dNBR with MODIS in R

Learning Objectives

After completing this tutorial, you will be able to:

- Calculate `dNBR` in `R`
- Be able to describe how the `dNBR` index is used to quantify fire severity.

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)](

As mentioned in the previous lesson, we can use NBR to map the extent and severity of a fire. Let's explore creating NBR using Landsat data.

Calculate dNBR using Landsat data

First, let's setup our spatial packages.

```
# load spatial packages
library(raster)
library(rgdal)
library(rgeos)
library(RColorBrewer)
# turn off factors
options(stringsAsFactors = F)
```

Next, we open up our landsat data and create a spatial raster stack.

```
# create stack
all_landsat_bands_pre <- list.files("data/week6/Landsat/LC80340322016189-SC20170128091153/crop",
          pattern=glob2rx("*band*.tif$"),
          full.names = T) # use the dollar sign at the end to get all files that END WITH
all_landsat_bands_pre
## [1] "data/week6/Landsat/LC80340322016189-SC20170128091153/crop/LC80340322016189LGN00_sr_band1_crop.t
## [2] "data/week6/Landsat/LC80340322016189-SC20170128091153/crop/LC80340322016189LGN00_sr_band2_crop.t
## [3] "data/week6/Landsat/LC80340322016189-SC20170128091153/crop/LC80340322016189LGN00_sr_band3_crop.t
## [4] "data/week6/Landsat/LC80340322016189-SC20170128091153/crop/LC80340322016189LGN00_sr_band4_crop.t
## [5] "data/week6/Landsat/LC80340322016189-SC20170128091153/crop/LC80340322016189LGN00_sr_band5_crop.t
## [6] "data/week6/Landsat/LC80340322016189-SC20170128091153/crop/LC80340322016189LGN00_sr_band6_crop.t
## [7] "data/week6/Landsat/LC80340322016189-SC20170128091153/crop/LC80340322016189LGN00_sr_band7_crop.t

# stack the data
landsat_stack_pre <- stack(all_landsat_bands_pre)
```

Next we calculate dNBR using the following steps:

1. Open up pre-fire data and calculate *NBR*
2. Open up the post-fire data and calculate *NBR*
3. Calculate **dNBR** (difference NBR) by subtracting post-fire NBR from pre-fire NBR.
4. Classify the dNBR raster using the classification table below.

Landsat derived Normalized Burn Index (NBR)
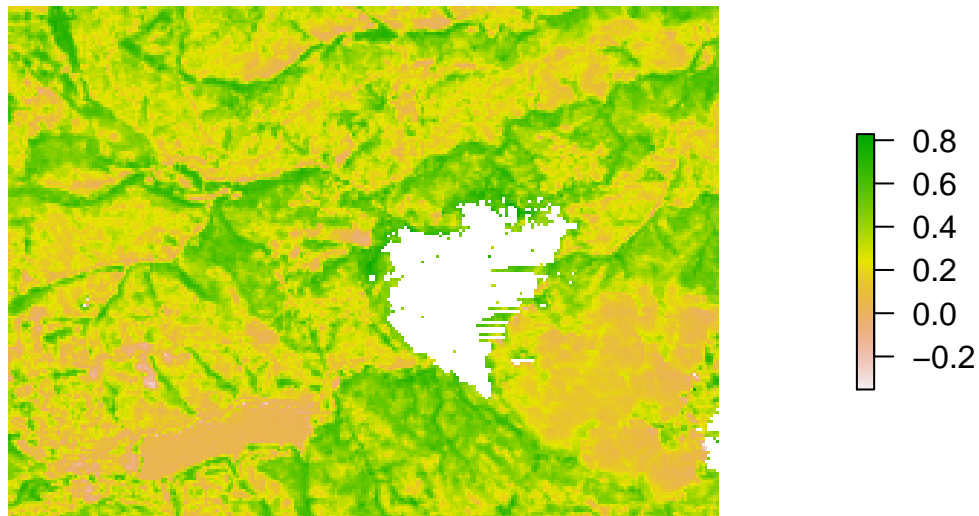# Pre–fire – you will need to figure out the date using the Julian Day

Figure 1: landsat derived NDVI plot

. Note the code to do this is hidden. You will need to figure out what bands are required to calculate NBR using Landsat.

You can export the NBR raster if you want using `writeRaster()`.

```
writeRaster(x = landsat_nbr_pre,
            filename="data/week6/outputs/landsat_nbr",
            format = "GTiff", # save as a tif
            datatype='INT2S', # save as a INTEGER rather than a float
            overwrite = T)
```

Next, we can open the post-fire landsat data to calculate post-fire NBR.

```
all_landsat_bands_post <- list.files("data/week6/Landsat/LC80340322016205-SC20170127160728/crop",
         pattern=glob2rx("*band*.tif$"),
         full.names = T) # use the dollar sign at the end to get all files that END WITH
all_landsat_bands_post
## [1] "data/week6/Landsat/LC80340322016205-SC20170127160728/crop/LC80340322016205LGN00_sr_band1_crop.ti
## [2] "data/week6/Landsat/LC80340322016205-SC20170127160728/crop/LC80340322016205LGN00_sr_band2_crop.ti
## [3] "data/week6/Landsat/LC80340322016205-SC20170127160728/crop/LC80340322016205LGN00_sr_band3_crop.ti
## [4] "data/week6/Landsat/LC80340322016205-SC20170127160728/crop/LC80340322016205LGN00_sr_band4_crop.ti
## [5] "data/week6/Landsat/LC80340322016205-SC20170127160728/crop/LC80340322016205LGN00_sr_band5_crop.ti
## [6] "data/week6/Landsat/LC80340322016205-SC20170127160728/crop/LC80340322016205LGN00_sr_band6_crop.ti
## [7] "data/week6/Landsat/LC80340322016205-SC20170127160728/crop/LC80340322016205LGN00_sr_band7_crop.ti

# stack the data
landsat_stack_post <- stack(all_landsat_bands_post)
```

Then we calculate NBR on the post data - note the code here is purposefully hidden. You need to figure out what bands to use to perform the math!

Finally, calculate the DIFFERENCE between the pre and post NBR!!

Landsat derived Normalized Burn Index (NBR)
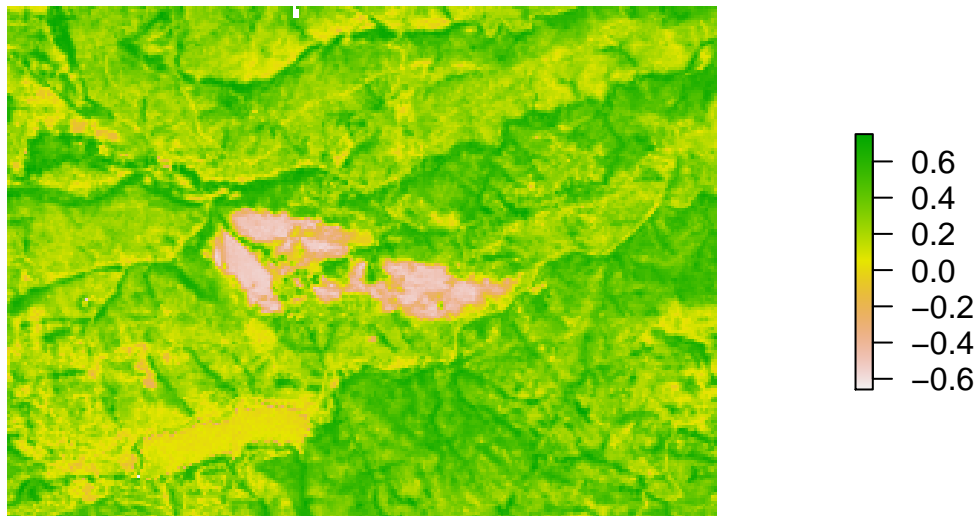## Post Fire

Figure 2: landsat derived NBR post fire

```
# calculate difference
landsat_nbr_diff <- landsat_nbr_pre - landsat_nbr_post
plot(landsat_nbr_diff,
     main="Difference NBR map \n Pre minus post Cold Springs fire",
     axes=F, box=F)
```

When you have calculated dNBR or the difference in NBR pre minus post fire, classify the output raster using the `classify()` function and the classes below.

SEVERITY LEVEL
Enhanced Regrowth
Unburned
Low Severity
Moderate Severity
High Severity

NOTE: your min an max values for NBR may be slightly different from the table shown above! If you have a smaller min value ($<$ -700) then adjust your first class to that smallest number. If you have a largest max value ($>$1300) then adjust your last class to that largest value in your data.

Alternatively, you can use the `Inf` to specify the smallest `-Inf` and largest `Inf` values.

Your classified map should look something like:

Compare to fire boundary

As an example to see how our fire boundary relates to the boundary that we've identified using MODIS data, we can create a map with both layers. I'm using the shapefile in the folder:

`data/week6/vector_layers/fire-boundary-geomac/co_cold_springs_20160711_2200_dd83.shp`

Add fire boundary to map.

Make it look a bit nicer using a colobrewer palette. I used the `RdYlGn` palette:

`brewer.pal(5, 'RdYlGn')`

I also did a bit of legend trickery to get a box with a fill. There's probably a better way to do this!

Difference NBR map
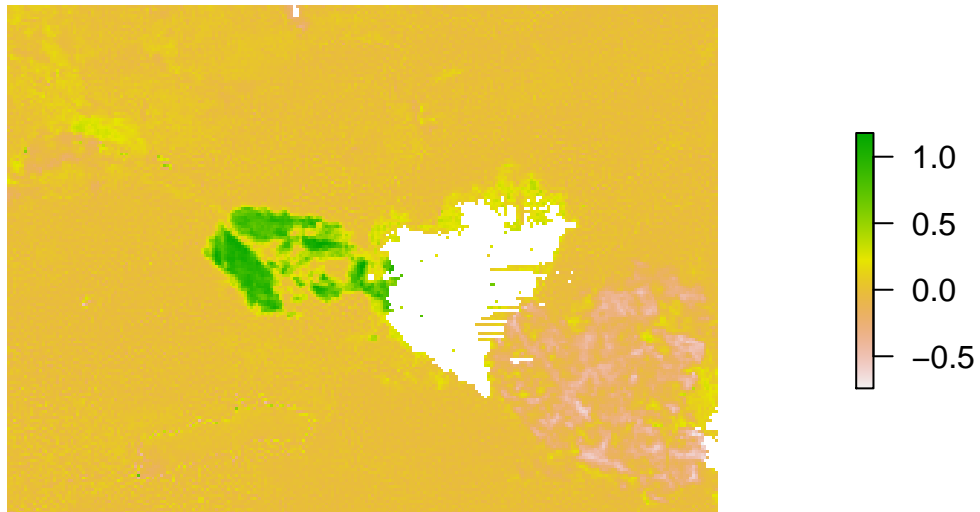**Pre minus post Cold Springs fire**

Figure 3: Difference NBR map

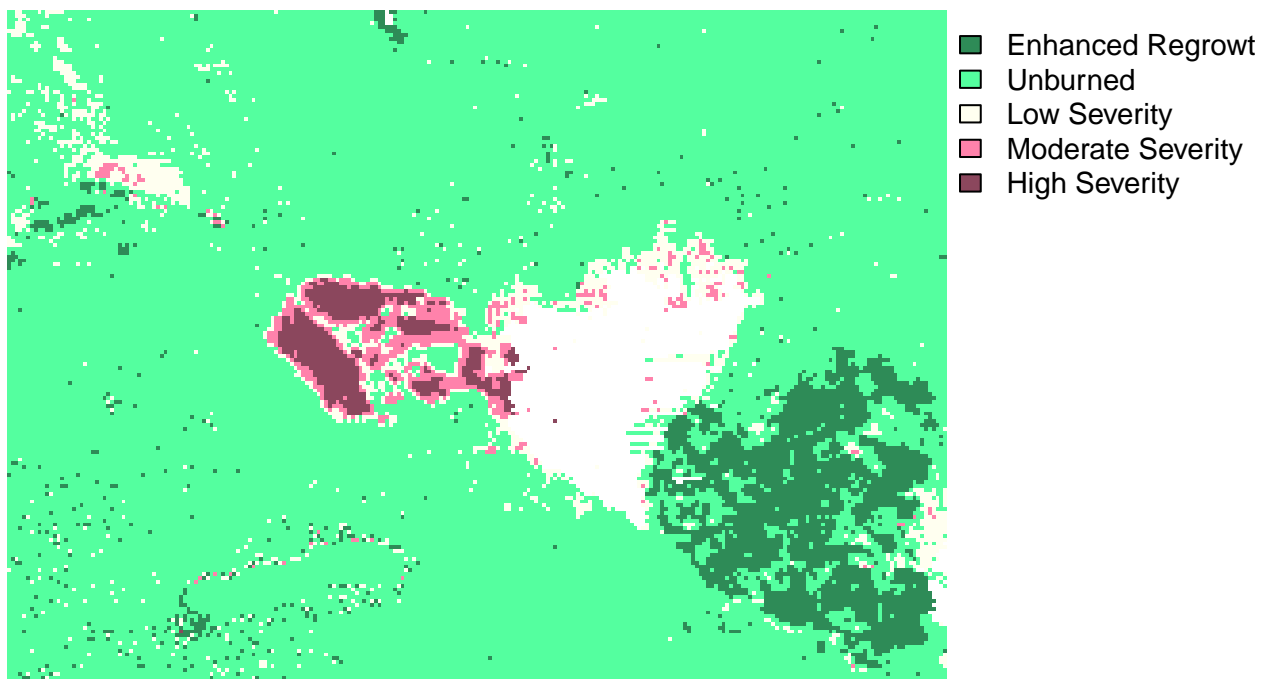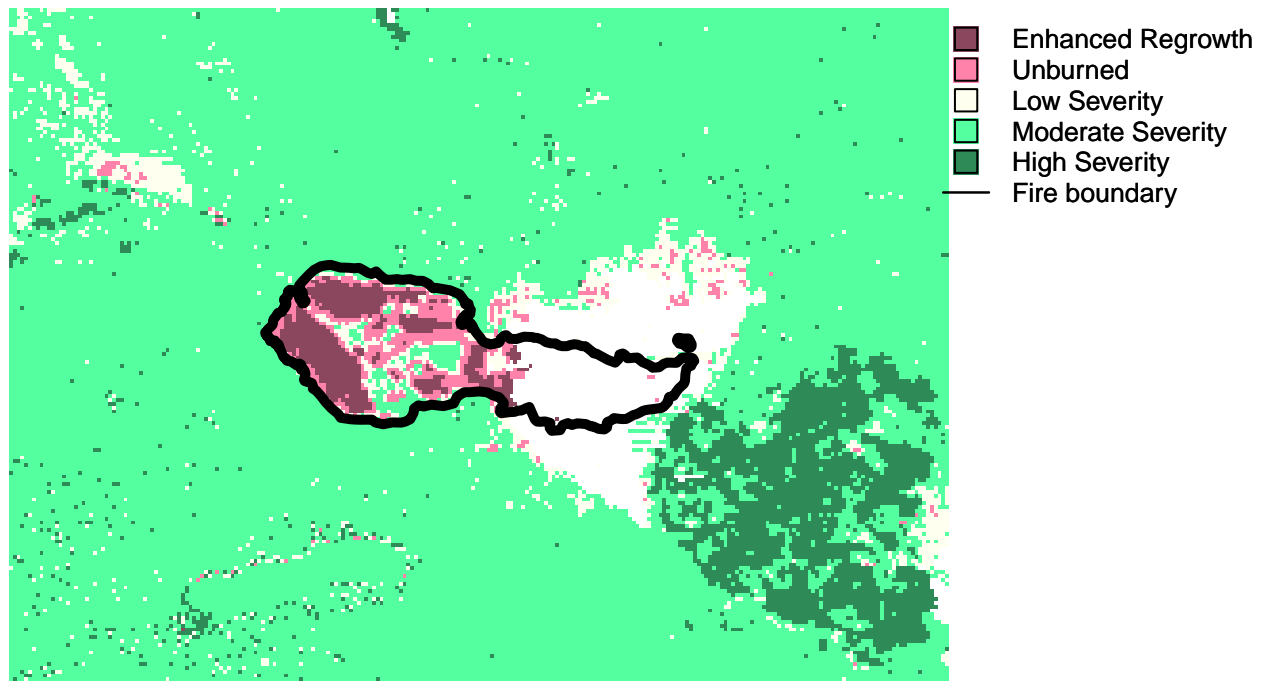**Landsat NBR – Cold Spring fire site**
Add date of the data here

Figure 4: classified NBR output

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Figure 5: classified NBR output

Landsat NBR – Cold Spring fire site
Add date of the data here

Enhanced Regrowth
Unburned
Low Severity
Moderate Severity
High Severity
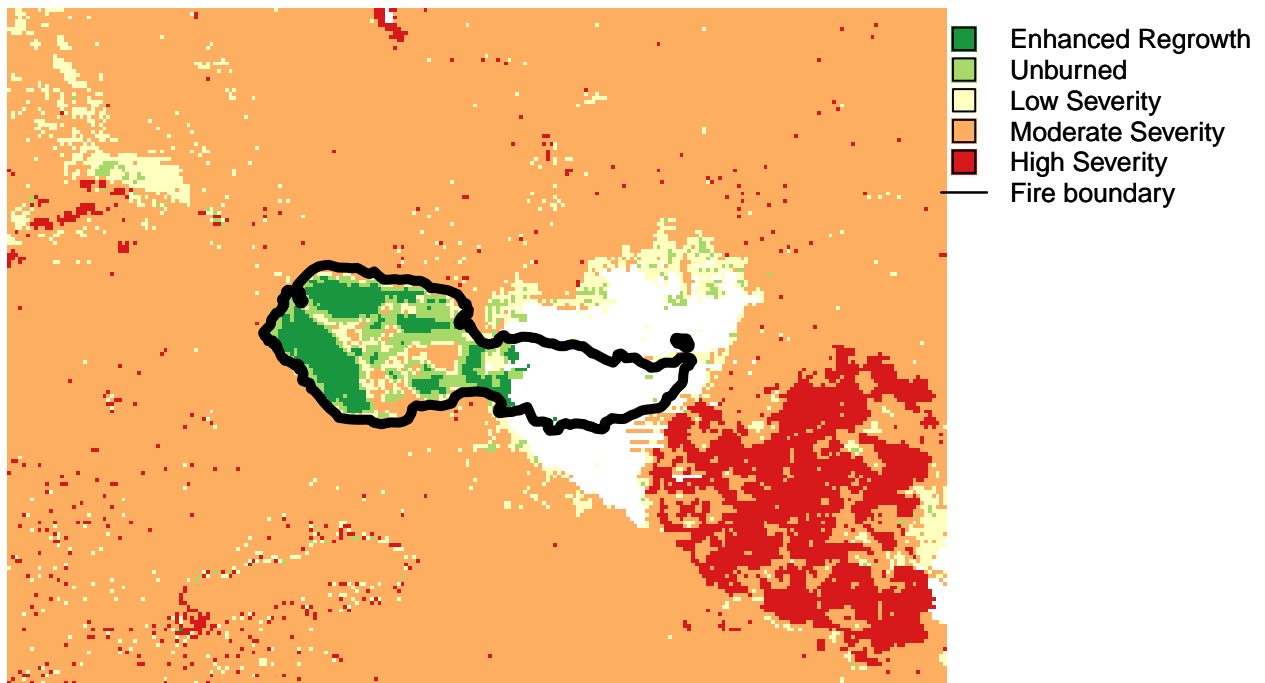Fire boundary

Figure 6: classified NBR output
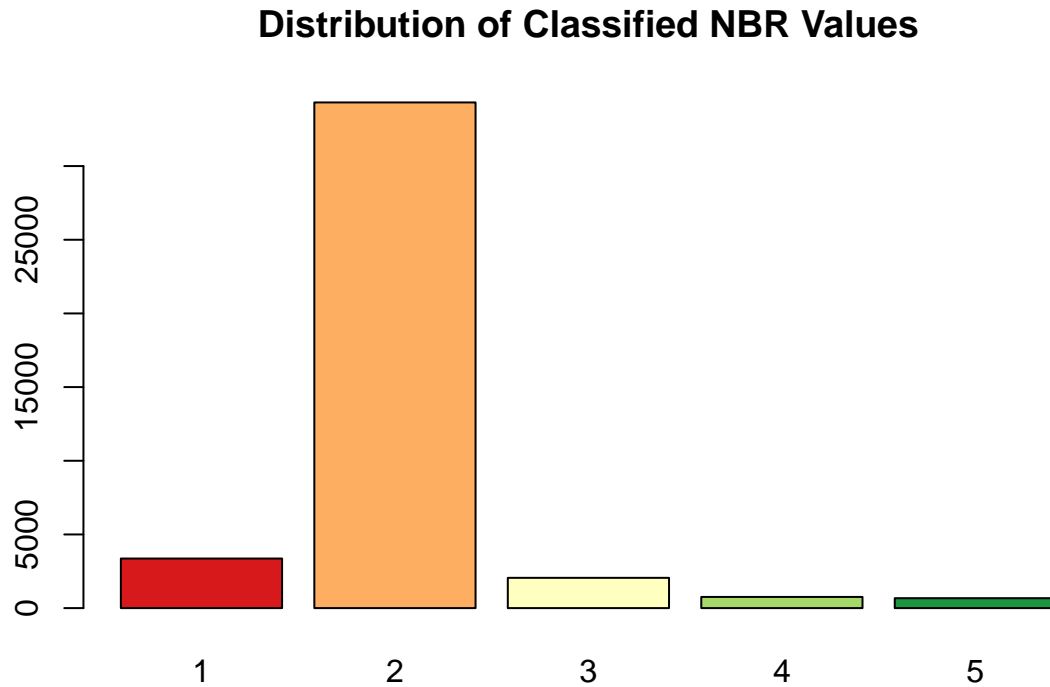
Distribution of Classified NBR Values

Figure 7: plot hist

Note that you will have to figure out what date these data are for! I purposefully didn't include it in the title of this map.

NBR & MODIS

Similarly the table below shows the band ranges for the MODIS sensor. What bands should we use to calculate NBR using MODIS?

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

Additional Resources

- http://gsp.humboldt.edu/olm_2015/Courses/GSP_216_Online/lesson5-1/NBR.html