Package ‘nightmares’

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Type Package

Title Common Analysis with Remote Sensing Data

Version 0.0.2

Depends R (>= 3.4.0)

Imports raster, sp, rgdal

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Description A collection of functions used in remote sensing analysis (e.g., conversion from digital numbers to radiance, reflectance, and temperature). It includes several algorithms to calculate the albedo: Liang (2000) <doi:10.1016/S0034-4257(00)00205-4>, Silva et al. (2016) <doi:10.32614/RJ-2016-051>, Tasumi et al. (2008) <doi:10.1061/(ASCE)1084-0699(2008)13:2(51)>, among others; and include functions to derive several spectral indices. Although the current version implements basic functions, it will be expandable to a more robust tool for water cycle modeling (e.g., to include surface runoff and evapotranspiration calculations) in the near future. This package is under development at the Institute about Natural Resources Research (INIRENA) from the Universidad Michoacana de San Nicolas de Hidalgo.

License GPL (>= 3)

Encoding UTF-8

LazyData true

URL http://hydro-geomatic-lab.com/

VignetteBuilder knitr

Suggests knitr, rmarkdown

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NeedsCompilation no

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R topics documented:

`alb_oli` *Albedo*

Description

This function is used to Convert Reflectance values to Albedo.

Usage

```
alb_oli(x, method = c(Chemin, Liang, Olmedo, Silva, Tasumi))
```

Arguments

`x`	A raster stack containing the reflectance values of the first seven Landsat OLI bands.
`method`	Specify the method to be used (Chemin, Liang, Olmedo, Silva or Tasumi)

Value

A raster layer object with the Albedo values.

References

Chemin Method, please see i.albedo function (GRASS). Only for OLI images.

Liang, S. 2000. Narrowband to broadband conversions of land surface albedo I: Algorithms. Remote Sensing of Environment, 76(2), 213-238.

Olmedo et al., 2016. water: Tools and functions to estimate actual evapotranspiration Using land surface energy balance models in R. The R journal, 8(2), 352-369.

Silva et al., 2016. Procedures for calculation of the albedo with OLI-Landsat 8 images: Application to the Brazilian semi-arid. Revista Brasileira de Engenharia Agrícola e Ambiental, 20(1), 3-8.

Tasumi et al., 2008. At-Surface Reflectance and Albedo from Satellite for Operational Calculation of Land Surface Energy Balance. Journal of Hydrologic Engineering, 13, 51-63.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
x <- stack(list.files(path_files,".tif", full.names=TRUE))
alb_oli(x, method="Chemin")
alb_oli(x, method="Liang")
alb_oli(x, "Tasummi")
```

---

atm_pressure *Atmospheric pressure*

Description

This function is used to estimate the The atmospheric pressure, P, by using a simplification of the ideal gas law, assuming 20°C for a standard atmosphere. Please, see the equation 7 from the FAO Irrigation and drainage paper 56.

Usage

```
atm_pressure(z)
```

Arguments

z	Elevation above sea level in meters.

Value

Atmospheric pressure in kPa.

References

Allen et al., 1998. Crop Evapotranspiration. Guidelines for computing crop water requirements. FAO Irrigation and drainage paper 56. http://www.fao.org/3/X0490E/x0490e00.htm.

Examples

```
atm_pressure(z= 1120)
```

AVI *AVI - Advanced Vegetation Index*

Description

AVI is similar to NDVI and it is used in vegetation studies to monitor crop and forest variations over time. Through the multi-temporal combination of the AVI and the NDVI, users can discriminate different types of vegetation and extract phenology characteristics.

Usage

```
AVI(R, NIR)
```

Arguments

R	A raster layer object with the reflectance values for the Red band.
NIR	A raster layer object with the reflectance values for the Near Infrared band.

Value

AVI - Advanced Vegetation Index

References

Rikimaru et al., 2002. Tropical forest cover density mapping. Tropical Ecology, 43, 39-47. https://www.geo.university/pages/spectral-indices-with-multispectral-satellite-data.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
bands <- stack(list.files(path_files,".tif", full.names=TRUE))
x <- ref_oli(bands, sun.elev= 67.97)
AVI(x[[4]], x[[5]])
```

BSI *BSI - Bare Soil Index*

Description

BSI can be used for soil mapping and crop identification. This index relates the Blue, Red, Near Infrared and Short Wave Infrared bands.

Usage

```
BSI(B, R, NIR, SWIR1)
```

Arguments

B	A raster layer object with the reflectance values for the Blue band.
R	A raster layer object with the reflectance values for the Red band.
NIR	A raster layer object with the reflectance values for the Near Infrared band.
SWIR1	A raster layer object with the reflectance values for the Short Wave Infrared band.

Value

BSI - Bare Soil Index.

References

Rikimaru et al., 2002. Tropical forest cover density mapping. Tropical Ecology, 43, 39-47. https://www.geo.university/pages/spectral-indices-with-multispectral-satellite-data.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
bands <- stack(list.files(path_files,".tif", full.names=TRUE))
x <- ref_oli(bands, sun.elev= 67.97)
BSI(x[[2]], x[[4]], x[[5]], x[[6]])
```

dsi_oli *Landsat Surface Reflectance Derived Spectral Indices*

Description

This function requires Landsat Surface Reflectance from Landsat 8 Operational Land Imager to derive spectral indices.

Usage

```
dsi_oli(x)
```

Arguments

x	A raster layer object with the Top of atmosphere planetary reflectance with at least the first seven bands.

Value

Layer 1 - Normalized Difference Vegetation Index

Layer 2 - Enhanced Vegetation Index

Layer 3 - Soil Adjusted Vegetation Index

Layer 4 - Modified Soil Adjusted Vegetation Index

Layer 5 - Normalized Difference Moisture Index

Layer 6 - Normalized Burn Ratio

Layer 7 - Normalized Burn Ratio 2

Layer 8 - Advanced Vegetation Index

Layer 9 - Bare Soil Index

References

https://www.usgs.gov/core-science-systems/nli/landsat/landsat-surface-reflectance-derived-spectral-
https://www.geo.university/pages/spectral-indices-with-multispectral-satellite-data.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
bands <- stack(list.files(path_files,".tif", full.names=TRUE))
x <- ref_oli(bands, sun.elev= 67.97)
dsi_oli(x)
```

ETo56_miss — *Determination of ETo with missing data*

Description

This function is used to the estimation of monthly ETo with the FAO Penman-Montheith equation for a data set containing only maximum and minimum air temperature. Please, see the example 20 from the FAO Irrigation and drainage paper 56.

Usage

```
ETo56_miss(lat, z, doy, tmax, tmin, tdew, u2, Rs, P)
```

Arguments

lat	Latitude in decimal degrees.
z	Elevation above sea level in meters.
doy	Day of the year.
tmax	Maximum air temperature in Celsius degrees.
tmin	Minimum air temperature in Celsius degrees.
tdew	Dewpoint temperature in Celsius degrees.
u2	Wind speed at 2 m height in m s-1.
Rs	Solar radiation in MJ/sq.m/day.
P	Atmospheric pressure in kPa.

Value

Reference Evapotranspiration in mm day-1

References

Allen et al., 1998. Crop Evapotranspiration. Guidelines for computing crop water requirements. FAO Irrigation and drainage paper 56. http://www.fao.org/3/X0490E/x0490e00.htm.

Examples

```
ETo56_miss(45.72, 200, 196, 26.6, 14.8, 14.8, 2, 22.29, 98.96)
```

EVI *EVI - Enhanced Vegetation Index*

Description

EVI is similar to the Normalized Difference Vegetation Index. However, EVI corrects for some atmospheric conditions and canopy background noise and is more sensitive in areas with dense vegetation.

Usage

```
EVI(B, R, NIR)
```

Arguments

B	A raster layer object with the reflectance values for the Blue band.
R	A raster layer object with the reflectance values for the Red band.
NIR	A raster layer object with the reflectance values for the Near Infrared band.

Value

EVI - Enhanced Vegetation Index.

References

https://www.usgs.gov/core-science-systems/nli/landsat/landsat-surface-reflectance-derived-spectral-
https://www.geo.university/pages/spectral-indices-with-multispectral-satellite-data.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
bands <- stack(list.files(path_files,".tif", full.names=TRUE))
x <- ref_oli(bands, sun.elev= 67.97)
EVI(x[[2]], x[[4]], x[[5]])
```

GCI — *GCI - Green Chlorophyll Index*

Description

This function is used to estimate leaf chlorophyll content of plants species.

Usage

```
GCI(G, NIR)
```

Arguments

G	A raster layer object with the reflectance values for the Green band.
NIR	A raster layer object with the reflectance values for the Near Infrared band.

Value

GCI - Green Chlorophyll Index.

References

Gitelson et al., 2003. Relationships between leaf chlorophyll content and spectral reflectance and algorithms for non-destructive chlorophyll assessment in higher plant leaves. Journal of Plant Physiology, 160, 271-282.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
bands <- stack(list.files(path_files,".tif", full.names=TRUE))
x <- ref_oli(bands, sun.elev= 67.97)
GCI(x[[3]], x[[5]])
```

LAI — *LAI - Leaf Area Index*

Description

This function calculate the Leaf Area Index (LAI) based on Boegh et al., 2002. High LAI values typically range from approximately 0 to 3.5. However, when the scene contains clouds and other bright features that produce saturated pixels, the LAI values can exceed 3.5.

Usage

```
LAI(EVI)
```

Arguments

EVI	A raster layer object with the Enhanced Vegetation Index.

Value

LAI - Leaf Area Index.

References

Boegh et al., 2002. Airborne Multi-spectral Data for Quantifying Leaf Area Index, Nitrogen Concentration and Photosynthetic Efficiency in Agriculture. Remote Sensing of Environment, 81(2-3), 179-193.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
bands <- stack(list.files(path_files,".tif", full.names=TRUE))
x <- ref_oli(bands, sun.elev= 67.97)
evi <- EVI(x[[2]], x[[4]], x[[5]])
LAI(evi)
```

MNDWI *MNDWI - Normalized Difference Water Index*

Description

MNDWI can enhance open water features while efficiently suppressing and even removing built-up land noise as well as vegetation and soil noise.

Usage

```
MNDWI(G, SWIR1)
```

Arguments

G	A raster layer object with the reflectance values for the Green band.
SWIR1	A raster layer object with the reflectance values for the Short Wave Infrared band.

Value

MNDWI - Normalized Difference Water Index

References

Xu, H. 2006. Modification of normalised difference water index (NDWI) to enhance open water features in remotely sensed imagery. International Journal of Remote Sensing, 27(14), 3025-3033.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
bands <- stack(list.files(path_files,".tif", full.names=TRUE))
x <- ref_oli(bands, sun.elev= 67.97)
MNDWI(x[[3]], x[[6]])
```

MSAVI *MSAVI - Modified Soil Adjusted Vegetation Index*

Description

MSAVI minimizes the effect of bare soil on the Soil Adjusted Vegetation Index.

Usage

```
MSAVI(R, NIR)
```

Arguments

R	A raster layer object with the reflectance values for the Red band.
NIR	A raster layer object with the reflectance values for the Near Infrared band.

Value

MSAVI - Modified Soil Adjusted Vegetation Index.

References

https://www.usgs.gov/core-science-systems/nli/landsat/landsat-surface-reflectance-derived-spectral-
https://www.geo.university/pages/spectral-indices-with-multispectral-satellite-data.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
bands <- stack(list.files(path_files,".tif", full.names=TRUE))
x <- ref_oli(bands, sun.elev= 67.97)
MSAVI(x[[4]], x[[5]])
```

NBR — *NBR - Normalized Burn Ratio*

Description

NBR is used to identify burned areas and provide a measure of burn severity.

Usage

```
NBR(NIR, SWIR2)
```

Arguments

NIR	A raster layer object with the reflectance values for the Near Infrared band.
SWIR2	A raster layer object with the reflectance values for the Short Wave Infrared band.

Value

NBR - Normalized Burn Ratio.

References

https://www.usgs.gov/core-science-systems/nli/landsat/landsat-surface-reflectance-derived-spectral-
https://www.geo.university/pages/spectral-indices-with-multispectral-satellite-data.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
bands <- stack(list.files(path_files,".tif", full.names=TRUE))
x <- ref_oli(bands, sun.elev= 67.97)
NBR(x[[5]], x[[7]])
```

NBR2 — *NBR2 - Normalized Burn Ratio 2*

Description

NBR2 modifies the Normalized Burn Ratio to highlight water sensitivity in vegetation and may be useful in post-fire recovery studies.

Usage

```
NBR2(SWIR1, SWIR2)
```

Arguments

`SWIR1`	A raster layer object with the reflectance values for the Short Wave Infrared 1 band.
`SWIR2`	A raster layer object with the reflectance values for the Short Wave Infrared 2 band.

Value

NBR2 - Normalized Burn Ratio 2.

References

https://www.usgs.gov/core-science-systems/nli/landsat/landsat-surface-reflectance-derived-spectral-
https://www.geo.university/pages/spectral-indices-with-multispectral-satellite-data.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
bands <- stack(list.files(path_files,".tif", full.names=TRUE))
x <- ref_oli(bands, sun.elev= 67.97)
NBR2(x[[6]], x[[7]])
```

NDMI *NDMI - Normalized Difference Moisture Index*

Description

NDMI is used to determine vegetation water content.

Usage

```
NDMI(NIR, SWIR)
```

Arguments

`NIR`	A raster layer object with the reflectance values for the Near Infrared band.
`SWIR`	A raster layer object with the reflectance values for the Short Wave Infrared band.

Value

NDMI - Normalized Difference Moisture Index.

References

https://www.usgs.gov/core-science-systems/nli/landsat/landsat-surface-reflectance-derived-spectral-
https://www.geo.university/pages/spectral-indices-with-multispectral-satellite-data.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
bands <- stack(list.files(path_files,".tif", full.names=TRUE))
x <- ref_oli(bands, sun.elev= 67.97)
NDMI(x[[5]], x[[6]])
```

NDVI *NDVI - Normalized Difference Vegetation Index*

Description

NDVI is used to quantify vegetation greenness and is useful in understanding vegetation density and assessing changes in plant health. This function requires the Red and Near Infrared values.

Usage

```
NDVI(R, NIR)
```

Arguments

R	A raster layer object with the reflectance values for the Red band.
NIR	A raster layer object with the reflectance values for the Near Infrared band.

Value

NDVI - Normalized Difference Vegetation Index.

References

https://www.usgs.gov/core-science-systems/nli/landsat/landsat-surface-reflectance-derived-spectral-
https://www.geo.university/pages/spectral-indices-with-multispectral-satellite-data.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
bands <- stack(list.files(path_files,".tif", full.names=TRUE))
x <- ref_oli(bands, sun.elev= 67.97)
NDVI(x[[4]], x[[5]])
```

NDWI *NDWI - Normalized Difference Water Index*

Description

This index is designed to maximize reflectance of water by using green wavelengths; minimize the low reflectance of NIR by water features; and take advantage of the high reflectance of NIR by vegetation and soil features. Water features have positive values and thus are enhanced, while vegetation and soil usually have zero or negative values and therefore are suppressed.The NDWI is useful in crop health monitoring, land-water boarding mapping, inland water discrimination from open sea water bodies, among others.

Usage

```
NDWI(G, NIR)
```

Arguments

`G`	A raster layer object with the reflectance values for the Green band.
`NIR`	A raster layer object with the reflectance values for the Near Infrared band.

Value

NDWI - Normalized Difference Water Index.

References

McFeeters, SK. 1996. The use of the Normalized Difference Water Index (NDWI) in the delineation of open water features. International Journal of Remote Sensing, 17(7), 1425-1432. https://www.geo.university/pages/spectral-indices-with-multispectral-satellite-data.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
bands <- stack(list.files(path_files,".tif", full.names=TRUE))
x <- ref_oli(bands, sun.elev= 67.97)
NDWI(x[[3]], x[[5]])
```

NPCRI — *NPCRI - Normalized Pigment Chlorophyll Ratio Index*

Description

NPCRI is an index that is associated with the chlorophyll content and can find applications in precission agriculture. Using the red and blue spectral bands, NPCRI captures the information needed to quantify chlorophyll and Nitrogen.

Usage

```
NPCRI(B, R)
```

Arguments

B	A raster layer object with the reflectance values for the Blue band.
R	A raster layer object with the reflectance values for the Red band.

Value

NPCRI - Normalized Pigment Chlorophyll Ratio Index.

References

https://www.geo.university/pages/spectral-indices-with-multispectral-satellite-data.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
bands <- stack(list.files(path_files,".tif", full.names=TRUE))
x <- ref_oli(bands, sun.elev= 67.97)
NPCRI(x[[2]], x[[4]])
```

rad_oli — *Radiance Landsat OLI*

Description

This function Convert Digital Numbers to TOA Radiance using the radiance rescaling factors in the MTL file.

Usage

```
rad_oli(x)
```

Arguments

`x`	A raster stack containing the first seven Landsat OLI bands.

Value

A raster layer object with the Top of atmosphere spectral radiance.

References

https://www.usgs.gov/core-science-systems/nli/landsat/using-usgs-landsat-level-1-data-product.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
x <- stack(list.files(path_files,".tif", full.names=TRUE))
rad_oli(x)
```

`ref_oli` *Reflectance Landsat OLI*

Description

This function convert Digital Numbers to TOA Reflectance using the rescaling coefficients in the MTL file.

Usage

```
ref_oli(x, sun.elev)
```

Arguments

`x`	A raster stack containing the first seven Landsat OLI bands.
`sun.elev`	Sun elevation angle in degrees.

Value

A raster layer object with the Top of atmosphere planetary reflectance.

References

https://www.usgs.gov/core-science-systems/nli/landsat/using-usgs-landsat-level-1-data-product.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
x <- stack(list.files(path_files,".tif", full.names=TRUE))
ref_oli(x, 67.97)
ref_oli(x, sun.elev=67.97)
```

SAVI *SAVI - Soil Adjusted Vegetation Index*

Description

SAVI is used to correct the Normalized Difference Vegetation Index for the influence of soil brightness in areas where vegetative cover is low.

Usage

```
SAVI(R, NIR)
```

Arguments

R	A raster layer object with the reflectance values for the Red band.
NIR	A raster layer object with the reflectance values for the Near Infrared band.

Value

SAVI - Soil Adjusted Vegetation Index.

References

https://www.usgs.gov/core-science-systems/nli/landsat/landsat-surface-reflectance-derived-spectral-
https://www.geo.university/pages/spectral-indices-with-multispectral-satellite-data.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
bands <- stack(list.files(path_files,".tif", full.names=TRUE))
x <- ref_oli(bands, sun.elev= 67.97)
SAVI(x[[4]], x[[5]])
```

SI *SI - Shadow Index*

Description

SI has main applications in forestry and crop monitoring. The characteristics of canopy shadow are associated by the total spectral radiance that is reflected from the canopy. Canopy shadow provides essential information about trees and plants arrangement.

Usage

```
SI(B, G, R)
```

Arguments

B	A raster layer object with the reflectance values for the Blue band.
G	A raster layer object with the reflectance values for the Green band.
R	A raster layer object with the reflectance values for the Red band.

Value

SI - Shadow Index

References

Rikimaru et al., 2002. Tropical forest cover density mapping. Tropical Ecology, 43, 39-47. https://www.geo.university/pages/spectral-indices-with-multispectral-satellite-data.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
bands <- stack(list.files(path_files,".tif", full.names=TRUE))
x <- ref_oli(bands, sun.elev= 67.97)
SI(x[[2]], x[[3]], x[[4]])
```

solrad *Solar radiation from air temperature differences*

Description

This function is used to estimate the Solar Radiation in MJ/sq.m/day from air temperature differences by using the Hargreaves radiation formula. Please, see the equation 50 from the FAO Irrigation and drainage paper 56.

Usage

```
solrad(kRs, tmax, tmin, lat, doy)
```

Arguments

kRs	Adjustment coefficient. Interior locations = 0.16, ..., Coastal locations = 0.19.
tmax	Maximum air temperature in Celsius degrees.
tmin	Minimum air temperature in Celsius degrees.
lat	Latitude in decimal degrees.
doy	Day of the year.

Value

Solar radiation in MJ/sq.m/day.

References

Allen et al., 1998. Crop Evapotranspiration. Guidelines for computing crop water requirements. FAO Irrigation and drainage paper 56. http://www.fao.org/3/X0490E/x0490e00.htm.

Examples

```
solrad(kRs= 0.19, tmax= 25, tmin= 15, lat= 43.5, doy= 150)
```

tasscap_oli *Tasselled Cap Transformation*

Description

This function Convert Reclectance values to Brightness, Greenness and Wetness.

Usage

```
tasscap_oli(x)
```

Arguments

x	A raster stack containing the reflectance values of the first seven Landsat OLI bands.

Value

Layer 1 - Brightness.

Layer 2 - Greenness.

Layer 3 - Wetness.

References

Baig et al., 2014. Derivation of a tasselled cap transformation based on Landsat 8 at-satellite reflectance. Remote Sensing Letters 5(5), 423-431.

Examples

```
library(raster)
path_files <- system.file("extdata/", package="nightmares")
x <- stack(list.files(path_files,".tif", full.names=TRUE))
tasscap_oli(x)
```

---

thermal_oli *Top of Atmosphere Brightness Temperature*

Description

This function Convert Digital Numbers to Top of Atmosphere Brightness Temperature.

Usage

```
thermal_oli(x, band = c(10, 11), units = c(Celsius, Kelvin, Fahrenheit))
```

Arguments

x	A raster containing the Landsat OLI band 10 or 11.
band	Specify if your raster is the Landsat OLI band 10 or 11
units	specify if your desired units are Celsius, Kelvin, or Fahrenheit degrees

Value

A raster layer object with the Top of atmosphere brightness temperature.

References

https://www.usgs.gov/core-science-systems/nli/landsat/using-usgs-landsat-level-1-data-product.

Examples

```
library(raster)
B10 <- raster(system.file("extdata/3047_20190517_B10.tif", package="nightmares"))
B11 <- raster(system.file("extdata/3047_20190517_B11.tif", package="nightmares"))
thermal_oli(B10, 10, "Celsius")
thermal_oli(B11, 11, "Fahrenheit")
```

Index