-cci.org.

5. References

Belenguer-Plomer, M. A., Tanase, M. A., Fernandez-Carrillo, A., & Chuvieco, E. (2019). Burned area detection and mapping using Sentinel-1 backscatter coefficient and thermal anomalies. Remote Sensing of Environment, 233, 111345.

ESA. Land Cover CCI Product User Guide Version 2. Tech. Rep. (2017). Available at: http://maps.elie.ucl.ac.be/CCI/viewer/download/ESACCI-LC-Ph2-PUGv2_2.0.pdf.

Fernandez-Carrillo, A., Belenguer-Plomer, M. A., Chuvieco, E., & Tanase, M. A. (2018). Effects of sample size on burned areas accuracy estimates in the Amazon Basin. In Earth Resources and Environmental Remote Sensing/GIS Applications IX (Vol. 10790, p. 107901S). International Society for Optics and Photonics.

Tanase M.A., Belenguer-Plomer, M.A. (2018) ESA CCI ECV Fire Disturbance: O3.D1 Algorithm Theoretical Basis Document (ATBD) – S1 South America, version 2.0. Available at: https://www.esa-fire-cci.org/documents

Padilla M., Chuvieco E. (2014) ESA CCI ECV Fire Disturbance: Product Validation Report I, version 2.0.

Annex 1: Land cover categories (extracted from LC_cci)

LC number		Class name	Fire_cci number
1st level	2nd level		
0		No data	**0**
10		Cropland, rainfed	**10**
	11	*Herbaceous cover*	***10***
	12	*Tree or shrub cover*	***10***
20		Cropland, irrigated or post-flooding	**20**
30		Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover) (<50%)	**30**
40		Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland (<50%)	**40**
50		Tree cover, broadleaved, evergreen, closed to open (>15%)	**50**
60		Tree cover, broadleaved, deciduous, closed to open (>15%)	**60**
	61	*Tree cover, broadleaved, deciduous, closed (>40%)*	**60**
	62	*Tree cover, broadleaved, deciduous, open (15-40%)*	**60**
70		Tree cover, needleleaved, evergreen, closed to open (>15%)	**70**
	71	*Tree cover, needleleaved, evergreen, closed (>40%)*	***70***
	72	*Tree cover, needleleaved, evergreen, open (15-40%)*	***70***
80		Tree cover, needleleaved, deciduous, closed to open (>15%)	**80**
	81	*Tree cover, needleleaved, deciduous, closed (>40%)*	***80***
	82	*Tree cover, needleleaved, deciduous, open (15-40%)*	***80***
90		Tree cover, mixed leaf type (broadleaved and needleleaved)	**90**
100		Mosaic tree and shrub (>50%) / herbaceous cover (<50%)	**100**
110		Mosaic herbaceous cover (>50%) / tree and shrub (<50%)	**110**
120		Shrubland	**120**
	121	*Shrubland evergreen*	***120***
	122	*Shrubland deciduous*	***120***
130		Grassland	**130**
140		Lichens and mosses	**140**
150		Sparse vegetation (tree, shrub, herbaceous cover) (<15%)	**150**
	152	*Sparse shrub (<15%)*	***150***
	153	*Sparse herbaceous cover (<15%)*	***150***
160		Tree cover, flooded, fresh or brackish water	**160**
170		Tree cover, flooded, saline water	**170**
180		Shrub or herbaceous cover, flooded, fresh/saline/brackish water	**180**

Note: Only the level 1 classes are considered, so the subdivisions have the number of broader categories. Only vegetated LC classes have been considered.

Annex 2: Metadata of the pixel product (XML file)

In each XML file corresponding to the pixel product, the following fields are populated:

- Universal Unique Identifier
- Language
- Contact
- Date stamp
- Metadata Standard Name
- Reference System
- Citation
  - Title
  - Creation date
  - Publication date
  - Abstract (contains information about each layer)
- Point of Contact
  - Resource provider
  - Distributor
  - Principal investigator
  - Processor
- Keywords
- Resource constraints
- Spatial resolution
- Extent:
  - Geographical extent
  - Temporal extent

Annex 3: Acronyms and abbreviations

BA	Burned Area
C-SAR	C-band SAR
CCI	Climate Change Initiative
CE	Commission Error
CESBIO	CEntre for the Study of the BIOsphere from space
CRS	Coordinate Reference System
ECV	Essential Climate Variables
ESA	European Space Agency
GCS	Geographic Coordinate System
GRD	Ground Range Detected
IW	Interferometric wide swath mode
LC	Land Cover
OE	Omission Error
OTB	Orfeo Toolbox
PUG	Product User Guide
S1	Sentinel-1
SAR	Synthetic Aperture Radar
VH	Vertical-horizontal polarization
VV	Vertical-vertical polarization
WGS84	World Geodetic System 84