Package ‘lakemorpho’

February 20, 2015

Type Package
Title Lake morphometry in R
Version 1.0
Date 2013-11-19
URL http://www.github.com/USEPA/lakemorpho
BugReports https://www.github.com/USEPA/lakemorpho/issues
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Description Lake morphometry metrics are used by limnologists to understand, among other things, the ecological processes in a lake. This package provides the tools to calculate a typical suite of these metrics from an input elevation model and lake polygon.

Depends R (>= 2.10), maptools
Imports rgdal, raster, rgeos, sp, geosphere
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NeedsCompilation no
Repository CRAN
Date/Publication 2014-08-29 20:29:33

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calcLakeMetrics

Calculate all Lake Morphometry Metrics

Description

This function is a wrapper function for all of the metrics. It calculates each metric for an input lakeMorphoClass. This returns a list of all metrics

Usage

calcLakeMetrics(inLakeMorpho, bearing, pointDens, correctFactor = 1)

Arguments

inLakeMorpho an object of lakeMorphoClass. Output of the lakeSurroundTopo function would be appropriate as input

bearing Character that indicates the bearing of the desired fetch

pointDens Number of points to place equidistant along shoreline for lakeMaxLength or density of lines to test for lakeMaxWidth and lakeFetch.

correctFactor Value used to correct the predicted maximum lake depth. Defaults to 1. Corrections are simply accomplished by multiplying estimated max depth by correction factor. Correction factors can be determined empirically by regressing the predicted depth against a known maximum depth while forcing the intercept through zero. The slope of the line would then be used as the correction factor(Hollister et. al, 2011).

Value

Returns a list with all lake metrics calculated for a given input lakemorpho object
References

Florida LAKEWATCH (2001). A Beginner’s guide to water management - Lake Morphometry (2nd ed.). Gainesville: Florida LAKEWATCH, Department of Fisheries and Aquatic Sciences. Link


Examples

```r
## Not run:
data(lakes)
calcLakeMetrics(inputLM,45,250)
## End(Not run)
```

---

**exampleElev**

*Elevation Data for `lakemorpho` examples*

**Description**

This example data is a RasterLayer of a small subset of the National Elevation Dataset named exampleElev.

**Format**

RasterLayer of 1094 x 1419 and 30 meter resolution

---

**exampleLake**

*Lake Data for `lakemorpho` examples*

**Description**

This example data is a SpatialPolygonsDataframe of lakes named exampleLakes. These lakes are originally from the NHDPlus V2 dataset.

**Format**

SpatialPolygonDataframe with 115 lakes, each with 13 variables
Description

This example lakemorpho class was generated using lakeSurroundTopo with the included exampleElev and exampleLake data.

Format

lakemorpho class

Function to calculate fetch along an input bearing

Description

The function calculates the maximum in lake distance of a line along an input bearing.

Usage

lakefetch(inLakeMorpho, bearing, addLine = T)

Arguments

inLakeMorpho  An object of lakeMorphoClass. Output of the lakeSurroundTopo function would be appropriate as input
bearing  Character that indicates the bearing of the desired fetch
addLine  Boolean to determine if the selected max length line should be added to the inLakeMorpho object. Defaults to True. Note that the line is returned in the same projection as the input data.

Value

Returns a numeric value indicating the length of the longest line in the lake along the input bearing. Units are the same as the input data.

References

Florida LAKEWATCH (2001). A Beginner’s guide to water management - Lake Morphometry (2nd ed.). Gainesville: Florida LAKEWATCH, Department of Fisheries and Aquatic Sciences. Link

Examples

data(lakes)
lakefetch(inputLM, 45)
Description

This function uses slope and distance to estimate max depth. This is based on the assumption that the slope of the surrounding topography is similar to the bathymetry of the lake (Hollister et. al 2011).

Usage

```r
lakemaxdepth(inLakeMorpho, correctFactor = 1)
```

Arguments

- `inLakeMorpho`: An object of `lakeMorphoClass`. Output of the `lakesurroundtopo` function would be appropriate as input
- `correctFactor`: Value used to correct the predicted maximum lake depth. Defaults to 1. Corrections are simply accomplished by multiplying estimated max depth by correction factor. Correction factors can be determined empirically by regressing the predicted depth against a known maximum depth while forcing the intercept through zero. The slope of the line would then be used as the correction factor (Hollister et. al, 2011).

Value

Returns a numeric value of the predicted maximum depth

References


Florida LAKEWATCH (2001). A Beginner’s guide to water management - Lake Morphometry (2nd ed.). Gainesville: Florida LAKEWATCH, Department of Fisheries and Aquatic Sciences. [Link](#)

Examples

```r
data(lakes)
lakeMaxDepth(inputLM)
```
Description

Maximum lake length is defined as the longest open water distance of a lake. This function determines the maximum lake length of lake by comparing the lengths of a user defined number of lines. The user specifies a number of points to distribute along the lake shoreline and the point to point line lengths are checked for multiple intersections (i.e. line not just open water), starting with the longest line first. Function is currently very sensitive to pointDens and slows down considerably for larger values. Small values of point dens are acceptable for lakes without complex shorelines. Care needs to be taken in selecting an appropriate pointDens and multiple values should be checked to ensure stability in the estimates.

Usage

\[
lakemaxlength(inLakeMorpho, pointDens, addLine = T)\]

Arguments

- **inLakeMorpho**: An object of `lakeMorphoClass`. Output of the `lakesurroundtopo` function would be appropriate as input.
- **pointDens**: Number of points to place equidistant along shoreline. The maximum point to point distance that does not also intersect the shoreline is used. To total of \(n(n-1)/2\) comparisons is possible, but in practice is usually significant less.
- **addLine**: Boolean to determine if the selected max length line should be added to the inLakeMorpho object. Defaults to True.

Value

This returns a numeric value indicating the length of the longest line possible in the lake. Units are the same as the input data.

References

Florida LAKEWATCH (2001). A Beginner’s guide to water management - Lake Morphometry (2nd ed.). Gainesville: Florida LAKEWATCH, Department of Fisheries and Aquatic Sciences. Link

Examples

```r
data(lakes)
lakeMaxLength(inputLM, 50)
```
lakeMaxWidth

Function to find line representing maximum lake Width

Description

Maximum lake width is defined as the maximum in lake distance that is perpendicular to the maximum lake length. This function calculates the equation of the perpendicular line and repeats that line pointDens number of times and returns the longest of those lines.

Usage

lakeMaxWidth(inLakeMorpho, pointDens, addLine = T)

Arguments

inLakeMorpho  An object of lakeMorphoClass. Output of the lakeSurroundTopo function would be appropriate as input
pointDens     Number of points to place equidistant along the lakeMaxLength. A line that crosses at that point and extends from shore to shore is calculated.
addLine       Boolean to determine if the selected max length line should be added to the inLakeMorpho object. Defaults to True

Value

Returns a numeric value indicating the length of the longest line perpendicular to the maximum length line.

References

Florida LAKEWATCH (2001). A Beginner’s guide to water management - Lake Morphometry (2nd ed.). Gainesville: Florida LAKEWATCH, Department of Fisheries and Aquatic Sciences. Link

Examples

data(lakes)
lakeMaxWidth(inputLM, 50)
lakeMeanDepth  

*Function to return lake Mean Depth*

**Description**
Calculates average depth of lake as a mean of lake volume divided by lake surface area

**Usage**
```r
lakeMeanDepth(inLakeMorpho)
```

**Arguments**
- `inLakeMorpho` An object of `lakeMorphoClass`. Output of the `lakeSurroundTopo` function would be appropriate as input

**Value**
Returns a numeric value for the mean depth of the lake

**References**
Florida LAKEWATCH (2001). A Beginner’s guide to water management - Lake Morphometry (2nd ed.). Gainesville: Florida LAKEWATCH, Department of Fisheries and Aquatic Sciences. [Link](#)

**Examples**
```r
data(lakes)
lakeMeanDepth(inputLM)
```

---

lakeMeanWidth  

*Function to return lake Mean Width*

**Description**
Mean lake width is the result of lake surface area divided by the maximum length.

**Usage**
```r
lakeMeanWidth(inLakeMorpho)
```

**Arguments**
- `inLakeMorpho` An object of `lakeMorphoClass`. Output of the `lakeSurroundTopo` function would be appropriate as input
Value

Returns a numeric value for the mean width of the lake

References

Florida LAKEWATCH (2001). A Beginner’s guide to water management - Lake Morphometry (2nd ed.). Gainesville: Florida LAKEWATCH, Department of Fisheries and Aquatic Sciences. Link

Examples

data(lakes)
lakeMeanWidth(inputLM)

Description

Lakemorpho provides a number of functions to calculate a standard suite of lake morphometry metrics. Most of the metrics are measurements of the shape of the lake. Metrics that rely on depth have traditionally been calculated with bathymetry data. In the absence of bathymetry data it is possible to estimate maximum depth from surrounding topography. Lakemorpho uses this approach to also estimate maximum depth, mean depth, and volume.

Details

This development version of this package is available at https://github.com/USEPA/lakemorpho

References

Florida LAKEWATCH (2001). A Beginner’s guide to water management - Lake Morphometry (2nd ed.). Gainesville: Florida LAKEWATCH, Department of Fisheries and Aquatic Sciences. Link


**lakeMorphoClass**  
*Function to create a lakeMorpho class - this is input to all other methods*

**Description**  
This is a helper function that creates a lakeMorpho class object

**Usage**  
lakeMorphoClass(inLake, inElev, inCatch, inLakeDist, lakeOnEdge = F)

**Arguments**
- **inLake**: input lake SpatialPolygons object
- **inElev**: input elevation model raster object
- **inCatch**: input catchment SpatialPolygons object, can be buffer around lake
- **inLakeDist**: input euclidean distance raster that measures distance from shore to any pixel in the lake
- **lakeOnEdge**: Boolean indicating if inCatch (or lake Buffer) extends beyond extent of elevation data

**Value**  
Returns an objec of class 'lakeMorpho'

**See Also**
- lakeSurroundTopo

---

**lakeShorelineDevelopment**  
*Function to calculate shoreline development*

**Description**  
Shoreline development is a measure of the complexity of the lake shoreline. It is simply the ratio of the shoreline length (i.e. perimeter) to the perimeter of an equally sized circle.

**Usage**  
lakeShorelineDevelopment(inLakeMorpho)
Arguments

inLakeMorpho An object of lakeMorphoClass. Output of the lakeSurroundTopo function would be appropriate as input

Value

Returns a numeric value for the shoreline development of the lake

References

Florida LAKEWATCH (2001). A Beginner’s guide to water management - Lake Morphometry (2nd ed.). Gainesville: Florida LAKEWATCH, Department of Fisheries and Aquatic Sciences. Link

Examples

data(lakes)
lakeshorelinedevelopment(inputLM)

---

Description

This function returns the length of the shoreline of the lake and is simply the perimeter of the input lake polyogn.

Usage

lakeshorelinelength(inLakeMorpho)

Arguments

inLakeMorpho An object of lakeMorphoClass. Output of the lakeSurroundTopo function would be appropriate as input

Value

Returns a numeric value for the length of the lake shoreline

References

Florida LAKEWATCH (2001). A Beginner’s guide to water management - Lake Morphometry (2nd ed.). Gainesville: Florida LAKEWATCH, Department of Fisheries and Aquatic Sciences. Link

Examples

data(lakes)
lakeshorelinelength(inputLM)
**lakeSurfaceArea**  
*Return lake surface area*

**Description**
This function simply returns the area of the lake SpatialPolygons that is part of the `lakeMorphoClass` class.

**Usage**
```r
lakeSurfaceArea(inLakeMorpho)
```

**Arguments**
- `inLakeMorpho`: an object of `lakeMorphoClass`. Output of the `lakesurroundtopo` function would be appropriate as input.

**Value**
Returns a numeric value for the total surface area of the lake.

**References**
Florida LAKEWATCH (2001). A Beginner’s guide to water management - Lake Morphometry (2nd ed.). Gainesville: Florida LAKEWATCH, Department of Fisheries and Aquatic Sciences. [Link](#)

**Examples**
```r
data(lakes)
lakeSurfaceArea(inputLM)
```

---

**lakesurroundtopo**  
*Calculate surrounding topography for lake*

**Description**
This function combines all input datasets into a `lakeMorphoClass`. As a part of this combination, the surrounding topography is also determined. If no input catchments are used, it is assumed that a buffer equal to the maximum in lake distance is used. If an input catchement is used, then the surrounding topography is the land area represented by the catchements that intersect the lake.

**Usage**
```r
lakesurroundtopo(inLake, inElev, inCatch = NULL, reso = res(inElev)[1])
```
lakeVolume

Arguments

inLake a SpatialPolygons representing the input lake
inElev a RasterLayer representing the elevation around the lake
inCatch Optional default is NULL which uses a buffer equal to the maximum in lake distance.
reso Optional resolution for raster output (e.g. lake distance). Defaults to the resolution of inElev

Value

Returns an object of class 'lakemorpho' that includes the surrounding topography of the lake.

Examples

## Not run:
data(lakes)
inputLM<-lakeSurroundTopo(exampleLake,exampleElev)
inputLM
## End(Not run)

lakeVolume

Calculates Lake Volume in R

Description

This function returns lake volume for the input lake. The volume is calculated using maximum lake depth and maximum distance ratio to transform all pixels and thus, distances, to an estimated depth. These depths are multiplied by the area of the pixel and summed.

Usage

lakeVolume(inLakeMorpho, correctFactor = 1)

Arguments

inLakeMorpho An object of lakeMorphoClass. Output of the lakeSurroundTopo function would be appropriate as input
correctFactor This a factor used by lakeMaxDepth to correct the predicted maximum lake depth. Defaults to 1.

Value

Returns a numeric value for the total volume of the lake
References


Florida LAKEWATCH (2001). A Beginner’s guide to water management - Lake Morphometry (2nd ed.). Gainesville: Florida LAKEWATCH, Department of Fisheries and Aquatic Sciences. Link

Examples

data(lakes)
lakeVolume(inputLM)

plot.lakeMorpho

Default plotting of a lakeMorpho object

Description

Plots the lakeMorpho class by showing lake, surround topography and in lake distance

Usage

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

Arguments

x 
input lakeMorpho class to plot

... 
allows for passing of other plot parameters

Examples

## Not run:
data(lakes)
plot(inputLM)
## End(Not run)
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