Surface Roughness

Jared Stabach, Smithsonian Conservation Biology Institute

24 October 2017

Calculate Surface Roughness

We assumed that Addax would select inter-dunal depressions. Instead of including the raw SRTM (elevation) data in our models, we created a variable from the raw eleavtion termed *Surface Roughness*. This variable is the change in elevation range between pixels. That is, it is the difference between the minimum and maximum values of a cell and its eight surrounding neighbors. Pixels with similar neighborhood values have a low change in elevation range (e.g., flat areas), whereas highly variables neighborhoods have a large change in elevation range (e.g., steep slopes) (Wilson, O'Connell, Brown, Guinan, & Grehan, 2007).

Wilson, M.F.J., O'Connell, B., Brown, C., Guinan, J.C., Grehan, A.J., 2007. Multiscale terrain analysis of multibeam bathymetry data for habitat mapping on the continental slope. Marine Geodesy 30: 3-35.

Original data were downloaded from EarthExplorer. Additional information on SRTM can be found here. I selected a study area window and the data product in the EarthExplorer application. The data were then bulk downloaded using the USGS bda tool.

30-m data often have no data areas (i.e., "holes"). These are errors that must be further processed. To fill these areas, I also downloaded an ancillary dataset (the 90-m SRTM gap-filled product (also available on the[EarthExplorer}(http://earthexplorer.usgs.gov/) site). In ArcGIS, I used a conditional statement to fill the no data areas with the 90-meter data (con(IsNull(srtm_30m),srtm_90m,srtm_30m). Data were projected to UTM Zone 32 North, WGS84 datum (30-meter spatial resolution).

Load Libraries

```
# Remove everything in memory
rm(list=ls())

# Load raster and rgdal library
library(raster)
```

```
## Loading required package: sp
```

```
library(sp)
library(rgdal)
```

```
## rgdal: version: 1.2-11, (SVN revision 676)
##  Geospatial Data Abstraction Library extensions to R successfully loaded
##  Loaded GDAL runtime: GDAL 2.2.0, released 2017/04/28
##  Path to GDAL shared files: C:/Users/Jared/Documents/R/win-library/3.4/rgdal/gdal
##  Loaded PROJ.4 runtime: Rel. 4.9.3, 15 August 2016, [PJ_VERSION: 493]
##  Path to PROJ.4 shared files: C:/Users/Jared/Documents/R/win-library/3.4/rgdal/proj
##  Linking to sp version: 1.2-5
```

```
library(proj4)
```

```
##
## Attaching package: 'proj4'
```

```
## The following object is masked from 'package:rgdal':
```

```
##
##     project
```

Set Working Directory

```
getwd()
```

Load Data

This is a dataset subset of the full study area.

```
# Load the 30-m SRTM dataset
srtm <- raster(paste0(getwd(),"/Data/srtm_30m"))

# Check resolution
res(srtm)
```

```
## [1] 30 30
```

```
# The project of the file is already defined
srtm
```

```
## class       : RasterLayer
## dimensions  : 3508, 3133, 10990564  (nrow, ncol, ncell)
## resolution  : 30, 30  (x, y)
## extent      : 760705.1, 854695.1, 1771859, 1877099  (xmin, xmax, ymin, ymax)
## coord. ref. : +proj=utm +zone=32 +datum=WGS84 +units=m +no_defs +ellps=WGS84 +towgs84=0,0,0
## data source : G:\Jared\Projects\Addax\Data\srtm_30m
## names       : srtm_30m
## values      : 360.3803, 595.9796  (min, max)
```

```
# Plot the result
plot(srtm)

# Load the point data
Sub <- readOGR(dsn="./Data", layer="Clipped_Add")
```

```
## OGR data source with driver: ESRI Shapefile
## Source: "./Data", layer: "Clipped_Add"
## with 661 features
## It has 12 fields
## Integer64 fields read as strings:  Pt_ID Id_1
```

```
plot(Sub,pch=15,cex=0.7,add=TRUE)
# Look at the file
head(Sub)
```

```
##   Pt_ID       Date YearMonth Id_1        X       Y Addax Dorcas Cornul
## 1    13 2008-12-06    200812   23 825358.1 1773472     0      3      0
## 2    14 2008-12-06    200812   23 830041.8 1776055     0      5      0
## 3    15 2008-12-06    200812   23 835354.5 1779007     0      7      0
## 4    17 2008-12-06    200812   23 840739.0 1781912     0      2      0
## 5    19 2008-12-06    200812   23 845644.1 1784587     0      1      0
## 6    21 2008-12-06    200812   23 850100.0 1787353     0     11      0
##   Stipa1 Stipa2 Human
```

```
## 1      1      0     0
## 2      0      0     0
## 3      0      0     1
## 4      1      0     0
## 5      0      0     1
## 6      0      1     0
```

```
# Look at the parameters
Sub
```

```
## class       : SpatialPointsDataFrame
## features    : 661
## extent      : 789521, 850100, 1773472, 1876866  (xmin, xmax, ymin, ymax)
## coord. ref. : +proj=utm +zone=32 +datum=WGS84 +units=m +no_defs +ellps=WGS84 +towgs84=0,0,0
## variables   : 12
## names       : Pt_ID,       Date, YearMonth, Id_1,        X,       Y, Addax, Dorcas, Cornul, Stipa1, S
## min values  :   109, 2008-12-06,    200812,    1, 789521.0, 1773472,     0,      0,      0,      0,
## max values  :    84, 2014-12-05,    201412,    8, 850100.0, 1876866,   166,    136,      1,      1,
```

```
# What if you had a .csv file
# Load your csv, then make spatial
MyData <- read.csv(file="./data/Clipped_Add_csvFile.csv",header=TRUE,sep=",")
head(MyData)
```

```
##   Pt_ID       Date YearMonth Id_1        X       Y Addax Dorcas Cornul
## 1    13 2008-12-06    200812   23 825358.1 1773472     0      3      0
## 2    14 2008-12-06    200812   23 830041.8 1776055     0      5      0
## 3    15 2008-12-06    200812   23 835354.5 1779007     0      7      0
## 4    17 2008-12-06    200812   23 840739.0 1781912     0      2      0
## 5    19 2008-12-06    200812   23 845644.1 1784587     0      1      0
## 6    21 2008-12-06    200812   23 850100.0 1787353     0     11      0
##   Stipa1 Stipa2 Human
## 1      1      0     0
## 2      0      0     0
## 3      0      0     1
## 4      1      0     0
## 5      0      0     1
## 6      0      1     0
```

```
# Make SpatialPointsFile
xy <- MyData[,c(5,6)]
MyData.Spatial <- SpatialPointsDataFrame(coords= xy, data = MyData,
                                         proj4string = CRS("+proj=utm +zone=32 +datum=WGS84 +units=m +n

# Look at the file
head(MyData.Spatial)
```

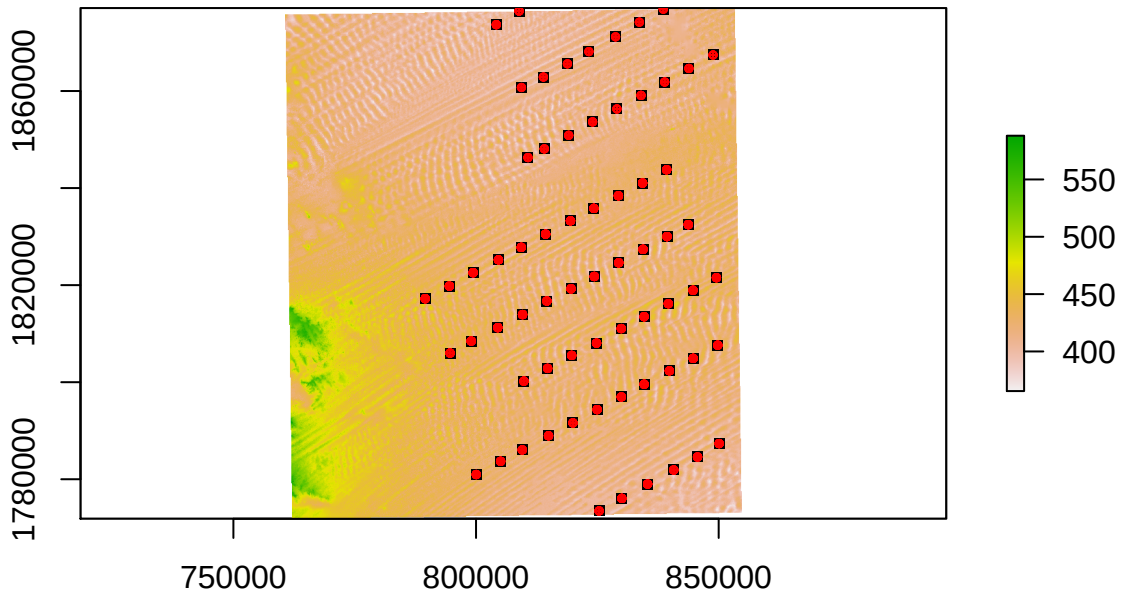
```
##   Pt_ID       Date YearMonth Id_1        X       Y Addax Dorcas Cornul
## 1    13 2008-12-06    200812   23 825358.1 1773472     0      3      0
## 2    14 2008-12-06    200812   23 830041.8 1776055     0      5      0
## 3    15 2008-12-06    200812   23 835354.5 1779007     0      7      0
## 4    17 2008-12-06    200812   23 840739.0 1781912     0      2      0
## 5    19 2008-12-06    200812   23 845644.1 1784587     0      1      0
## 6    21 2008-12-06    200812   23 850100.0 1787353     0     11      0
##   Stipa1 Stipa2 Human
## 1      1      0     0
## 2      0      0     0
```

```
## 3      0      0     1
## 4      1      0     0
## 5      0      0     1
## 6      0      1     0
```

```
# Look at the parameters
MyData.Spatial
```

```
## class       : SpatialPointsDataFrame
## features    : 661
## extent      : 789521, 850100, 1773472, 1876866  (xmin, xmax, ymin, ymax)
## coord. ref. : +proj=utm +zone=32 +datum=WGS84 +units=m +no_defs +ellps=WGS84 +towgs84=0,0,0
## variables   : 12
## names       : Pt_ID,       Date, YearMonth, Id_1,        X,       Y, Addax, Dorcas, Cornul, Stipa1, S
## min values  :    13, 2008-12-06,    200812,    1, 789521.0, 1773472,     0,      0,      0,      0,
## max values  :   110, 2014-12-05,    201412,   23, 850100.0, 1876866,   166,    136,      1,      1,
```

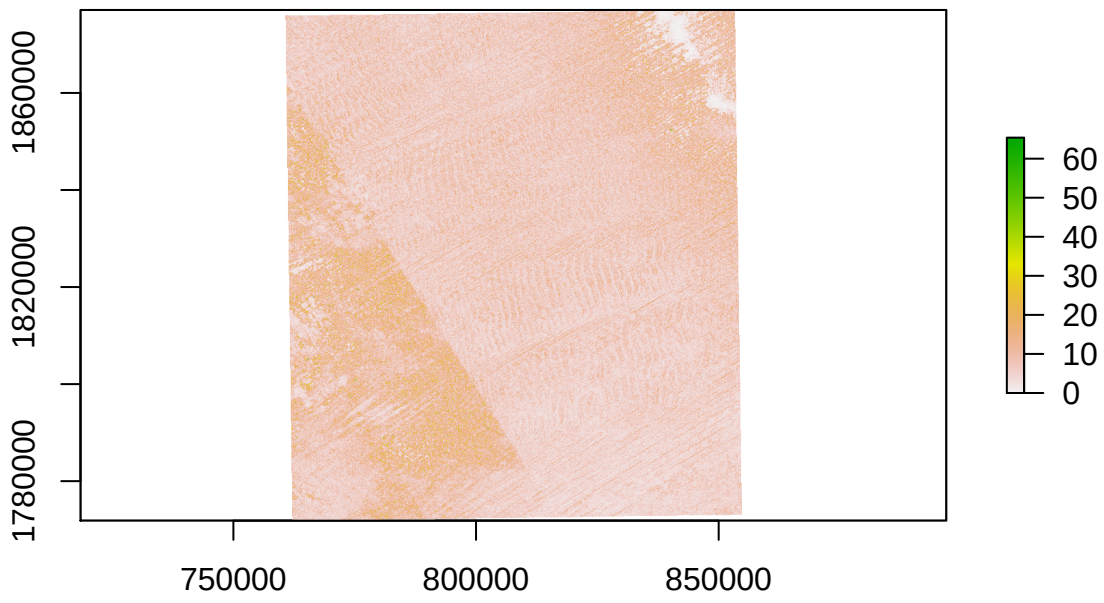
```
plot(MyData.Spatial,pch=10,cex=0.5,col="red",add=TRUE)
```



Generate Terrain Variables

```
rough <- terrain(srtm,opt='roughness')
# Other options. Use help(terrain) for more information
#TRI <- terrain(srtm,opt='TRI')
#TPI <- terrain(srtm,opt='TPI')
```

```
plot(rough)
```




```
#plot(TRI)
#plot(TPI)

# Other variables that could be calculated
#slope <- terrain(srtm,opt='slope', neighbors=8)
#aspect <- terrain(srtm,opt='aspect', neighbors=8)
# Or:
#x <- terrain(srtm, opt=c('slope', 'aspect'), unit='degrees')
#plot(x)
#hill <- hillShade(slope,aspect,angle=45,direction=0)

# Plot the hillshade and overlay the elevation (alpha is the transparency)
#plot(hill,col=grey(0:100/100),legend=FALSE,main='Niger')
#plot(srtm,col=rainbow(25,alpha=0.35), add=TRUE)
```

Variable Extraction

```
# Extract SRTM values at the point locations
# Take the average roughness within a 2.5 km buffer
Sub$ROUGH <- extract(rough,Sub,method='simple',buffer=2500,fun=mean)
#Sub$TRI <- extract(TRI,Sub,method='simple',buffer=2500,fun=mean)
#Sub$TPI <- extract(TPI,Sub,method='simple',buffer=2500,fun=mean)
```

```r
# How is this different than just extracting at the point?
Sub$RGH_PT <- extract(rough,Sub)

# Look at the data
head(Sub)
```

```
##   Pt_ID       Date YearMonth Id_1        X       Y Addax Dorcas Cornul
## 1    13 2008-12-06    200812   23 825358.1 1773472     0      3      0
## 2    14 2008-12-06    200812   23 830041.8 1776055     0      5      0
## 3    15 2008-12-06    200812   23 835354.5 1779007     0      7      0
## 4    17 2008-12-06    200812   23 840739.0 1781912     0      2      0
## 5    19 2008-12-06    200812   23 845644.1 1784587     0      1      0
## 6    21 2008-12-06    200812   23 850100.0 1787353     0     11      0
##   Stipa1 Stipa2 Human    ROUGH   RGH_PT
## 1      1      0     0 3.779610 8.420227
## 2      0      0     0 4.224870 6.208954
## 3      0      0     1 4.340925 2.746216
## 4      1      0     0 4.744831 2.647980
## 5      0      0     1 5.101785 6.040466
## 6      0      1     0 4.952497 2.737762
```

```r
# You could do the same with the .csv file you loaded above
MyData.Spatial$ROUGH <- extract(rough,MyData.Spatial,method='simple',buffer=2500,fun=mean)
MyData.Spatial$RGH_PT <- extract(rough,MyData.Spatial)

# Look at the Data
head(MyData.Spatial)
```

```
##   Pt_ID       Date YearMonth Id_1        X       Y Addax Dorcas Cornul
## 1    13 2008-12-06    200812   23 825358.1 1773472     0      3      0
## 2    14 2008-12-06    200812   23 830041.8 1776055     0      5      0
## 3    15 2008-12-06    200812   23 835354.5 1779007     0      7      0
## 4    17 2008-12-06    200812   23 840739.0 1781912     0      2      0
## 5    19 2008-12-06    200812   23 845644.1 1784587     0      1      0
## 6    21 2008-12-06    200812   23 850100.0 1787353     0     11      0
##   Stipa1 Stipa2 Human    ROUGH   RGH_PT
## 1      1      0     0 3.779610 8.420227
## 2      0      0     0 4.224870 6.208954
## 3      0      0     1 4.340925 2.746216
## 4      1      0     0 4.744831 2.647980
## 5      0      0     1 5.101785 6.040466
## 6      0      1     0 4.952497 2.737762
```