Package 'gfcanalysis'

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Description Supports analyses using the Global Forest Change dataset released by Hansen et al. gfcanalysis was originally written for the Tropical Ecology Assessment and Monitoring (TEAM) Network. For additional details on the Global Forest Change dataset, see: Hansen, M. et al. 2013. ``High-Resolution Global Maps of 21st-Century Forest Cover Change." Science 342 (15 November): 850-53. The forest change data and more information on the product is available at <http://earthenginepartners.appspot.com>.

License GPL (>= 3)

URL https://github.com/azvoleff/gfcanalysis

BugReports https://github.com/azvoleff/gfcanalysis/issues

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R topics documented:

`animate_annual` *Plot an animation of forest change within a given area of interest (AOI)*

Description

Produces an animation of annual forest change in the area bounded by the extent of a given AOI, or AOIs. The AOI polygon(s) is(are) also plotted on the image. The `gfc_stack` must be pre-calculated using the `annual_stack` function. The animation can be either an animated GIF (if `type` is set to 'gif') or a series of '.png' files with a corresponding '.html' webpage showing a simple viewer and the forest change animation (if `type` is set to 'html'). The HTML option is recommended as it requires no additional software to produce it. The animated GIF option will only work if the imagemagicK software package is installed beforehand (this is done outside of R).

Usage

```
animate_annual(aoi, gfc_stack, out_dir = getwd(),
  out_basename = "gfc_animation", site_name = "", type = "html",
  height = 3, width = 3, dpi = 300, dataset = "GFC-2017-v1.5")
```

Arguments

`aoi`	one or more AOI polygons as a `SpatialPolygonsDataFrame` object. If there is a 'label' field in the dataframe, it will be used to label the polygons in the plots. If the AOI is not in the WGS84 geographic coordinate system, it will be reprojected to WGS84.
`gfc_stack`	a GFC product subset as a `RasterStack` (as output by `annual_stack`)
`out_dir`	folder for animation output

out_basename	basename to use when naming animation files
site_name	name of the site (used in making title)
type	type of animation to make. Can be either "gif" or "html"
height	desired height of the animation GIF in inches
width	desired width of the animation GIF in inches
dpi	dots per inch for the output image
dataset	which version of the Hansen data to use annual_stack was run

See Also

annual_stack

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annual_stack *Generate an annual stack of forest change from GFC product*

Description

Uses thresholded GFC data as output by threshold_gfc to make an annualized layer stack of forest change. See Details for the class codes used in the annual raster stack. The animate_annual function can be used to produce an animation of forest change from the generated layer stack.

Usage

```
annual_stack(gfc, dataset = "GFC-2017-v1.5")
```

Arguments

gfc	thresholded extract of GFC product for a given AOI (see threshold_gfc)
dataset	which version of the Hansen data to use

Details

The output raster stack uses the following codes to describe forest change at each pixel:

Nodata	0
Forest	1
Non-forest	2
Forest loss	3
Forest gain	4
Forest loss and gain	5
Water	6

See Also

threshold_gfc, animate_annual

`calc_gfc_tiles` *Calculate the GFC product tiles needed for a given AOI*

Description

Intersects an (optionally buffered) AOI with the GFC product grid to determine what tiles are need to cover the AOI.

Usage

```
calc_gfc_tiles(aoi)
```

Arguments

`aoi`	an Area of Interest (AOI) as a `SpatialPolygons*` object. If the AOI is not in the WGS84 geographic coordinate system, it will be reprojected to WGS84.

Value

a `SpatialPolygonsDataFrame` of the GFC tiles needed to cover the AOI

Examples

```
tiles <- calc_gfc_tiles(test_poly)
plot(tiles)
plot(test_poly, lt=2, add=TRUE)
```

`calc_pixel_areas` *Calculates the pixel area for each line of a raster*

Description

Calculates the pixel area for each line of a raster

Usage

```
calc_pixel_areas(x)
```

Arguments

`x`	a `Raster*` object

Value

a vector with the area in square meters of the pixels in each line of `x` (vector has length equal to `nrow(x)`)

download_tiles *Download a set of GFC tiles*

Description

This function first checks whether each tile in a set GFC product tiles is present locally, and that local file sizes match the file sizes of the files available on the Google server hosting the GFC product. Next, the function downloads all tiles that either are not present locally, or that are present but have file sizes differing from the file on the Google server.

Usage

```
download_tiles(tiles, output_folder, images = c("treecover2000", "lossyear",
  "gain", "datamask"), dataset = "GFC-2017-v1.5")
```

Arguments

tiles	SpatialPolygonsDataFrame with GFC product tiles to download, as calculated by the calc_gfc_tiles function.
output_folder	the folder to save output data in
images	which images to download. Can be any of 'treecover2000', 'loss', 'gain', 'lossyear', 'datamask', 'first', and 'last'.
dataset	which version of the Hansen data to use

See Also

extract_gfc

Examples

```
## Not run:
output_folder <- 'H:/Data/TEAM/GFC_Product'
tiles <- calc_gfc_tiles(test_poly)
download_tiles(tiles, output_folder)

## End(Not run)
```

`extract_gfc` *Extracts GFC data for a given AOI*

Description

This function extracts a dataset for a given AOI from a series of pre-downloaded GFC tiles. The `download_tiles` function should be used beforehand in order to download the necessary data to the specified `data_folder`. Note that the output file format is fixed as GeoTIFF with LZW compression.

Usage

```
extract_gfc(aoi, data_folder, to_UTM = FALSE, stack = "change",
  dataset = "GFC-2017-v1.5", ...)
```

Arguments

`aoi`	an Area of Interest (AOI) as a `SpatialPolygons*` object. If the AOI is not in WGS 1984 (EPSG:4326), it will be reprojected to WGS84.
`data_folder`	folder where downloaded GFC product tiles are located (see `download_tiles` function.
`to_UTM`	if TRUE, then reproject the output into the UTM zone of the AOI centroid. If FALSE, retain the original WGS84 projection of the GFC tiles.
`stack`	the layers to extract from the GFC product. Defaults to "change". See Details.
`dataset`	which version of the Hansen data to use
`...`	additional arguments as for `writeRaster`, such as `filename`, or `overwrite`.

Details

The `stack` option can be "change" (the default), "first", or "last". When set to "change", the forest change layers (treecover2000, loss, gain, lossyear, and datamask) will be extracted for the given `aoi`. The "first" and "last" options will mosaic the 2000 or last year composite top of atmosphere (TOA) reflectance images (respectively).

Value

`RasterStack` with GFC layers

See Also

`download_tiles`, `annual_stack`, `gfc_stats`

gen_grid *Generate a spatial grid*

Description

Produces an arbitrary grid in any user-defined coordinate system. Used by `gfcanalysis` for producing the 10x10 degree WGS84 grid that the GFC product is tiled on, so that an AOI polygon can be intersected with the grid to calculate the appropriate tiles to download.

Usage

```
gen_grid(origin_x, dx, max_x, origin_y, dy, max_y, grid_proj4string = NULL)
```

Arguments

`origin_x`	x coordinate of the origin
`dx`	cell size in the x direction
`max_x`	maximum value in x direction
`origin_y`	y coordinate of the origin
`dy`	cell size in the y direction
`max_y`	maximum value in y direction
`grid_proj4string`	coordinate system as a crs object (defaults to WGS-84)

See Also

`download_tiles`

Examples

```
gfc_tiles <- gen_grid(-180, 10, 180, -60, 10, 80)
```

gfc_stats *Produce a table of forest cover change statistics for a given AOI*

Description

For a given AOI, this function produces two tables: an annual forest loss table (in hectares, by default), and a table specifying 1) the total area of pixels that experienced forest gain and, 2) the total area of pixels that experienced both loss and gain over the full period (from 2000 through the end date of the specific product you are using, depending on the chosen `dataset`). Note that forest gain and combined loss and gain are not available in the GFC product on an annualized basis. Use `extract_gfc` to extract the GFC data for the AOI, and threshold it using `threshold_gfc` prior to running this function.

Usage

```
gfc_stats(aoi, gfc, scale_factor = 1e-04, dataset = "GFC-2017-v1.5")
```

Arguments

aoi	one or more Area of Interest (AOI) polygon(s) as a SpatialPolygons* object. See Details.
gfc	extract of GFC product for a given AOI (see extract_gfc), recoded using threshold_gfc.
scale_factor	how to scale the output data (from meters). Defaults to .0001 for output in hectares.
dataset	which version of the Hansen data to use

Details

If theaoi SpatialPolygons* object is not in the coordinate system of gfc, it will be reprojected. If there is a "label" attribute, it will be used to label the output statistics. Otherwise, unique names ("AOI 1", "AOI 2", etc.) will be generated and used to label the output. If multiple AOIs share the same labels, statistics will be provided for the union of these AOIs.

Value

list with two elements "loss_table", a data.frame with statistics on forest loss, and "gain_table", with the area of forest gain, and area that experienced both loss and gain. The units of the output are hectares (when scale_factor is set to .0001).

See Also

extract_gfc, threshold_gfc

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gfc_tiles *Grid of tiles used for the GFC product*

Description

Contains a SpatialPolygonsDataFrame with a 10 x 10 degree grid in WGS84 coordinate system, covering the area from 180W-180E and 80N-60S, the tile system used by the GFC Product.

plot_gfc *Plot forest change (relative to 2000) for a given year*

Description

Plots a single layer of forest change from a layer stack output by annual_stack.

Usage

```
plot_gfc(fchg, aoi, title_string = "", size_scale = 1, maxpixels = 50000)
```

Arguments

fchg	a forest change raster layer (a single layer of the layer stack output by annual_stack
aoi	one or more AOI polygons as a SpatialPolygonsDataFrame object. If there is a 'label' field in the dataframe, it will be used to label the polygons in the plots. If the AOI is not in WGS 1984 (EPSG:4326), it will be reprojected to WGS84.
title_string	the plot title
size_scale	a number used to scale the size of the plot text
maxpixels	the maximum number of pixels from fchg to use in plotting

See Also

annual_stack, animate_annual

scale_by_pixel_area *Scales a raster by the area of each pixel in meters*

Description

Calculates the area (in meters) of each pixel in a raster, scales the value of each pixel by the area, applies the desired scale factor, and returns the result as a RasterLayer. Useful for calculating class areas based on a classified raster in a geographic coordinate system. Assumes that raster is not rotated (latitudes of every pixel in a given row are identical). Processes block by block to support handling very large rasters.

Usage

```
scale_by_pixel_area(x, filename, datatype, pixel_areas = NULL,
  scale_factor = 1)
```

Arguments

x	a Raster* object
filename	(optional) filename for output raster
datatype	(optional) datatype for output raster see dataType NOT YET SUPPORTED
pixel_areas	a vector giving the area of each cell in a single column of the raster. See calc_pixel_areas. If NULL, this vector will be calculated based on the coordinate system of x.
scale_factor	a value to scale the results by

Value

RasterLayer with pixel areas (in meters)

---

scale_toar *Scale the first or last top of atmosphere (TOA) reflectance images*

Description

This function applies the scale factors provided by Hansen et al. to rescale the first and last TOA reflectance images from integer to floating point. The following scale factors are used: band 3, 508; band 4, 254; band 5, 363; band 7, 423. The output datatype is FLT4S.

Usage

```
scale_toar(x, ...)
```

Arguments

x	the "first" or "last" image for a given aoi as a RasterStack (see stack option for extract_gfc).
...	additional arguments as for writeRaster, such as filename, or overwrite.

Value

RasterStack of TOA reflectance values

See Also

extract_gfc

test_poly *Polygon outlining TEAM site in Caxiuanã, Brazil*

Description

Contains a `SpatialPolygonsDataFrame` with a simplified polygon of the area within the Tropical Ecology Assessment and Monitoring (TEAM) network site in Caxiuanã, Brazil.

threshold_gfc *Threshold the GFC product*

Description

Uses the GFC data output from `extract_gfc` to make an thresholded layer stack with five layers: treecover2000, loss, gain, lossyear, and datamask layers. See Details for the coding used in each layer. Note that the output file format is fixed as GeoTIFF with LZW compression.

Usage

```
threshold_gfc(gfc, forest_threshold = 25, ...)
```

Arguments

`gfc`	extract of GFC product for a given AOI (see `extract_gfc`)
`forest_threshold`	percent woody vegetation to use as a threshold for mapping forest/non-forest
`...`	additional arguments as for writeRaster, such as `filename` or `overwrite`

Details

The output uses the following codes to describe forest change at each pixel:

Band 1 (forest2000)

Non-forest	0
Forest	1

Band 2 (lossyear)

No loss	0
Loss in 2001	1
Loss in 2002	2
Loss in 2003	3
Loss in 2004	4

Loss in 2005	5
Loss in 2006	6
Loss in 2007	7
Loss in 2008	8
Loss in 2009	9
Loss in 2010	10
Loss in 2011	11
Loss in 2012	12
Loss in 2013	13
Loss in 2014	14

Note that lossyear is zero for pixels that were not forested in 2000, and that the 2013 and 2014 loss layers are not available in the original 2013 Hansen dataset (the 2013 loss layer is available in the 2014 and 2015 updates, while the 2014 loss layer is available in the 2015 update only).

Band 3 (gain)

No gain	0
Gain	1

Note that gain is zero for pixels that were forested in 2000

Band 4 (lossgain)

No loss and gain	0
Loss and gain	1

Note that loss and gain is difficult to interpret from the thresholded product, as the original GFC product does not provide information on the sequence (loss then gain, or gain then loss), or the levels of canopy cover reached prior to loss (for gain then loss) or after loss (for loss then gain pixels). The layer is calculated here as: `lossgain <- gain & (lossyear != 0)`, where loss year and gain are the original GFC gain and lossyear layers, respectively.

Band 5 (datamask)

No data	0
Land	1
Water	2

Value

`RasterBrick` with thresholded GFC product (see details above)

See Also

`extract_gfc`

utm_zone *Given a spatial object, calculate the UTM zone of the centroid*

Description

For a line or polygon, the UTM zone of the centroid is given, after reprojecting the object into WGS-84.

Usage

```
utm_zone(x, y, proj4string = FALSE)

## S4 method for signature 'numeric,numeric'
utm_zone(x, y, proj4string = FALSE)

## S4 method for signature 'Spatial,missing'
utm_zone(x, proj4string)
```

Arguments

x	a longitude (with western hemisphere longitudes negative), or a Spatial object
y	a latitude (with southern hemisphere latitudes negative), or missing (if x is a Spatial object)
proj4string	if FALSE (default) return the UTM zone as a string (for example "34S" for UTM Zone 34 South). If TRUE, return a proj4string using the EPSG code as an initialization string.

Details

Based on the code on gis.stackexchange.com at http://bit.ly/17SdcuN.

Examples

```
utm_zone(45, 10)
utm_zone(45, -10)
utm_zone(45, 10, proj4string=TRUE)
```

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