FIRE_CCI

Object-based burned area detection and related fire emission estimations based on Sentinel-1 data applied in Tropical Africa

D6

Burned area Africa

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1 General overview

The aim of this task is the application of the burned area algorithm developed for Indonesia in another tropical test site. The site in Tropical Africa was specified in coordination with the fire_cci consortium. This short report is an extension to the ATBD (Fire_cci_Ph1_RSS_D1_ATBD_v1_2) and the AID (Fire_cci_Ph2_RSS_D5_AID_V1_1) explaining the content of deliverable D6.

2 Methods

2.1 Burned area

A detailed description of the burned area methodology can be found in the ATBD (Fire_cci_Ph1_RSS_D1_ATBD_v1_2). For the African test site dual-pol data (VV/VH) was available, but only VV polarization was used because our algorithm is based only on this data. In total, 16 Sentinel-1 scenes were processed between 04 November 2015 and 16 December 2016 taking into account relatively dry conditions (Table 1). An analysis of the fire season and precipitation data can be found in the AID (Fire_cci_Ph2_RSS_D5_AID_V1_1).

Table 1: Sentinel-1 data used for burned area mapping of the African test site.

Area	Polarization	Relative Orbit	Pass	Acquisition date
African test site	VV/VH	161	ascending	04.11.2015
African test site	VV/VH	161	ascending	16.11.2015
African test site	VV/VH	161	ascending	28.11.2015
African test site	VV/VH	161	ascending	10.12.2015
African test site	VV/VH	161	ascending	22.12.2015
African test site	VV/VH	161	ascending	03.01.2016
African test site	VV/VH	161	ascending	15.01.2016
African test site	VV/VH	161	ascending	27.01.2016
African test site	VV/VH	161	ascending	08.02.2016
African test site	VV/VH	161	ascending	20.02.2016
African test site	VV/VH	161	ascending	03.03.2016
African test site	VV/VH	161	ascending	15.03.2016
African test site	VV/VH	161	ascending	27.03.2016
African test site	VV/VH	161	ascending	08.04.2016
African test site	VV/VH	161	ascending	20.04.2016
African test site	VV/VH	161	ascending	16.12.2016

2.1 Fire emission estimation

Fire emission estimations were derived from burned vegetation emissions calculated on the basis of the intersection of spatially explicit burned area maps with the ESA CCI land cover classification using IPCC default emission factors [1].

Emissions were calculated using a stratify and multiply approach. Vegetation emission estimation was performed by intersecting classified burned areas with a thematic map of land cover class or vegetation type [2]. We utilized the most recent ESA CCI land cover map from 2015 at a spatial resolution of 300 m [3]. Mean AGB values for each land cover class were determined from IPCC default values [1]. The AGB

information was then converted to emissions (Mt CO2e) by assuming a carbon content of 50 % in dry biomass and a conversion factor of 3.67 from C to CO2e. Biome-averaged values for fire efficiency (fraction of fuel exposed to a fire that was actually consumed or volatilized) were used [4]. A detailed list of the specific AGB values per land cover class together with steps for simplified emission estimation can be found in the results section.

3 Results

3.1 Burned area

Figure 1 shows mapped burned areas derived from Sentinel-1 in the African test site subset as well as the date of the detected burned areas. The classified burned area amounts to 15,564 ha; most burned areas were detected in the southern part of the study site.

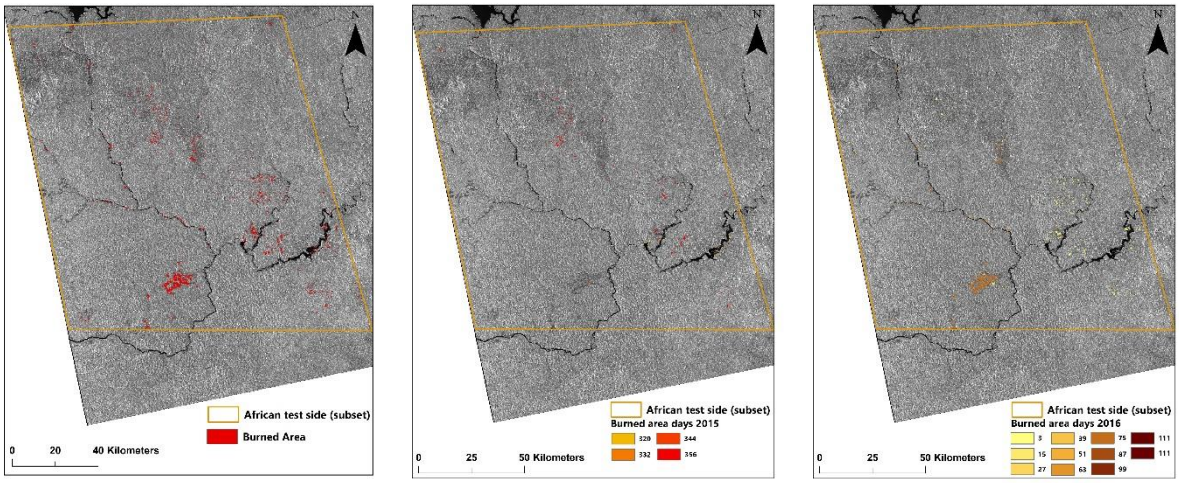

Figure 1: Spatial distribution of Sentinel-1 burned areas in the African test site subset (left). The date of detected burned areas is depicted for the year 2015 in the middle panel and for the year 2016 in the right panel.

3.1 Fire emissions estimation

The detailed emission estimation for the subset area per land cover class is depicted in Table 2. Total estimated fire emissions amount to 2.37 Mt CO2e.

Table 2: Burned area statistics and derived estimated emissions for each of the ESA CCI land cover classes.

ESA CCI LC Code	ESA CCI LC Name	Area (ha)	AGB (t/ha) IPCC	CO2 equivalents / ha	emissions CO2 (Mt)	fire efficency factor [4]	corrected CO2e (Mt)
10	Cropland, rainfed	172.84	41	75.24	0.01	0.75	0.01
11	Herbaceous cover	22.86	6	11.38	0.00	0.81	0.00
30	Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover) (<50%)	392.56	41	75.42	0.03	0.75	0.02
40	Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland (<50%)	1,102.89	39	71.69	0.08	0.47	0.04
50	Tree cover, broadleaved, evergreen, closed to open (>15%)	3,579.78	310	568.85	2.04	0.49	1.00
60	Tree cover, broadleaved, deciduous, closed to open (>15%)	78.04	260	477.10	0.04	0.49	0.02
62	Tree cover, broadleaved, deciduous, open (15-40%)	8,532.58	160	293.60	2.51	0.49	1.23
100	Mosaic tree and shrub (>50%) / herbaceous cover (<50%)	299.52	38	69.91	0.02	0.47	0.01
110	Mosaic herbaceous cover (>50%) / tree and shrub (<50%)	1,229.55	38	69.91	0.09	0.47	0.04
120	Shrubland	129.64	70	128.45	0.02	0.47	0.01
170	Tree cover, flooded, saline water	5.90	260	477.10	0.00	0.49	0.00
190	Urban areas	0.08	0	0.00	0.00	0.00	0.00
210	Water bodies	18.14	0	0.00	0.00	0.00	0.00
	Total	**15,564**					**2.37**

The land cover classes *Tree cover, broadleaved, evergreen, closed to open (>15%)* and *Tree cover, broadleaved, deciduous, open (15-40%)* had the largest share of burned areas and produced most of the fire emissions (Figure 2 and Figure 3).

The comparison of classified burned area and number of MODIS hotspots per land cover class shows that burned areas occurring in the forest classes (LC codes 50 and 62) agree very well with the relative

number of hotspots in these land cover classes. However, there is a relatively large share of MODIS hotspots in the shrub land class (class code 100) in which almost no burned areas were mapped with Sentinel-1.

It should be noted that burned areas were classified in apparently non-burnable land cover classes (e.g. urban areas, water) which is most likely due to the different spatial resolution (300 m compared to 10 m).

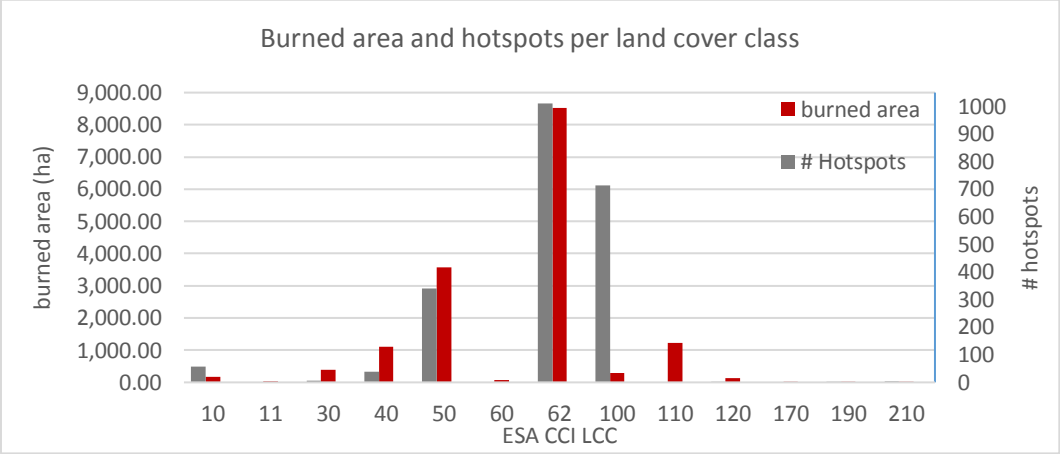

Figure 2: Burned area and number of MODIS hotspots per ESA CCI Land cover class (class codes see Table 2).

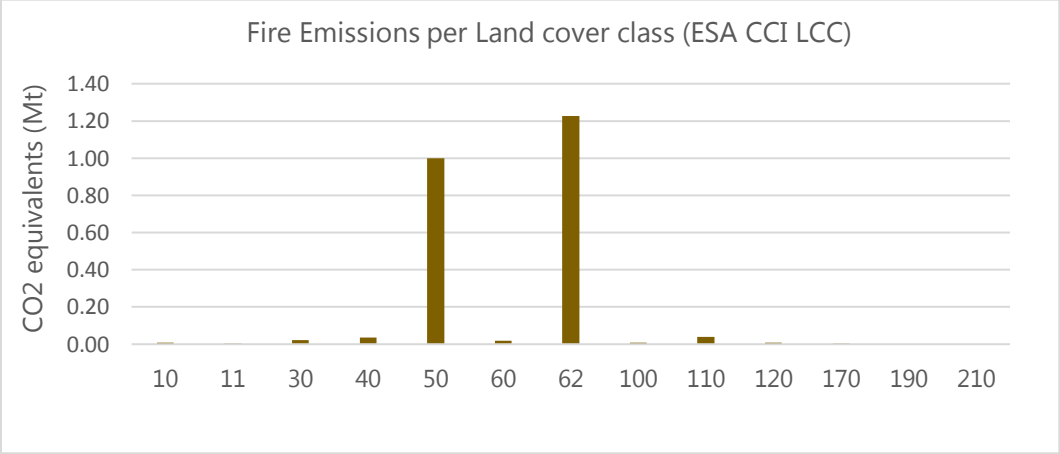

Figure 3: Fire emissions per ESA CCI land cover class (class codes see Table 2).

4 Conclusion

To conclude this analysis, it is obvious that our algorithm works very well in tropical forest ecosystem for which it was developed. The application in tropical rain forests showed that there is a good match of mapped burned area and relative number of MODIS hotspots in this area. In contrast, burned areas in the shrub land cover class are not very well classified with our developed burned area algorithm. This might be due to the fact that the signal of burned areas in Sentinel-1 imagery in this land cover class is very different from those in Indonesia. An example of the SAR burned area signal is depicted in Figure 3 in the AID (Fire_cci_Ph2_RSS_d5_AID_V1_1).

5 Products

The final products include burned area maps for the subset area, pre-fire land cover classification and related carbon dioxide emissions (depicted in Table 3).

The burned area product has two layers (exactly the same product as delivered for Indonesia 2016). The first layer contains burned and not-burned information. The second layer contains the enhanced information of the date on which the burned area was detected.

Table 3: Emission database based on different ESA cci land cover classes for the African subset area from November 2015 until December 2016.

		Emissions
	Dataset	**African test site (subset)**
Vegetation emissions	*ESA CCI LC*	**2.37 Mt CO_2e**

The products can be downloaded from our FTP server:
ftp://CCI_Indonesia:3urned_RSS@ftp2.rssgmbh.de

Or ftp://ftp2.rssgmbh.de/
User: CCI_Indonesia
Password: 3urned_RSS