

MODIS data in R.

Learning Objectives

After completing this tutorial, you will be able to:

- Open MODIS imagery in R
- Create NBR index using MODIS imagery in R
- Calculate total burned area in R.

What you need

You will need a computer with internet access to complete this lesson and the data for week 6 of the course.

Download Week 6 Data (~500 MB){:data-proofer-ignore="".btn }

First, let's import MODIS data. Below notice that we have used a slightly different version of the `list.files()` pattern argument.

We have used `glob2rx("*sur_refl*.tif$")` to select all layers that both

1. have the word `sur_refl` in them and
2. contain the extention `.tif`

Let's import our MODIS layer.

```
# open modis bands (layers with sur_refl in the name)
all_modis_bands_july7 <- list.files("data/week6/modis/reflectance/07_july_2016/crop",
                                     pattern=glob2rx("*sur_refl*.tif$"),
                                     full.names = T)

# create spatial raster stack
all_modis_bands_st_july7 <- stack(all_modis_bands_july7)

# view range of values in stack
str(all_modis_bands_st_july7[[2]])

## Formal class 'RasterLayer' [package "raster"] with 12 slots
## ..@ file      :Formal class '.RasterFile' [package "raster"] with 13 slots
## ... . . . @ name       : chr "/Users/lewa8222/Documents/earth-analytics/data/week6/modis/reflectanc
## ... . . . @ datanotation: chr "INT2S"
## ... . . . @ byteorder   : chr "little"
## ... . . . @ nodatavalue : num -Inf
## ... . . . @ NAchanged    : logi FALSE
## ... . . . @ nbands      : int 1
## ... . . . @ bandorder   : chr "BIL"
## ... . . . @ offset       : int 0
## ... . . . @ toptobottom : logi TRUE
## ... . . . @ blockrows    : int 1
## ... . . . @ blockcols    : int 2400
## ... . . . @ driver       : chr "gdal"
## ... . . . @ open         : logi FALSE
## ..@ data      :Formal class 'SingleLayerData' [package "raster"] with 13 slots
## ... . . . @ values     : logi(0)
## ... . . . @ offset      : num 0
## ... . . . @ gain        : num 1
## ... . . . @ inmemory    : logi FALSE
```

```

## ... .@ fromdisk : logi TRUE
## ... .@ isfactor : logi FALSE
## ... .@ attributes: list()
## ... .@ haveminmax: logi TRUE
## ... .@ min      : num -32768
## ... .@ max      : num 32767
## ... .@ band     : int 1
## ... .@ unit     : chr ""
## ... .@ names    : chr "MOD09GA.A2016189.h09v05.006.2016191073856_sur_refl_b02_1"
## ... @ legend   :Formal class '.RasterLegend' [package "raster"] with 5 slots
## ... .@ type     : chr(0)
## ... .@ values   : logi(0)
## ... .@ color    : logi(0)
## ... .@ names    : logi(0)
## ... .@ colortable: logi(0)
## ... @ title    : chr(0)
## ... @ extent   :Formal class 'Extent' [package "raster"] with 4 slots
## ... .@ xmin    : num -10007555
## ... .@ xmax    : num -8895604
## ... .@ ymin    : num 3335852
## ... .@ ymax    : num 4447802
## ... @ rotated  : logi FALSE
## ... @ rotation:Formal class '.Rotation' [package "raster"] with 2 slots
## ... .@ geotrans: num(0)
## ... .@ transfun:function ()
## ... @ ncols   : int 2400
## ... @ nrows   : int 2400
## ... @ crs     :Formal class 'CRS' [package "sp"] with 1 slot
## ... .@ projargs: chr "+proj=sinu +lon_0=0 +x_0=0 +y_0=0 +a=6371007.181 +b=6371007.181 +units=m"
## ... @ history : list()
## ... @ z       : list()

```

Reflectance values range 0-1

As we've discussed in class, the normal range of reflectance values is 0-1 where 1 is the BRIGHTEST values and 0 is the darkest value. Have a close look at the min and max values in the second raster layer of our stack, above. What do you notice?

The min and max values are widely outside of the expected range of 0-1 - min: -32768, max: 32767 What could be causing this? We need to better understand our data before we can work with it more. Have a look at the table in the MODIS users guide. The data that we are working with is the MOD09GA product. Look closely at the table on page 14 of the guide. Part of the table can be seen below.

[Click here](#) to check out the MODIS user guide - check out page 14 for the MOD09GA table.

Notice the valid values for the MOD09GA reflectance product. The range is -100 to 10000.

Looking at the table, answer the following questions

1. What is valid range of values for our data?
2. What is the scale factor associated with our data?

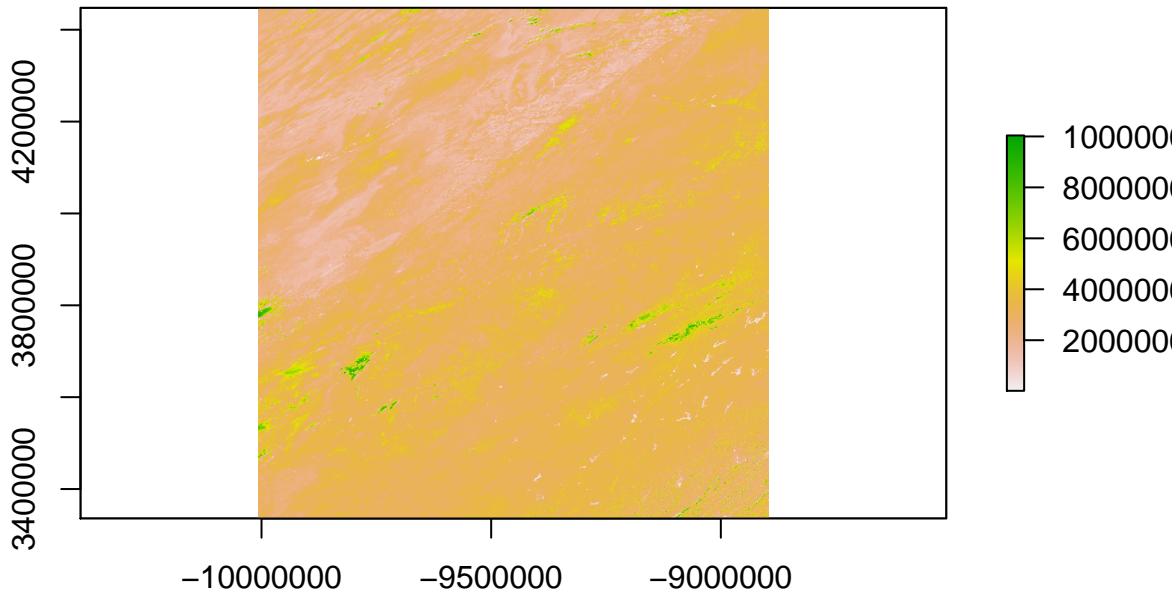


Figure 1:

NoData Values

Let's first deal with no data values. we can see that our data have a “fill” value of -28672 which we can presume to be missing data. But also we see that valid range values begin at -100. Let's set all values less than -100 to NA to remove the extreme negative values that may impact our analysis.

```
# deal with nodata value -- -28672
all_modis_bands_st_july7[all_modis_bands_st_july7 < -100 ] <- NA
# options("scipen"=100, "digits"=4)
plot(all_modis_bands_st_july7[[2]])
```

After assigning our No data values to NA

Next we plot MODIS layers. Use the MODIS band chart to figure out what bands you need to plot to create a RGB (true color) image.

Band	Wavelength range (nm)	Spatial Resolution (m)	Spectral Width (nm)
Band 1 - red	620 - 670	250	2.0
Band 2 - near infrared	841 - 876	250	6.0
Band 3 - blue/green	459 - 479	500	6.0
Band 4 - green	545 - 565	500	3.0
Band 5 - near infrared	1230 – 1250	500	8.0
Band 6 - mid-infrared	1628 – 1652	500	18
Band 7 - mid-infrared	2105 - 2155	500	18

In the plot below, i've called attention to the AOI boundary with a yellow color. Why is it so hard to figure out where the study area is in this MODIS image?

MODIS cloud mask

Next, we can deal with clouds in the same way that we dealt with them using Landsat data. However, our cloud mask in this case is slightly different with slightly different cloud cover values as follows:

State
00
01
10

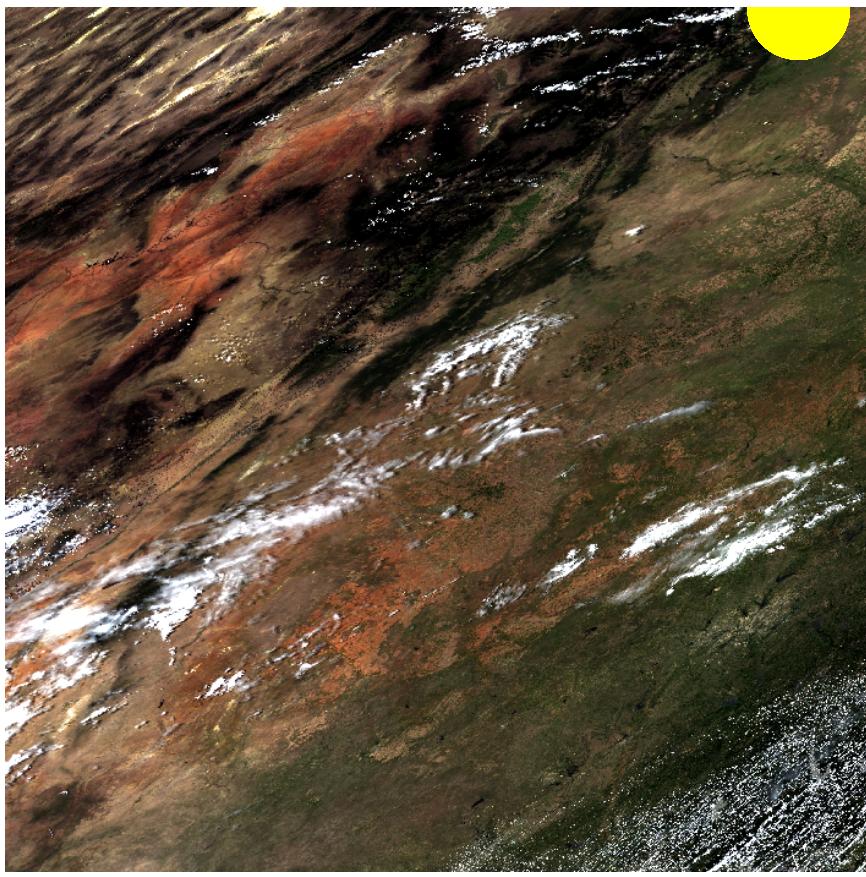


Figure 2: plot MODIS stack

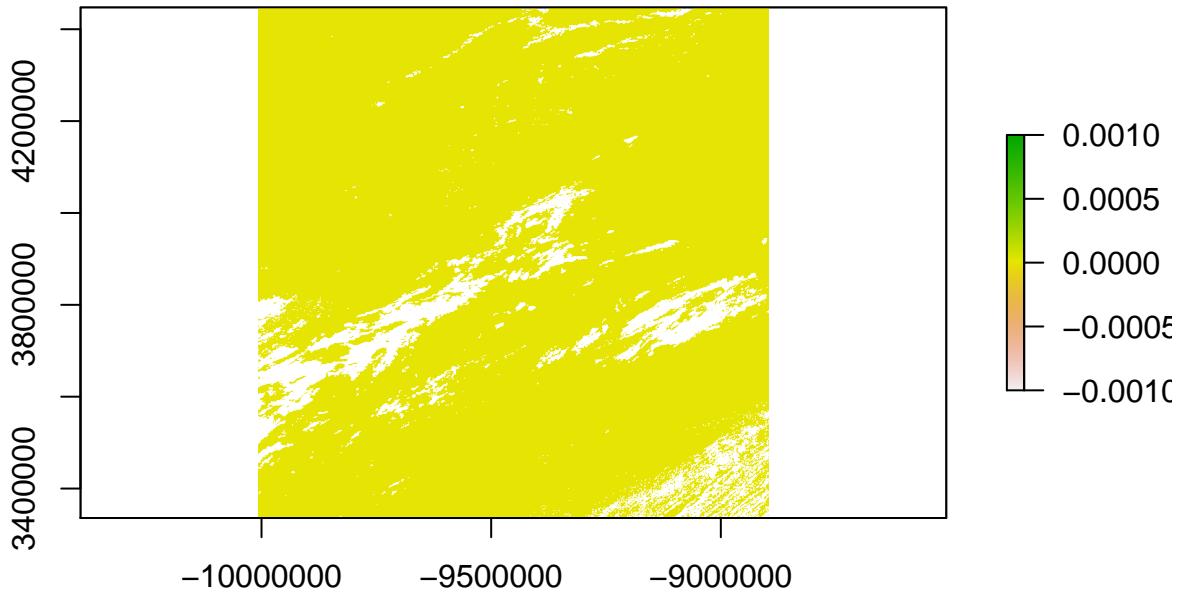


Figure 3: cloud mask plot

MODIS data mask applied Cold springs fire AOI

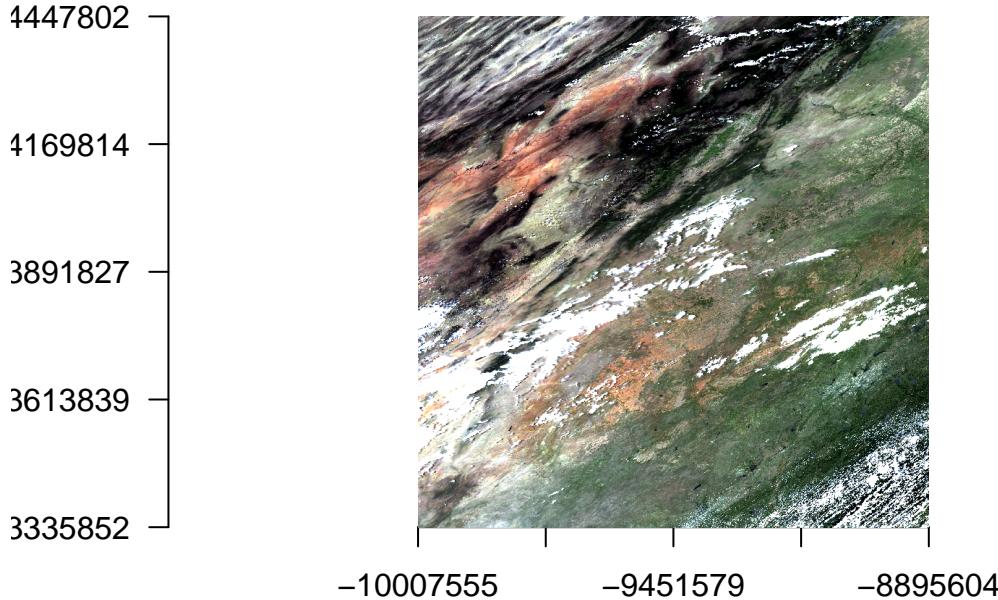


Figure 4: MODIS with cloud mask

```
## 3 = blue, 4 = green, 1= red 2= nir
```

Plot the masked data. Notice that now the clouds are gone as they have been assigned the value NA.
Finally crop the data to see just the pixels that overlay our study area.

<u>SEVERITY LEVEL</u>
Enhanced Regrowth
Unburned
Low Severity
Moderate Severity
High Severity

After we've calculated NBR, we may want to calculate total burn AREA. We can do this using the `freq()` function in R. This function gives us the total number of pixels associated with each value in our classified raster.

Calculate frequency - ignoring NA values: `freq(modis_nbr_cl, useNA='no')` Calculate frequency, ignore NA & only could values == 5 (`freq(modis_nbr_cl, useNA='no', value=5)`)

```
# get summary counts of each class in raster
freq(modis_nbr_cl, useNA='no')
##      value count
## [1,]     4    24

final_burn_area_high_sev <- freq(modis_nbr_cl, useNA='no', value=5)
final_burn_area_moderate_sev <- freq(modis_nbr_cl, useNA='no', value=4)
```

Using MODIS data from 7 July 2016 - calculate the total area of land classified as:

1. Burn: moderate severity
2. Burn: high severity

5

```
# clouds removed
plotRGB(all_modis_bands_st_mask_july17,
       1,4,3,
```



Figure 5: cropped data

MODIS NBR for the Cold Springs site

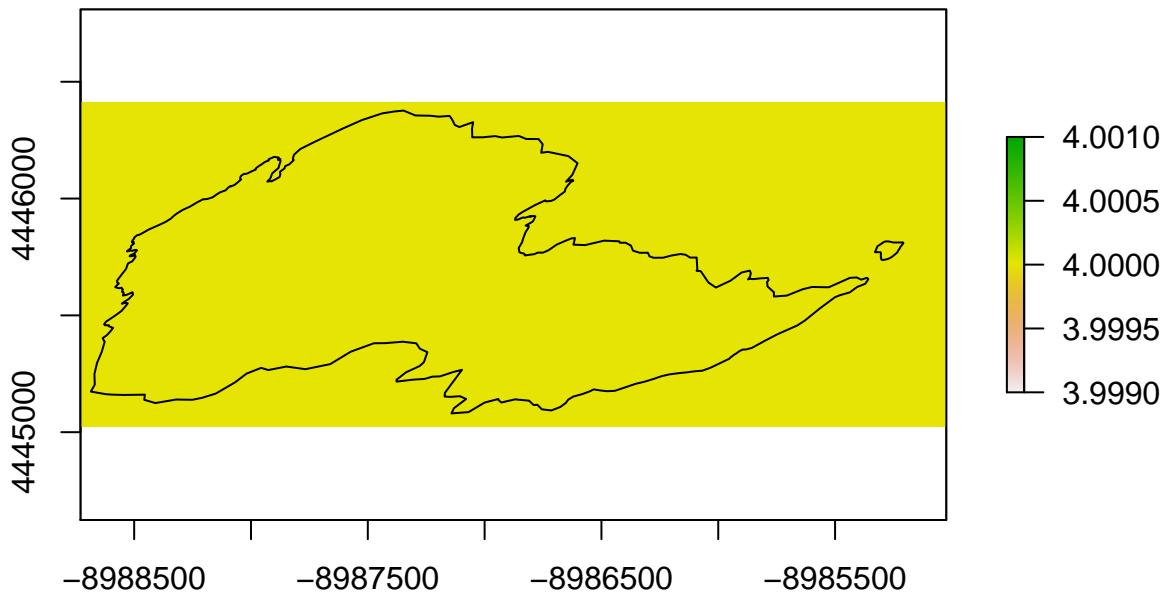


Figure 6:

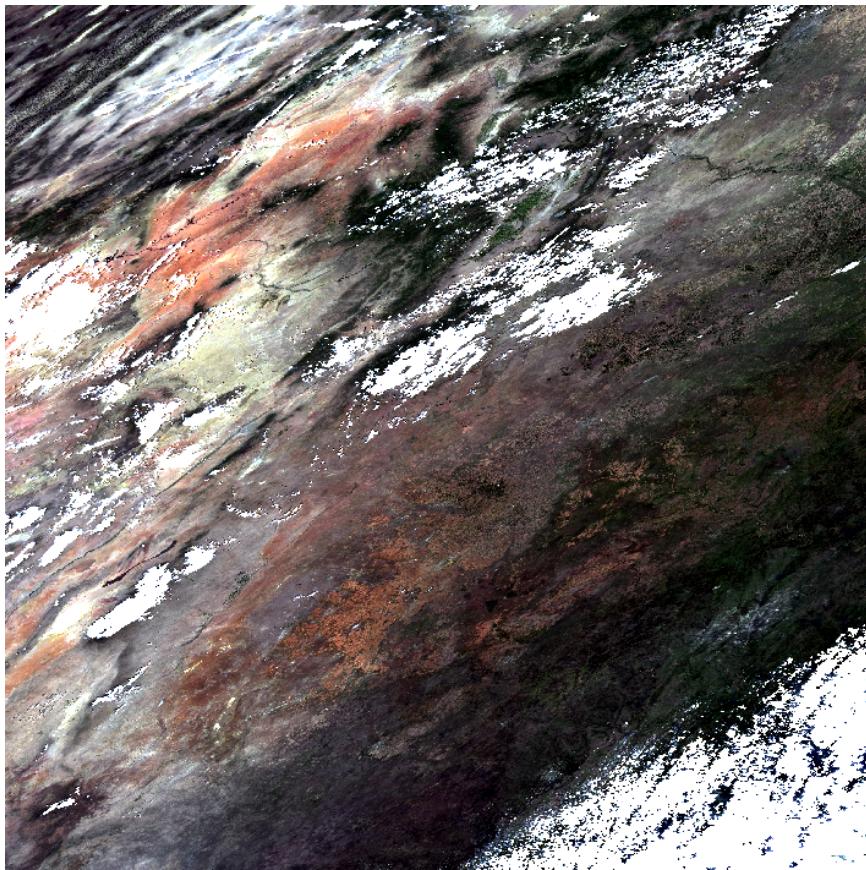


Figure 7: RGB post fire

Distribution of burn values

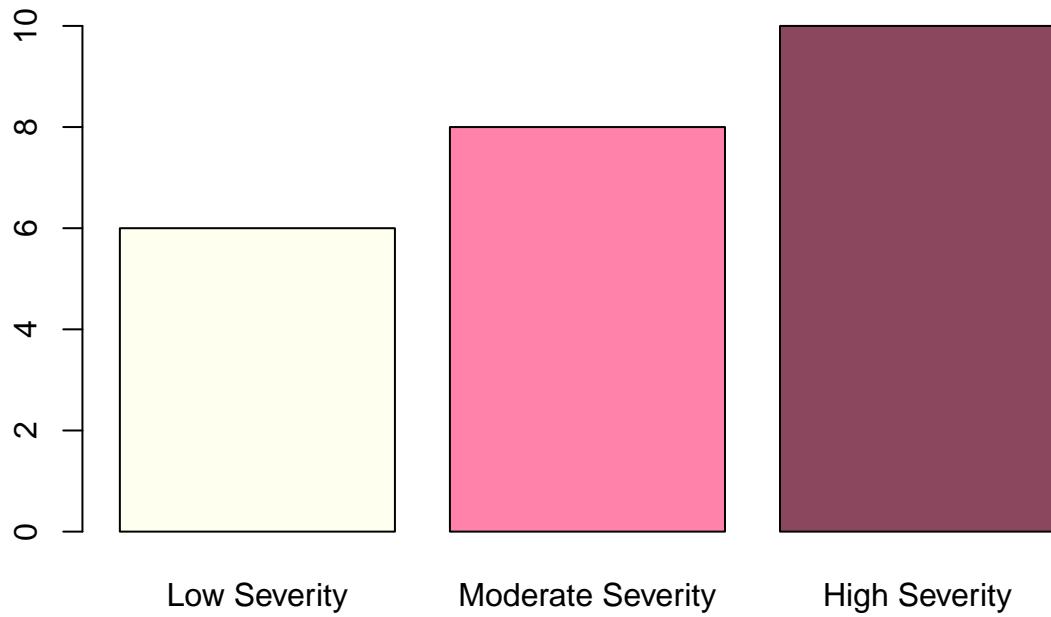


Figure 8: barplot of final post fire classified data.

MODIS NBR for the Cold Springs site

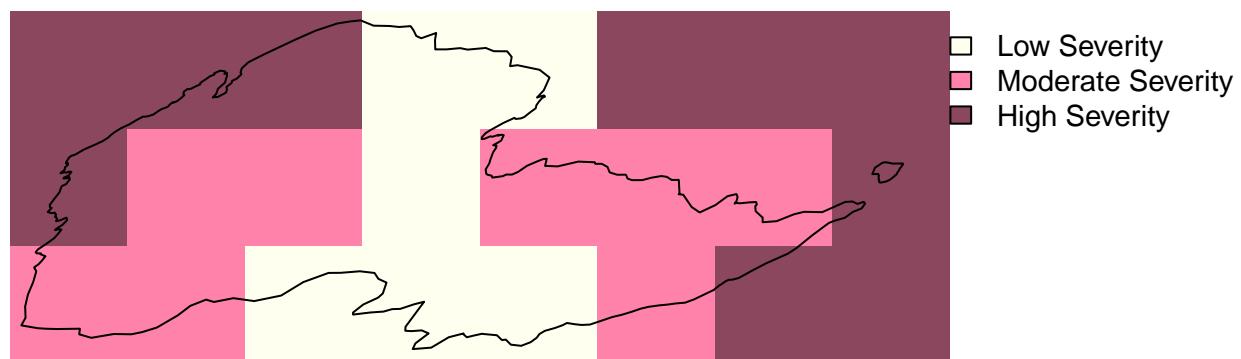


Figure 9: