Global Wilfire Information System (GWIS)
Biomass burning emission tools

Duarte Oom & GWIS team

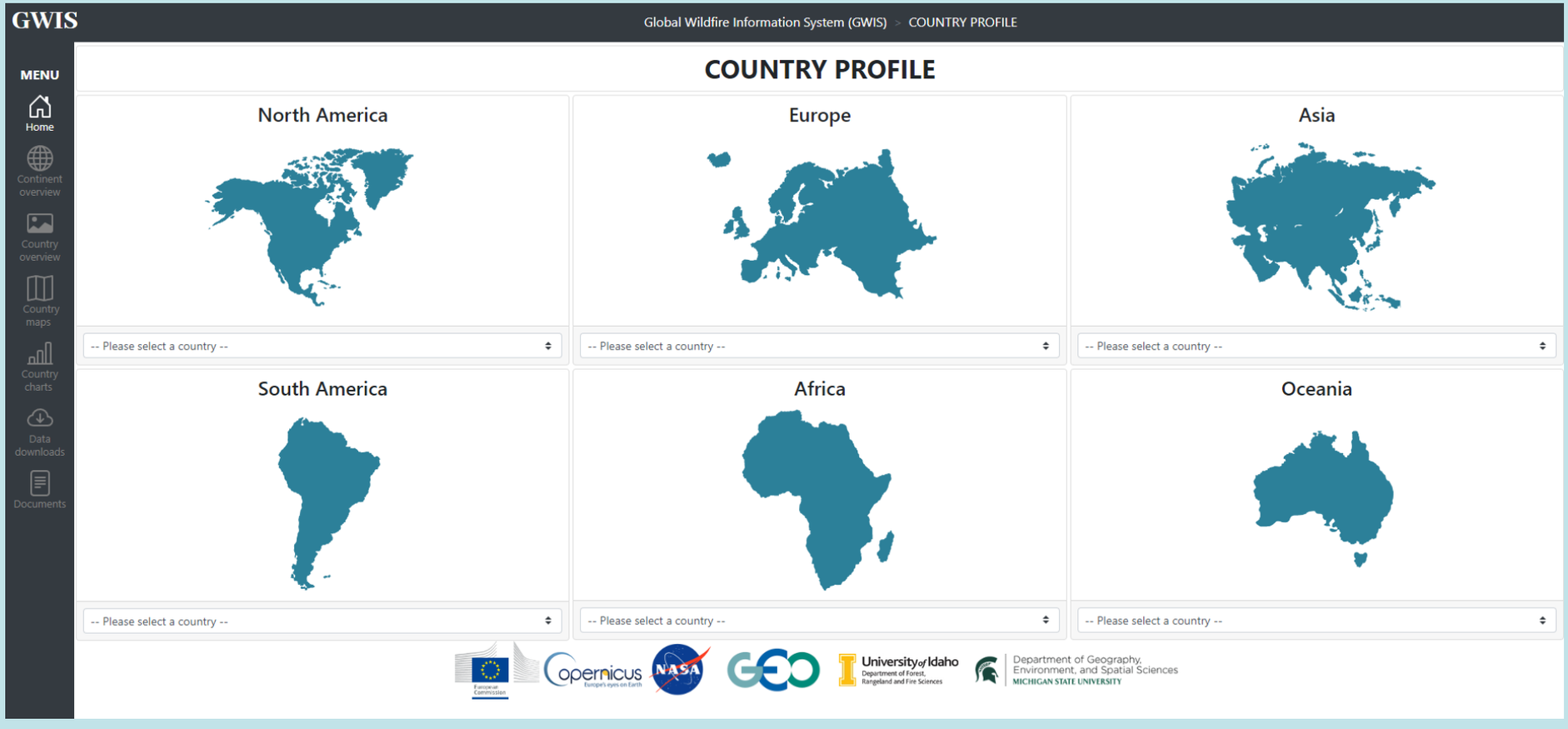
with inputs from Luigi Boschetti & Monica Crippa

5th GWIS Nd GOFC-GOLD Fire IT meeting

21st- 23rd June 2022

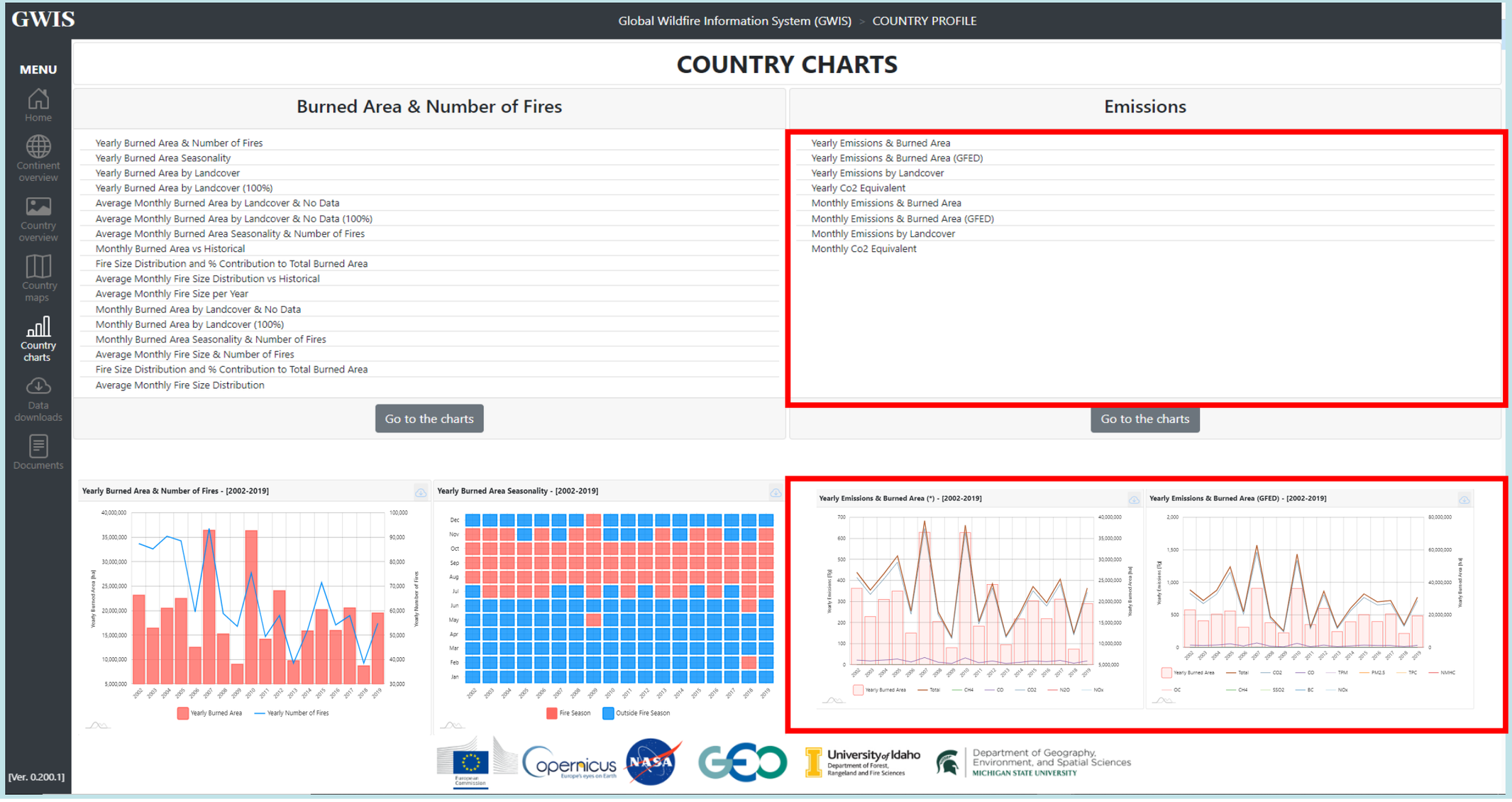
European Commission

GWIS Country profiles



https://gwis.jrc.ec.europa.eu/apps/country.profile/

GWIS Country profiles/charts



GWIS Country profiles/charts/Emissions

- Generating global, multiyear greenhouse gas emission estimates from remote sensing datasets

IPCC Tier-1 methodology

Tier 1 estimates of GHG emissions **based on the 2006 AFOLU IPCC Guidelines** by using burned area activity data from the **MCD64A1**, Collection 6 stratified by landcover

GFED4.1s

Estimates for 2017 based on relations between MODIS active fire detections and GFED4s for 2003-2016.

GFEDvs5?

GFAS

The CAMS Global Fire Assimilation System (GFAS) assimilates fire radiative power (FRP) observations from satellite-based sensors to produce daily estimates of wildfire and biomass burning emissions.

GWIS Country profiles/charts/Emissions

- **IPCC Tier 1 reporting of greenhouse gas emissions: bottom up emission estimation: general formulas and stratification by landcover and geographic area**

The 2006 IPCC Guidelines present a generic equation for the estimation of biomass and peat fires emissions, based on the bottom-up approach first proposed by Seiler and Crutzen (1980):

$$L_{fire,x,v} = A_v * M_{B,v} * C_{f,v} * G_{ef,x,v} \quad (1)$$

where:

- $L_{fire,x,v}$ are GHG emissions of gas x, for a given vegetation type v, at a given time;
- A_v is the burned area with vegetation cover v;
- $M_{B,v}$ is the biomass fuel available for combustion of vegetation type v, including biomass, dead wood, and ground litter;
- $C_{f,v}$ is a combustion factor, indicating the efficiency of combustion of vegetation type v; and
- $G_{ef,x,v}$ is the emission factor for gas x and for the vegetation type v.

IPCC Tier-1 methodology

In a Tier 1 assessment (simpler approach), the parameters of equation 1 are typically not available for each pixel, but static/reference values are used instead, for instance those given by the 2006 IPCC AFOLU/Wetlands supplement guidelines stratified by landcover class

$$L_{fire,x,v} = A_v * M_{B,v} * C_{f,v} * G_{ef,x,v} \quad (1)$$

TABLE 2.4
FUEL (DEAD ORGANIC MATTER PLUS LIVE BIOMASS) BIOMASS CONSUMPTION VALUES (TONNES DRY MATTER HA^{-1}) FOR FIRES IN A RANGE OF VEGETATION TYPES
(To be used in Equation 2.27 , to estimate the product of quantities ' $M_B \bullet C_f$ ' , i.e., an absolute amount)

TABLE 2.6
ORGANIC SOIL FUEL CONSUMPTION VALUES
(MASS OF DRY MATTER FOR A RANGE OF ORGANIC SOIL AND FIRE TYPES, TO BE USED IN CONJUNCTION WITH EQUATION 2.8, TO ESTIMATE THE PRODUCT OF QUANTITIES M_B AND C_F)

TABLE 2.5
EMISSION FACTORS (g kg^{-1} DRY MATTER BURNT) FOR VARIOUS TYPES OF BURNING. VALUES ARE MEANS ± SD AND ARE BASED ON THE COMPREHENSIVE REVIEW BY ANDREAE AND MERLET (2001)
(To be used as quantity 'G_{ef}' in Equation 2.27)

TABLE 2.7
EMISSION FACTORS (G KG^{-1} DRY MATTER BURNT) FOR ORGANIC SOIL FIRES. VALUES ARE MEANS ± 95% CI (TO BE USED AS QUANTITY G_{EF} IN EQUATION 2.8)

2014, 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands, Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. and Troxler, T.G. (eds). Published: IPCC, Switzerland

IPCC (2006) IPCC Guidelines for National Greenhouse Gas Inventories – Volume 4. Egglestone HS, Buendia L,Miwa K, Ngara T, Tanabe K (Eds), IPCC/TFI

Rossi, S., Tubiello, F. N., Prosperi, P., Salvatore, M., Jacobs, H., Biancalani, R., ... & Boschetti, L. (2016). FAOSTAT estimates of greenhouse gas emissions from biomass and peat fires. Climatic Change, 135(3), 699-711.

Prosperi, P., Bloise, M., Tubiello, F. N., Conchedda, G., Rossi, S., Boschetti, L., ... & Bernoux, M. (2020). New estimates of greenhouse gas emissions from biomass burning and peat fires using MODIS Collection 6 burned areas. Climatic Change, 161(3), 415-432.

IPCC Tier-1 methodology

$$L_{fire,x,v} = A_v * M_{B,v} * C_{f,v} * G_{ef,x,v} \quad (1)$$

$$L_{lc} = A_{lc} \times Mb_{lc} \times Cf_{lc} \times Gef_{lc}$$

Where:

L_{lc} [g] is the quantity of emitted gas or particulate for **landcover** class *lc*

A_{lc} [m^2] is the total area burned in **landcover** class *lc*

Mb_{lc}, Cf_{lc} and Gef_{lc} are the fuel load, the combustion factor and the emission factor derived from the IPCC tables for **landcover** class *lc*.

The total emission over the whole **area of interest** is the summation of L_{lc} for all the **landcover** areas: $L = \sum L_{lc}$

Rossi, S., Tubiello, F. N., Prosperi, P., Salvatore, M., Jacobs, H., Biancalani, R., ... & Boschetti, L. (2016). FAOSTAT estimates of greenhouse gas emissions from biomass and peat fires. Climatic Change, 135(3), 699-711.

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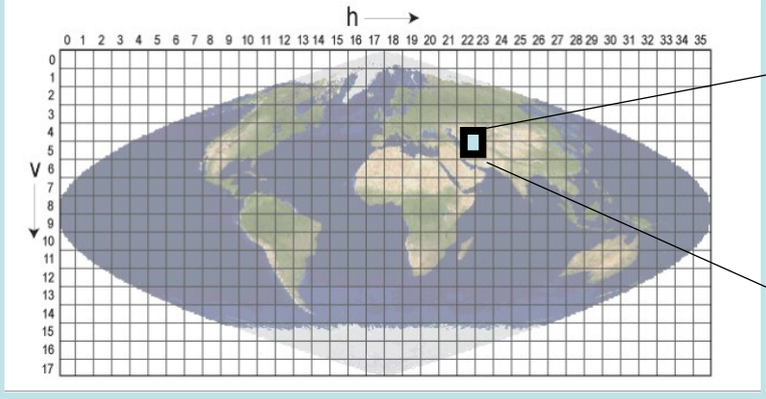
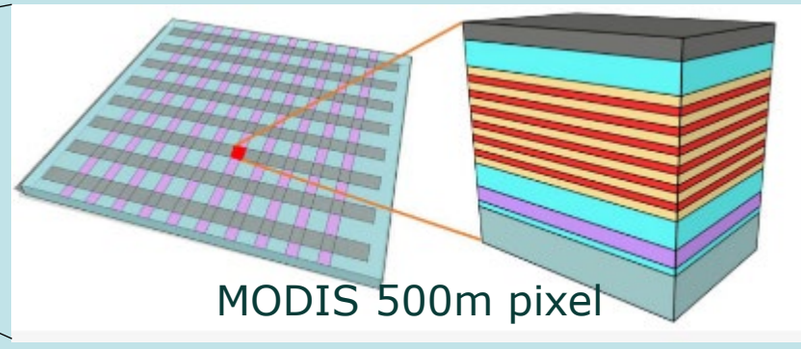
IPCC Tier-1 methodology – towards IPCC classes

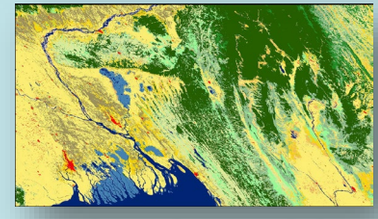
$$L_{lc} = A_{lc} \times Mb_{lc} \times Cf_{lc} \times Gef_{lc}$$





MCD64A1, C6

Any day between 1 and 366 was counted as one fire occurred

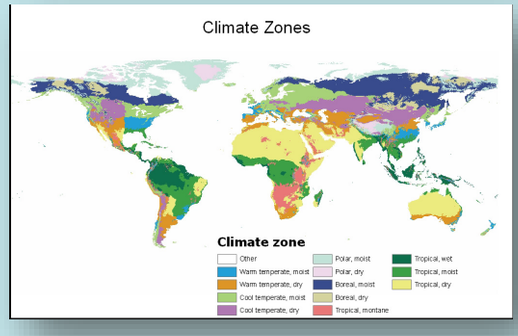


IGBP legend

MCD12A1, C6

Climatic Zone and Soil Type

Resampled and reprojected to the MODIS sinusoidal projection, and tiled into the MODIS geometry, to ensure interoperability with the MODIS MCD64A1 and MCD12A1 products.



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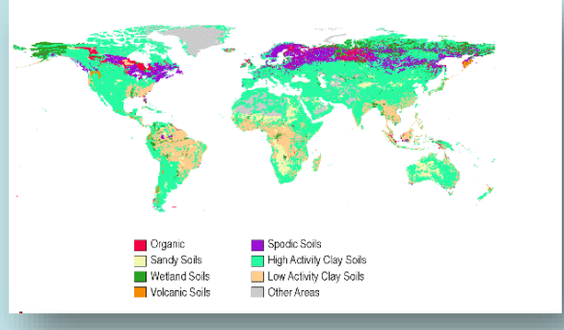


IPCC Tier-1 methodology – towards IPCC classes

$$L_{lc} = A_{lc} \times Mb_{lc} \times Cf_{lc} \times Gef_{lc}$$

```
;Input: climate zones (Clim)
; 1 Warm Temperate Moist
; 2 Warm Temperate Dry
; 3 Cool Temperate Moist
; 4 Cool Temperate Dry
; 5 Polar Moist
; 6 Polar Dry
; 7 Boreal Moist
; 8 Boreal Dry
; 9 Tropical Montane
; 10 Tropical Wet
; 11 Tropical Moist
; 12 Tropical Dry
```

```
; Input: soil type (Soil)
; 1 Organic
; 2 Sandy Soils
; 3 Wetland Soils
; 4 Volcanic Soils
; 5 Spodic Soils
; 6 High Activity Clay Soils
; 7 Low Acticity Clay Soils
; 8 Other Areas
```

```
; Output: climate zone and soil raster
; 1-boreal                      <- Clim = {7,8} AND Soil = {!1}
; 2-polar                       <- Clim = {5,6} AND Soil = {!1}
; 3-temperate                   <- Clim = {1,2,3,4} AND Soil = {!1}
; 4-tropical                    <- Clim = {10,11,12} AND Soil = {!1}
; 5-organic soils, tropical     <- Clim = {10,11,12} AND Soil = {1}
; 6-organic soils, non-tropical <- Clim = {1..9} AND Soil = {1}
```

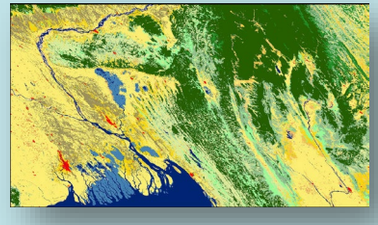
Table 1 Biomass consumption and emission factors from the 2006 IPCC guidelines used in the present study, as reported by Rossi et al. (2016), and field-derived biomass consumption compiled from literature (van Leeuwen et al. 2014, Table 3). Standard deviation (SD) is reported in parenthesis

Fire emission source	IPCC biomass consumption	Field-derived biomass consumption	IPCC emission factors		
	(t ha^{-1})	(t ha^{-1})	(g kg^{-1}) N_2O	CH_4	CO_2
Savanna (tropical)	7	4.6 (2.2)	0.21	2.3	1613
Savanna (non-tropical)	4.1		0.21	2.3	1613
Woody savanna (tropical	6	5.1 (2.2)	0.21	2.3	1613
Woody savanna (non-tropical)	3.3		0.21	2.3	1613
Grassland (tropical)	5.2	4.3 (2.2)	0.21	2.3	1613
Grassland (non-tropical)	4.1		0.21	2.3	1613
Open shrublands	14.3	32 (19)	0.21	2.3	1613
Closed shrublands	26.7		0.21	2.3	1613
Forest (boreal)	41	39 (19)	0.26	4.7	1569
Forest (temperate)	50.4	93 (79)	0.26	4.7	1569
Forest (tropical)	54.1	126 (77)	0.2	6.8	1580
Peatlands (tropical)	353	314 (196)	0.2	20.8	1703
Peatlands (boreal and temperate)	66	42 (–)			

Cross-walk from landcover classes to IPCC lookup tables

```
;;;;; MCD12 IGBP legend (LC1)
; 1 evergreen needleleaf forest
; 2 evergreen broadleaf forest
; 3 deciduous needleleaf forest
; 4 deciduous broadleaf forest
; 5 mixed forests
; 6 closed shrublands
; 7 open shrublands
; 8 woody savannas
; 9 savannas
; 10 grasslands
; 11 permanent wetlands
; 12 croplands
; 13 urban and built-up
; 14 cropland / natural vegetation mosaic
; 15 permanent snow and ice
; 16 barren
; 17 water bodies
; 255 unclassified
```

MCD12A1, C6

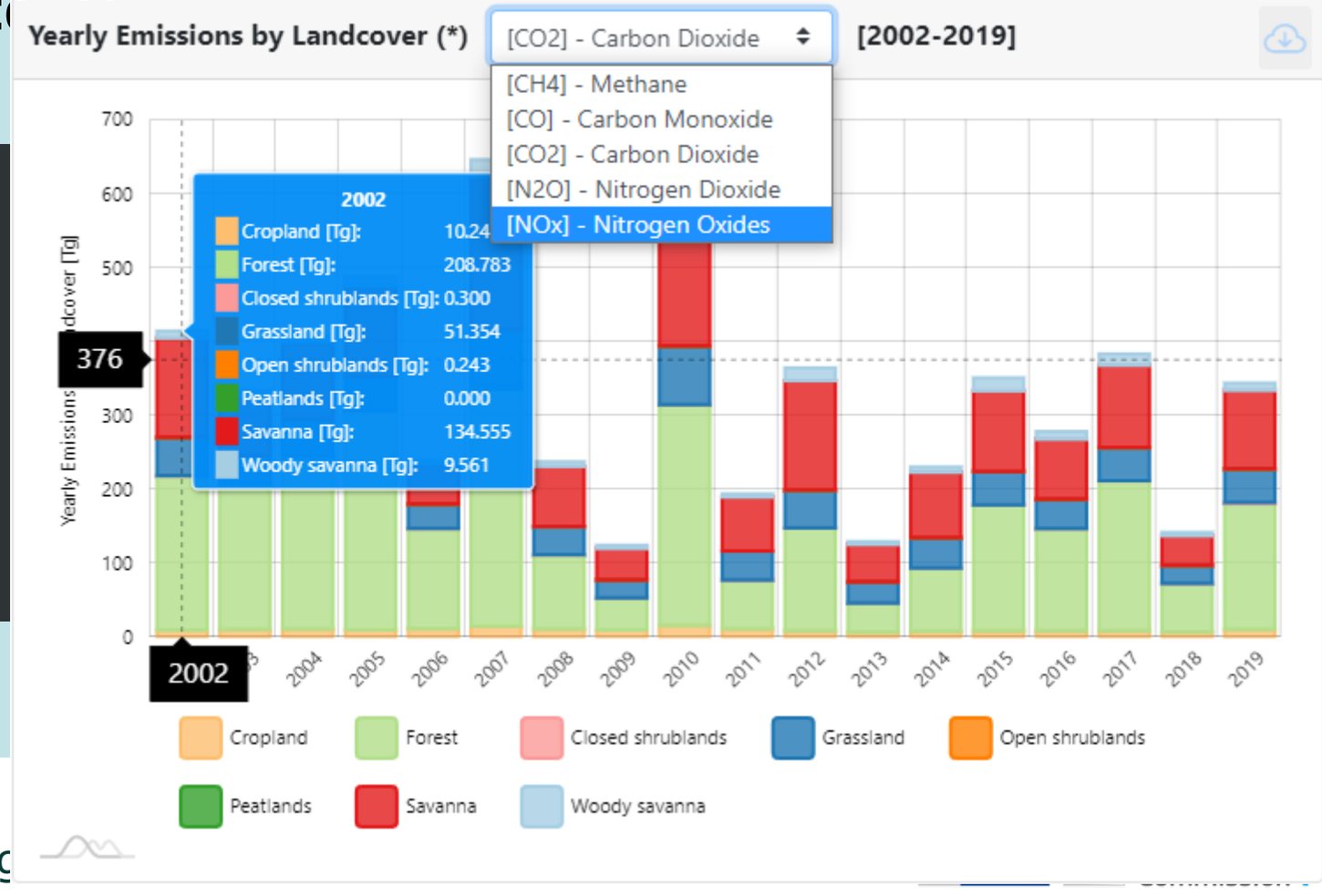


IPCC Tier-1 methodology – towards IPCC classes

$$L_{lc} = A_{lc} \times Mb_{lc} \times Cf_{lc} \times Gef_{lc}$$

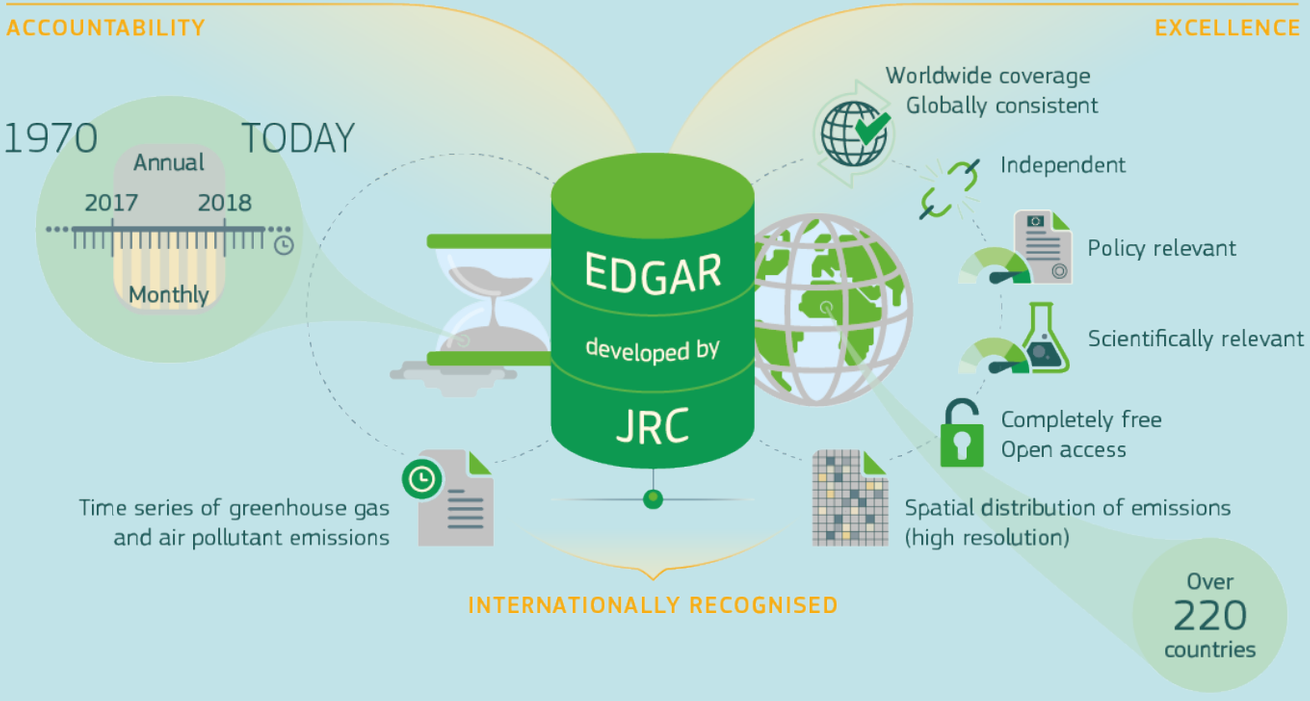
500 m landcover map, which uses a set of vegetation classes compatible with the IPC

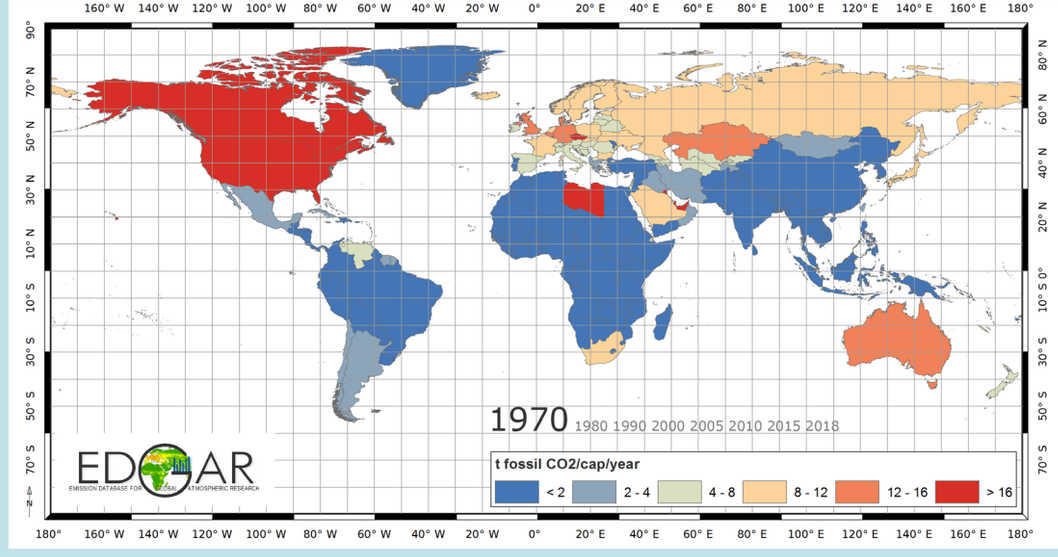
```
; IPCC_LC class aggregation:
; 1   Savanna, tropical              -> 1 Savanna
; 2   Savanna, non-tropical          -> 1 Savanna
; 3   Woody savanna, tropical        -> 2 Woody_Savanna
; 4   Woody savanna, non-tropical    -> 2 Woody_Savanna
; 5   Grassland, tropical            -> 3 Grassland
; 6   Grassland, non-tropical        -> 3 Grassland
; 7   Open Shrublands                -> 4 Open_Shrublands
; 8   Closed Shrublands              -> 5 Closed_Shrublands
; 9   Forest,Boreal                  -> 6 Forest
; 10  Forest,Temperate               -> 6 Forest
; 11  Forest,Tropical                -> 6 Forest
; 12  Croplands                      -> 7 Croplands
; 13  Peatlands, tropical            -> 8 Peatlands
; 14  Peatlands, non-tropical        -> 8 Peatlands
```



Incorporation of GWIS emissions in EDGAR

The Emissions Database for Global Atmospheric Research (EDGAR)





EDGAR provides a global independent picture of GHG emission estimates compared to what reported by Member States or Parties under the UNFCCC with <u>scientific and policy relevant purposes.</u>

Incorporation of GWIS emissions in EDGAR

Development of the global EDGAR-GHG-LULUCF emissions

Large scale biomass burning with Savanna burning, forest fires, and sources and sinks from land-use, land-use change and forestry (LULUCF) are excluded……

The first globally consistent inventory of GHG emissions from LULUCF (IPCC Tier 1 methodology).

2022 Updates:

-Inclusion (ongoing) of the Global Wildfire Information System (GWIS): https://gwis.jrc.ec.europa.eu/

-refinement of EDGAR-LULUCF CO2 emissions from forests to provide country specific estimates

Thank you

Questions?

Contact EFFIS/GWIS team at:

JRC-EFFIS@ec.europa.eu