Package 'CropPhenology'

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Type Package

Title Extract phenologic metrics from timeseries vegetation index data

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Description CropPhenology-package

License GPL (>=2)

Encoding UTF-8

URL https://github.com/SofanitAraya/CropPhenology,
http://cropphenology.wix.com/package

Repository github

Depends foreign, raster, sp (>= 1.0-13), maptools, shapefiles, rgdal,Rcpp, rgdal, rgeos

SystemRequirments R (> 3.0)

LazyLoad true

LazyData true

RoxygenNote 6.0.1

R topics documented:

`CropPhenology` *Extract phenologic metrics from timeseries vegetation index data*

Description

Extract phenological metrics from time series vegetation index data

Details

Introduction

Multi temporal vegetation index data can be used to get information on seasonal vegetation growth dynamics. This information indicates vegetation phenological growth stages and conditions of environmental factors influencing the vegetation growth. In cropping regions the crop growth dynamics observed from multi temporal vegetation index data has been used in applications such as crop type detection (Zhong et.al. 2011, Roerink et.al. 2011), regional crop yield estimation (Hill et.al. 2003) and many more related studies. Moreover, the long term vegetation dynamics can provide information about influential environmental factors such as soil property mapping (Araya et,al. 2016). Plotting a time series of vegetation index values across time creates a curve that summarises the vegetation dynamics (Figure 1). Extraction of seasonal parameters is an essential step for analysing such vegetation dynamics curve. CropPhenology package has been developed to extract phenological parameters from time series vegetation index data in cropping regions.

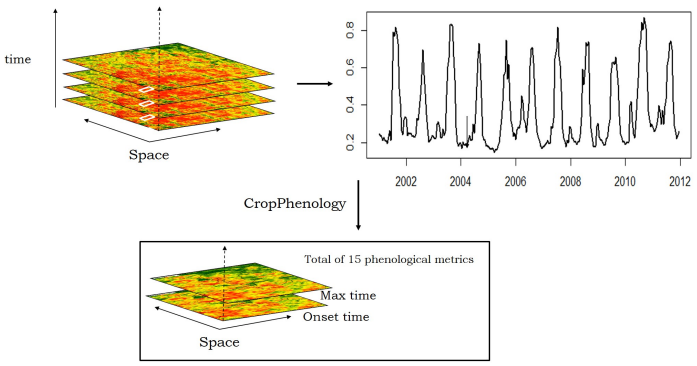

Figure 1 – Illustration for vegetation dynamics derived from multi temporal vegetation index data, and phenological metrics derived from vegetation dynamics using CropPhenology package

Overview of data processing

CropPhenology has two functions: PhenoMetrics and MultiPointsPlot. PhenoMetrics:- takes the path for the time series vegetation index data and the vector file that defines the Area of Interest (AOI). It extracts fifteen phenological metrics (Figure 2) which represent the seasonal growth condition of the crop at each pixel for the season. The output is presented as a raster stack of phenological metrics or a table of phenological metrics for point AOI. Table 1 summaises the defined metrics and their descriptions.

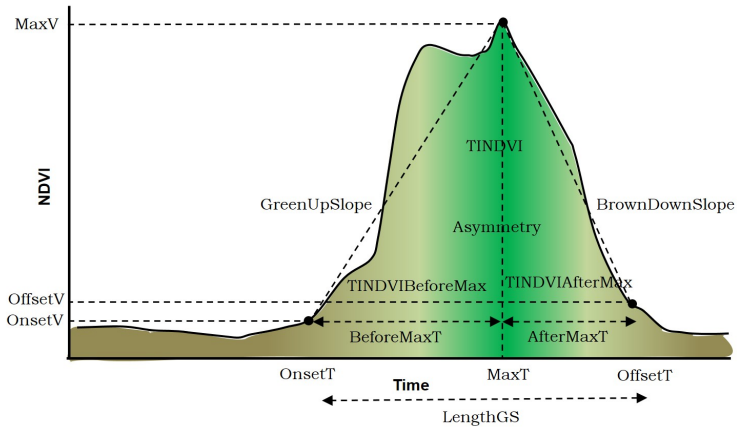

Figure 2 –NDVI dynamics curve with representation of phenological metrics

Metrics	Definition on the NDVI curve, Formula, and description
OnsetV (in NDVI value)	NDVI value measured at the start of continuous positive slope over a threshold between successive NDVI values. The threshold is defined as user defined percentage above the minimum NDVI value before the Maximum value.
OnsetT (in MODIS image period)	MODIS acquisition time when OnsetV is derived.
MaxV (in NDVI value)	Maximum NDVI value achieved during the season MaxV= Maximum (NDVI1 : NDVI23)
MaxT (in MODIS imaging period)	MODIS acquisition time when MaxV is derived.
OffsetV (in NDVI value)	NDVI value measured at the lowest slope below a threshold between successive NDVI values. The threshold is defined as the user defined percentage of the minimum NDVI value after maximum. Values are higher than 0.2.
OffsetT (in MODIS imaging period)	MODIS acquisition period when OffsetV is derived.
LengthGS (in MODIS imaging period)	The duration of time that the crop takes to go through all the stages of crop growth $LengthGS = OffsetT - OnsetT$
BeforeMaxT (in MODIS image period)	The length of time from OnsetT to the MaxT $BeforeMaxT = MaxT - OnsetT$
AfterMaxT (in MODIS image period)	The length of time from MaxT and OffsetT $AfterMaxT = OffsetT - MaxT$
GreenUpSlope	The rate at which NDVI increases from the OnsetV to MaxV over the time difference between MaxT and OnsetT $GreenUpSlope = \frac{(MaxV - OnsetV)}{(MaxT - OnsetT)}$
BrownDownSlope	The rate at which NDVI decreases from MaxV to OffsetV over the difference between OffsetT and MaxT. $\text{BrownDownSlope} = \frac{(\text{MaxV} - \text{OffsetV})}{(\text{OffsetT} - \text{MaxT})}$
TINDVI (Accumulated NDVI value)	Area under the NDVI curve between OnsetT and OffsetT. TINDVI is estimated using trapezoidal numerical integration.
TINDVIBeforeMax (Accumulated NDVI value)	Numerical integration of NDVI between OnsetT and MaxT. This metric indicates the pre-anthesis crop growth.
TINDVIAfterMax (Accumulated NDVI value)	Numerical integration of NDVI between MaxT and OffsetT. This metric indicates the post-anthesis growth.
Asymmetry (in NDVI value)	The symmetry of the NDVI curve. It measures which part of the growing season attain relatively higher accumulated NDVI values. $Asymmetry = TINDVIBeforeMax - TINDVIAfterMax$

Table 1 – summary of descriptions of the phenological metrics defined in CropPhenology

MultiPointsPlot:- provides the user with the ability to visualise the NDVI curve by plotting the temporal sequences of NDVI values of user selected raster pixels (maximum of five). This allows the user to observe the spatial and temporal differences in relative dynamics of the vegetation index for the selected points. Figure 3 shows example for the output of MultiPointsPlot.

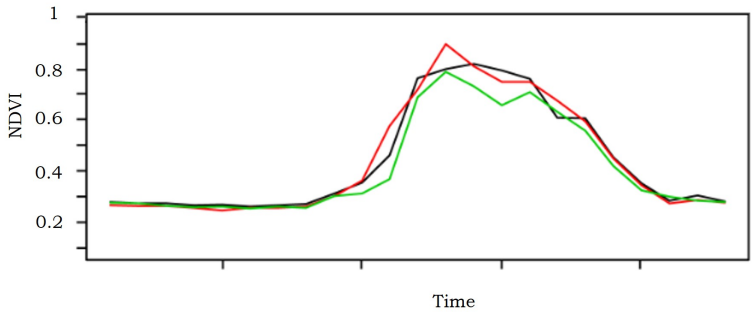

Figure 3 – Illustration for NDVI dynamics from 3 locations ploted together using MultiPointsPlots

References

Araya, S., Lyle, G., Lewis, M., and Ostendorf, B. 2016. Phenologic metrics derived from MODIS NDVI as indicators for Plant Available Water-holding Capacity. *Ecological Indicators* **60:1263-1272**. http://dx.doi.org/10.1016/j.ecolind.2015.09.012

Hill, M. J. and Donald, G. E. 2003. Estimating spatio-temporal patterns of agricultural productivity in fragmented landscapes using AVHRR NDVI time series. *Remote Sensing of Environment* **84:367-384.** DOI:10.1016/s0034-4257(02)00128-1

Roerink, G. J., Danes, M. H. G. I., Prieto, O. G., De Wit, A. J. W., and Van Vliet, A. J. H. 2011. Deriving plant phenology from remote sensing. *in 6th International Workshop on the Analysis of Multi-temporal Remote Sensing Images*, Trento, Italy, **Pages 261-264**

Zhong, L., Hawkins, T., Biging, G., Gong, P., 2011. A phenology-based approach to map crop types in the San Joaquin Valley, California.*International Journal of Remote Sensing,* **32, 7777-7804.**

`MultiPointsPlot` *Time series curves for Multiple points in the Region of Interest*

Description

MultiPointsPlot function takes the ID for the pixels within the region of interst and returns, the timeseries curves from these points, ploted together. The Id numbers can be obtained from the txt file (AllPixels.txt) outputs.

Usage

```
MultiPointsPlot(path, N, Id1, Id2, Id3, Id4, Id5)
```

Arguments

`path`	- the path whee AllPixel.txt saved
`N`	- number of intersted points
`Id1`	- ID number for point 1
`Id2`	- Id number for point 2
`Id3`	- ID number for point 3
`Id4`	- ID number for point 4
`Id5`	- ID number for point 5

Details

This function allows plotting time series curves from multiple points together in a single plot which helps understanding the growth variability across the field. The maximum number of pixeles allowed plotting togther are 5 points.

Value

Multiple time series curves together at the plot panel

See Also

PhenoMetrics()

PhenoMetrics *Phenologic metrics from time series vegetation index data*

Description

This function extracts 15 phenologic metrics from time series vegetaion index data, as raster and Ascii files. The function takes path of the vegetation index data and the boolean Value for BolAOI (True- if there is AOI polygon, FALSE- if the parameters are calculated for the whole region).

Usage

```
PhenoMetrics(Path, BolAOI, Percentage, Smoothing)
```

Arguments

`Path`	- Text value - the path where the time series images saved
`BolAOI`	- Logical value - if there is any area of intererst or not
`Percentage`	- Optional Numeric Vlaue - percentage of minimum NDVI value at which the Onset and Offset is defined. The 'Percentage' paramenter is optional; if not provided, a Default value of 10 will be taken.
`Smoothing`	- Optional logical value - if the user chooses to use smoothed curve or row/unsmoothed curve. If "Smoothing' is set to TRUE, the moving avegare filter will be applied to the vegetation index curve. The default value, if not provided, is FALSE, then the unsmoothed row data be used for the analysis.

Value

PhenoStack.img - a raster stack of 15 images in the order of OnsetV, OnsetT, MaxV, MaxT, OffsetV, OffsetT, LengthGS, BeforeMaxT, AfterMaxT, GreenUpSlope, BrownDownSlope, TINDVI, TINDVIBeforeMax, TINDVIAfterMax, Asymmetry

See Also

MultiPointsPlot (Path, N,Id1, Id2...IdN)

Examples

```
#EXAMPLE - 1

#PhenoMetrics(system.file("extdata/data1", package="CropPhenology"), FALSE, 15, TRUE)

#EXAMPLE - 2

# PhenoMetrics(system.file("extdata/data2", package="CropPhenology"), TRUE)
```

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