

# Package ‘forestChange’

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**Type** Package

**Title** Computing Essential Biodiversity Variables from Global Forest Change Data

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## Description

Metrics and statistics of Essential Biodiversity Variables are computed by processing Global Forest Change data (Hansen et al., 2013) <doi:10.1126/science.1244693>, Canopy Cover data (Sexton et al., 2013) <doi:10.1080/17538947.2013.786146>, and polygon geometries (e.g., GADM, see <<https://gadm.org/>>).

**License** GPL-3

**Depends** raster

## Imports

rgdal,parallel,curl,gdalUtils,ggplot2,graphics,rvest,stats,landscapemetrics,sp,tibble,utils,xml2,dplyr

**Encoding** latin1

**LazyData** TRUE

**NeedsCompilation** no

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forestChange-package    *Computing Essential Biodiversity Variables from Global Forest Change Data*

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## Description

Metrics and statistics of Essential Biodiversity Variables are computed by processing Global Forest Change data (Hansen et al., 2013) <doi:10.1126/science.1244693> , Canopy Cover data (Sexton et al., 2013) <doi:10.1080/17538947.2013.786146>, and polygon geometries (e.g., GADM, see <<https://gadm.org/>>).

## Details

The DESCRIPTION file:

```

Package:      forestChange
Type:         Package
Title:        Computing Essential Biodiversity Variables from Global Forest Change Data
Version:      1.0
Date:         2020-02-14
Author:       Wilson Lara <wilarhen@temple.edu>, Victor Gutierrez-Velez <victorhugo@temple.edu>
Maintainer:  Wilson Lara <wilarhen@temple.edu>
Description:  Metrics and statistics of Essential Biodiversity Variables are computed by processing Global Forest Change data
License:      GPL-3
Depends:      raster
Imports:      rgdal,parallel,curl,gdalUtils,ggplot2,graphics,rvest,stats,landscapemetrics,sp,tibble,utils,xml2,dplyr
Encoding:     latin1
LazyData:    TRUE
NeedsCompilation: no
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```

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| barplot.EBVstats     | barplot EBV Stats   |
| forestChange-package | Computing Essential Biodiversity Variables from Global Forest Change Data |
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### Author(s)

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|                  |                          |
|------------------|--------------------------|
| barplot.EBVstats | <i>barplot EBV Stats</i> |
|------------------|--------------------------|

---

### Description

A barplot of [EBVstats](#) is printed.

### Usage

```
## S3 method for class 'EBVstats'
barplot(height, ...)
```

### Arguments

|        |   |
|--------|---|
| height | list of EBVstats.                                 |
| ...    | Additional arguments in <a href="#">barplot</a> . |

### Value

Plot of EBVstats.

### Author(s)

Wilson Lara <wilarhen@temple.edu>, Victor Gutierrez-Velez <victorhugo@temple.edu>

### Examples

```
height <- list(mean = abs(rnorm(4)), sd = abs(rnorm(4)))
class(height) <- 'EBVstats'
barplot(height, main = '\nEBV Stats')
```

CCPolygon

*Canopy-cover polygon***Description**

This function computes regions of interest across GFC areas for tree-cover data (GFC30TC).

**Usage**

```
CCPolygon(pol = NULL, path, int.patt = "[[:digit:]].tif", mc.cores = detectCores(),
  ...)
```

**Arguments**

|                       |  |
|-----------------------|--|
| <code>pol</code>      | SpatialPolygonsDataFrame, character or NULL. Polygon geometry, GADM, stack such as tha produced by FCPolygon, or NULL. If NULL then a list of GADM units is printed. |
| <code>path</code>     | character. File path(s) to GFC30TC layers (.tif), or to zip archives containing GFC30TC.   |
| <code>int.patt</code> | character. If files in path are compressed then common pattern in the extracted files. Default '[[:digit:]].tif'.  |
| <code>mc.cores</code> | logical. Use parallel execution. Default TRUE. Ignored in Windows machines.  |
| <code>...</code>      | Additional arguments in <a href="#">FCMask</a> .   |

**Value**

RasterStack, set of GADM units, or NULL.

**Author(s)**

Wilson Lara <[wilarhen@temple.edu](mailto:wilarhen@temple.edu)>, Victor Gutierrez-Velez <[victorhugo@temple.edu](mailto:victorhugo@temple.edu)>

**References**

Sexton, J. O., Song, X. P., Feng, M., Noojipady, P., Anand, A., Huang, C., ... & Townshend, J. R. (2013). Global, 30-m resolution continuous fields of tree cover: Landsat-based rescaling of MODIS vegetation continuous fields with lidar-based estimates of error. *International Journal of Digital Earth*, 6(5), 427-448.

**Examples**

```
mun <- CCPolygon(NULL)
```

---

EBVMask

*EBV Mask*

---

### Description

This function combines EBV distribution maps with forest/non-forest masks from [FCMask](#).

### Usage

```
EBVMask(pol = NULL, path, int.patt = "[[:digit:]].tif", mc.cores = detectCores(),
  ...)
```

### Arguments

|                       |   |
|-----------------------|---|
| <code>pol</code>      | SpatialPolygonsDataFrame, character or NULL. User-defined polygon, the name of a GADM, or such a name plus its corresponding higher-level unit. If NULL then a list of GADM units is printed. |
| <code>path</code>     | character. File path(s) to the distribution maps maps. (.tif). Compressed files (.zip) are extracted.   |
| <code>int.patt</code> | character. If files in path are compressed then common pattern in the extracted files. Default ' <code>[[:digit:]].tif</code> '.  |
| <code>mc.cores</code> | numeric. The number of cores.   |
| <code>...</code>      | additional arguments in <a href="#">FCMask</a> . This argument only works if <code>pol</code> is not an object produced by <a href="#">FCMask</a> .   |

### Value

RasterStack, set of GADM units, or NULL.

### Author(s)

Wilson Lara <[wilarhen@temple.edu](mailto:wilarhen@temple.edu)>, Victor Gutierrez-Velez <[victorhugo@temple.edu](mailto:victorhugo@temple.edu)>

### Examples

```
mun <- EBVMask(NULL)
```

---

 EBVmetric

*EBV metric*


---

### Description

This function formats GFC and computes structural metrics of Essential Biodiversity Variables (EBV metrics): forest-cover areas and landscape metrics, in predefined polygons or GADM.

### Usage

```
EBVmetric(pol, what = "lsm_l_tafc", mc.cores = detectCores(),
  ...)
```

### Arguments

|                       |  |
|-----------------------|--|
| <code>pol</code>      | RasterStack.Stack such as these produced by <a href="#">FCMask</a> .   |
| <code>what</code>     | character. The metrics. These include 'lsm_l_tafc' to compute total forest-cover areas (ha) and other landscape metrics in <a href="#">calculate_lsm</a> . Default ('lsm_l_tafc'). |
| <code>mc.cores</code> | numeric. The number of cores, see <a href="#">mclapply</a> .   |
| <code>...</code>      | additional arguments in <a href="#">calculate_lsm</a> .  |

### Details

Coordinate system of the spatial units should be UTM. Metrics other than 'lsm\_l\_tafc' are calculated implementing [calculate\\_lsm](#).

### Value

tibble.

### Author(s)

Wilson Lara <[wilarhen@temple.edu](mailto:wilarhen@temple.edu)>, Victor Gutierrez-Velez <[victorhugo@temple.edu](mailto:victorhugo@temple.edu)>

### References

O'Connor, B., Secades, C., Penner, J., Sonnenschein, R., Skidmore, A., Burgess, N. D., & Hutton, J. M. (2015). Earth observation as a tool for tracking progress towards the Aichi Biodiversity Targets. *Remote sensing in ecology and conservation*, 1(1), 19-28.

### Examples

```
mpio <- 'Uribia'
msk <- FCMask(mpio, year = 10:17)
met <- EBVmetric(msk, what = 'lsm_l_frac_mn')
plot(met)
```

---

 EBVstats

*EBV Stats*


---

**Description**

This function is a wrapper of `cellStats` to computes statistics for [CCPolygon](#) objects.

**Usage**

```
EBVstats(ccp, stats, mc.cores = detectCores(), ...)
```

**Arguments**

|                       |   |
|-----------------------|---|
| <code>ccp</code>      | RasterStack or NULL. Stack such as that produced by <a href="#">CCPolygon</a> . If NULL then NULL is returned.        |
| <code>stats</code>    | character vector of stats defined in <a href="#">cellStats</a> . If missing then 'mean', 'sd' and 'max' are computed. |
| <code>mc.cores</code> | numeric. The number of cores, see <a href="#">mclapply</a> .  |
| <code>...</code>      | Additional arguments in <code>cellStats</code>  |

**Value**

list of EBVstats.

**Author(s)**

Wilson Lara <[wilarhen@temple.edu](mailto:wilarhen@temple.edu)>, Victor Gutierrez-Velez <[victorhugo@temple.edu](mailto:victorhugo@temple.edu)>

**Examples**

```
EBVstats(NULL)
```

---

FCMask

*Forest-Change Mask*


---

**Description**

This function can format GFC into forest-distribution regions of interest over time.

**Usage**

```
FCMask(pol = NULL, year = 1:2, cummask = TRUE, deforest = FALSE,
       perc = 80:100, mc.cores = detectCores(), ...)
```

**Arguments**

|                       |   |
|-----------------------|---|
| <code>pol</code>      | RasterStack; SpatialPolygonsDataFrame; Extent; character, or NULL. Spatial object such as any of these produced by <code>getGADM</code> or by <code>FCPolygon</code> . If NULL then a list of unit names is printed, see <code>getGADM</code> . |
| <code>year</code>     | numeric. Years between 0 and 18 (or between 2000 and 2018).   |
| <code>cummask</code>  | logical. Compute cumulative masks instead of discrete masks. Default TRUE.  |
| <code>deforest</code> | logical. Process non-forest areas instead of forest areas. Default FALSE.   |
| <code>perc</code>     | numeric. Percentage of canopy closure. Default 80:100. This argument is ignored if <code>deforest = TRUE</code> .   |
| <code>mc.cores</code> | numeric. The number of cores, see <code>mclapply</code> .   |
| <code>...</code>      | Additional arguments in <code>FCPolygon</code> .  |

**Value**

RasterBrick of forest/non-forest masks over time. or character vector with GADM.

**Author(s)**

Wilson Lara <[wilarhen@temple.edu](mailto:wilarhen@temple.edu)>, Victor Gutierrez-Velez <[victorhugo@temple.edu](mailto:victorhugo@temple.edu)>

**Examples**

```
## A mask of GFC layers in the municipality of 'Uribia' is computed:

UribiaMask <- FCMask('Uribia')
plot(UribiaMask)
```

---

FCMosaic

*Forest-Change Mosaic*

---

**Description**

This function tests whether adjacent layers of GFC can be bounded together using partial matching over the layer names. If it is possible then `mosaic` is implemented.

**Usage**

```
FCMosaic(rst = NULL, lyrs = c("treecover2000", "lossyear"), mc.cores = detectCores())
```

**Arguments**

|                       |   |
|-----------------------|---|
| <code>rst</code>      | list or NULL. List of GFC layers. If NULL then other arguments are ignored and the function returns NULL. |
| <code>lyrs</code>     | character. Vector of strings matching layer names in GFC data. Defaults 'treecover2000' and 'lossyear'.   |
| <code>mc.cores</code> | logical. Use parallel execution. Default TRUE. Ignored in Windows machines.                               |

**Details**

The function is implemented by [FCPolygon](#) to cut GFC data.

**Value**

list of rasters.

**Author(s)**

Wilson Lara <[wilarhen@temple.edu](mailto:wilarhen@temple.edu)>, Victor Gutierrez-Velez <[victorhugo@temple.edu](mailto:victorhugo@temple.edu)>

**Examples**

```
## Printing NULL output:
FCMosaic(NULL)
```

---

FCPolygon

*Forest-Cover Polygon*

---

**Description**

This function can retrieve and crop layers of Global Forest Change (GFC) using polygon geometries (i.e., GADM).

**Usage**

```
FCPolygon(pol = NULL, lyrs = c("treecover2000", "lossyear"),
          path, url, pr.utm = TRUE, mc.cores = detectCores(), ...)
```

**Arguments**

|                       |  |
|-----------------------|--|
| <code>pol</code>      | SpatialPolygonsDataFrame, or character. Polygon geometry, the name of a GADM, or such a name plus its corresponding higher-level unit. If NULL then a list of GADM units is printed, see <a href="#">getGADM</a> . |
| <code>lyrs</code>     | character. Vector of strings matching layer names in the GFC. Defaults 'treecover2000' and 'lossyear'.   |
| <code>path</code>     | character. Location of a directory with the GFC. This argument overrides the action of <code>url</code> .  |
| <code>url</code>      | character. Web resource with text files containing lists of URLs for the GFC layers. If missing then data from the application programming interface of GFC is retrieved, see <a href="#">GFCurls</a> .            |
| <code>pr.utm</code>   | logical. Project to UTM crs.   |
| <code>mc.cores</code> | numeric. The number of cores, see <a href="#">mclapply</a> .   |
| <code>...</code>      | Additional arguments in <a href="#">getGADM</a> .  |

## Details

The GADM are imported using the in-package `getGADM`. Links to the data sets are obtained using the in-package `GFCurls`. Geographic extents in both the GADM and the GFC are intersected implementing `HansenUrltoExtent`. Common areas between GFC and GADM are cropped using two functions of the `raster` package: `crop` and `rasterize`. Depending on localization of the GADM unit, several GFC layers by data type might be required. This is done implementing the in-package `FCMosaic`. This function could be memory demanding if the extents of the polygons used to cut the GFC are big (30,000 km<sup>2</sup>). For these cases, machines with RAM of 8 GB or greater should be used. In unix-alike systems, the package implements parallel execution, see `parallel` package.

## Value

RasterStack, or set of GADM units.

## Author(s)

Wilson Lara <wilarhen@temple.edu>, Victor Gutierrez-Velez <victorhugo@temple.edu>

## References

Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A. A., Tyukavina, A., ... & Kommareddy, A. (2013). High-resolution global maps of 21st-century forest cover change. *science*, 342(6160), 850-853.

## Examples

```
## A list of departments of Colombia is printed:

dep <- FCPolygon(level = 1)
head(dep)

## Two adjacent layers of GFC must be bounded together before cropping
## the GFC data using the boundaries of the the municipality of
## 'Cumaribo' in Colombia. This is automatically developed by
## FCPolygon:

cumariboArea <- FCPolygon(pol = 'Cumaribo')

## The name 'Mosquera' matches two municipalities of Colombia. A
## corresponding department should be specified in the argument 'pol'
## of FCPolygon:

mosquera <- FCPolygon('Mosquera')
mosqueraNarinho <- FCPolygon(pol = c('Mosquera','Narino'))
```

---

`getGADM`*Get Geographic Administrative Unit*

---

**Description**

This function is a wrapper of `getData` used to import levels in Geographic Administrative Units (GADM).

**Usage**

```
getGADM(unit.nm = NULL, level = 2, country = "COL")
```

**Arguments**

|                      |   |
|----------------------|---|
| <code>unit.nm</code> | character or NULL. Name of an administrative unit (e.g. municipality), or the name of such a name plus its corresponding higher-level unit (e.g. department/state). If NULL then a list of unit names is printed. |
| <code>level</code>   | numeric. A number between zero and two, indicating any of the levels of administrative subdivisions in GADM: 0=country, 1=first level of subdivision, and 2=second level of subdivision).                         |
| <code>country</code> | character. ISO code specifying a country. Default 'COL'   |

**Value**

SpatialPolygonsDataFrame or character vector of GADM units..

**Author(s)**

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**References**

<https://gadm.org/>

**Examples**

```
## Printing municipalities of Colombia:  
  
muni <- getGADM()  
head(muni)
```

---

GFCurls

*URLs of GFC data*


---

**Description**

This function retrieves URL of Global Forest Change (GFC) data.

**Usage**

```
GFCurls(lyrs = c("treecover2000", "lossyear"), url)
```

**Arguments**

`lyrs` character. Name(s) of the layers. Default 'treecover2000', and 'lossyear'  
`url` character. Path to the html file containing the files. Default NULL retrieves URLs stored in the application programming interface of GFC, see References.

**Value**

character vector.

**Author(s)**

Wilson Lara <wilarhen@temple.edu>, Victor Gutierrez-Velez <victorhugo@temple.edu>

**References**

[https://earthenginepartners.appspot.com/science-2013-global-forest/download\\_v1.5.html](https://earthenginepartners.appspot.com/science-2013-global-forest/download_v1.5.html)

**Examples**

```
gainLayers <- GFCurls(lyrs = 'gain')
head(gainLayers)
```

---

HansenUrltoExtent

*Extents in GFC links*


---

**Description**

This function can extract extents of Global Forest Change data (GFC) using a corresponding URL.

**Usage**

```
HansenUrltoExtent(x, path. = "[[:digit:]]{1,3}[N|S|E|W]")
```

**Arguments**

x character. URL to the GFC such as any of these produced by [GFCurl1s](#).  
path. character. Pattern in the URL to extract the extent. Default extracts the 3 digits nearest to any of the cardinal directions:N, S, E, or W.

**Details**

The function is implemented by [FCPolygon](#).

**Value**

extent.

**Author(s)**

Wilson Lara <[wilarhen@temple.edu](mailto:wilarhen@temple.edu)>, Victor Gutierrez-Velez <[victorhugo@temple.edu](mailto:victorhugo@temple.edu)>

**References**

<http://earthenginepartners.appspot.com/science-2013-global-forest>

**Examples**

```
urtt <- 'https://storage.googleapis.com/earthenginepartners-hansen/
GFC-2017-v1.5/Hansen_GFC-2017-v1.5_treecover2000_10N_010E.tif'
HansenUrltoExtent(urtt)
```

---

plot.EBVmetric      *EBV-metric plot*

---

**Description**

A plot of [EBVmetric](#) is printed.

**Usage**

```
## S3 method for class 'EBVmetric'
plot(x, ...)
```

**Arguments**

x [tibble](#). Data set of metrics such as that produced by [EBVmetric](#).  
... Further arguments not implemented here.

**Value**

plot.

**Author(s)**

Wilson Lara <wilarhen@temple.edu>, Victor Gutierrez-Velez <victorhugo@temple.edu>

**Examples**

```
mpio <- 'Uribia'  
msk <- FCMask(mpio, year = 10:17)  
met <- EBVmetric(msk, what = 'lsm_l_frac_mn')  
plot(met)
```

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