

# 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
all_modis_bands_st_july7[[2]]
## class       : RasterLayer
## dimensions : 2400, 2400, 5760000 (nrow, ncol, ncell)
## resolution : 463.3, 463.3 (x, y)
## extent     : -10007555, -8895604, 3335852, 4447802 (xmin, xmax, ymin, ymax)
## coord. ref. : +proj=sinu +lon_0=0 +x_0=0 +y_0=0 +a=6371007.181 +b=6371007.181 +units=m +no_defs
## data source : /Users/lewa8222/Documents/earth-analytics/data/week6/modis/reflectance/07_july_2016/cr
## names       : MOD09GA.A2016189.h09v05.006.2016191073856_sur_refl_b02_1
## values      : -32768, 32767 (min, max)
```

## 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.

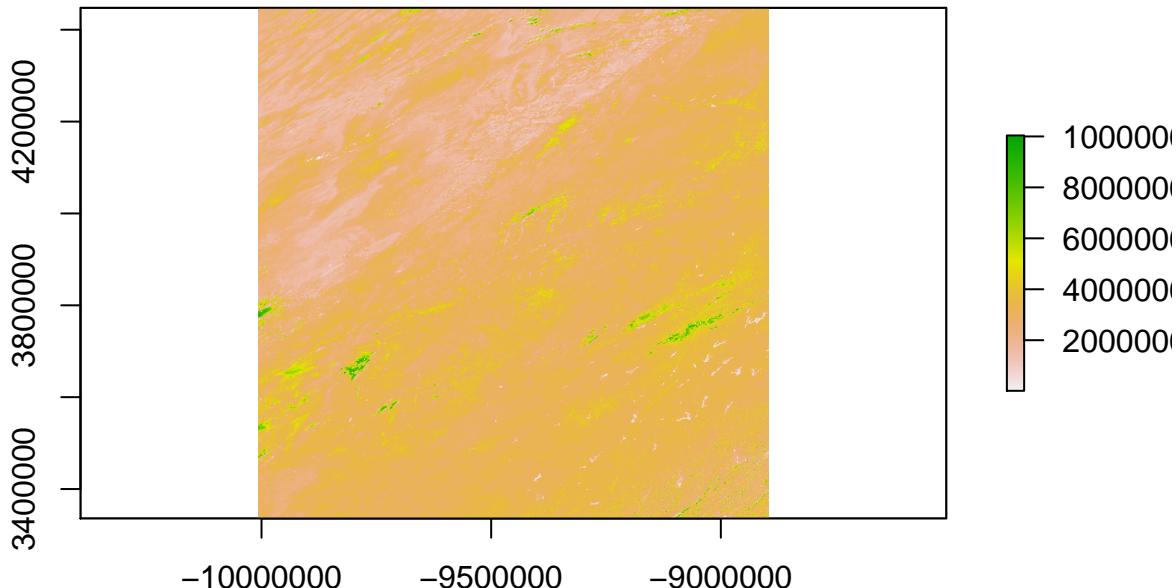


Figure 1:

[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?

## 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 out 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]])
```

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

## MODIS post-fire RGB image Cold springs fire site

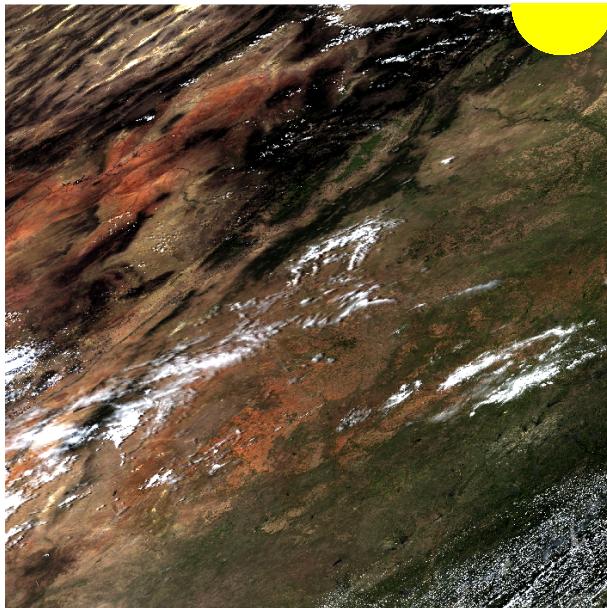


Figure 2: plot MODIS stack

Use the cloud cover layer `data/week6/modis/reflectance/07_july_2016/crop/cloud_mask_july7_500m` to create your mask.

Set all values >0 in the cloud cover layer to NA.

```
## RStudioGD
##      2
```

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.

SEVERITY LEVEL
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
## [2,]     5     24
## [3,]     6     24
## [4,]     7     24
## [5,]     8     24
## [6,]     9     24
## [7,]    10     24
## [8,]    11     24
## [9,]    12     24
## [10,]   13     24
## [11,]   14     24
## [12,]   15     24
## [13,]   16     24
## [14,]   17     24
## [15,]   18     24
## [16,]   19     24
## [17,]   20     24
## [18,]   21     24
## [19,]   22     24
## [20,]   23     24
## [21,]   24     24
## [22,]   25     24
## [23,]   26     24
## [24,]   27     24
## [25,]   28     24
## [26,]   29     24
## [27,]   30     24
## [28,]   31     24
## [29,]   32     24
## [30,]   33     24
## [31,]   34     24
## [32,]   35     24
## [33,]   36     24
## [34,]   37     24
## [35,]   38     24
## [36,]   39     24
## [37,]   40     24
## [38,]   41     24
## [39,]   42     24
## [40,]   43     24
## [41,]   44     24
## [42,]   45     24
## [43,]   46     24
## [44,]   47     24
## [45,]   48     24
## [46,]   49     24
## [47,]   50     24
## [48,]   51     24
## [49,]   52     24
## [50,]   53     24
## [51,]   54     24
## [52,]   55     24
## [53,]   56     24
## [54,]   57     24
## [55,]   58     24
## [56,]   59     24
## [57,]   60     24
## [58,]   61     24
## [59,]   62     24
## [60,]   63     24
## [61,]   64     24
## [62,]   65     24
## [63,]   66     24
## [64,]   67     24
## [65,]   68     24
## [66,]   69     24
## [67,]   70     24
## [68,]   71     24
## [69,]   72     24
## [70,]   73     24
## [71,]   74     24
## [72,]   75     24
## [73,]   76     24
## [74,]   77     24
## [75,]   78     24
## [76,]   79     24
## [77,]   80     24
## [78,]   81     24
## [79,]   82     24
## [80,]   83     24
## [81,]   84     24
## [82,]   85     24
## [83,]   86     24
## [84,]   87     24
## [85,]   88     24
## [86,]   89     24
## [87,]   90     24
## [88,]   91     24
## [89,]   92     24
## [90,]   93     24
## [91,]   94     24
## [92,]   95     24
## [93,]   96     24
## [94,]   97     24
## [95,]   98     24
## [96,]   99     24
## [97,]   100    24
## [98,]   101    24
## [99,]   102    24
## [100,]  103    24
## [101,]  104    24
## [102,]  105    24
## [103,]  106    24
## [104,]  107    24
## [105,]  108    24
## [106,]  109    24
## [107,]  110    24
## [108,]  111    24
## [109,]  112    24
## [110,]  113    24
## [111,]  114    24
## [112,]  115    24
## [113,]  116    24
## [114,]  117    24
## [115,]  118    24
## [116,]  119    24
## [117,]  120    24
## [118,]  121    24
## [119,]  122    24
## [120,]  123    24
## [121,]  124    24
## [122,]  125    24
## [123,]  126    24
## [124,]  127    24
## [125,]  128    24
## [126,]  129    24
## [127,]  130    24
## [128,]  131    24
## [129,]  132    24
## [130,]  133    24
## [131,]  134    24
## [132,]  135    24
## [133,]  136    24
## [134,]  137    24
## [135,]  138    24
## [136,]  139    24
## [137,]  140    24
## [138,]  141    24
## [139,]  142    24
## [140,]  143    24
## [141,]  144    24
## [142,]  145    24
## [143,]  146    24
## [144,]  147    24
## [145,]  148    24
## [146,]  149    24
## [147,]  150    24
## [148,]  151    24
## [149,]  152    24
## [150,]  153    24
## [151,]  154    24
## [152,]  155    24
## [153,]  156    24
## [154,]  157    24
## [155,]  158    24
## [156,]  159    24
## [157,]  160    24
## [158,]  161    24
## [159,]  162    24
## [160,]  163    24
## [161,]  164    24
## [162,]  165    24
## [163,]  166    24
## [164,]  167    24
## [165,]  168    24
## [166,]  169    24
## [167,]  170    24
## [168,]  171    24
## [169,]  172    24
## [170,]  173    24
## [171,]  174    24
## [172,]  175    24
## [173,]  176    24
## [174,]  177    24
## [175,]  178    24
## [176,]  179    24
## [177,]  180    24
## [178,]  181    24
## [179,]  182    24
## [180,]  183    24
## [181,]  184    24
## [182,]  185    24
## [183,]  186    24
## [184,]  187    24
## [185,]  188    24
## [186,]  189    24
## [187,]  190    24
## [188,]  191    24
## [189,]  192    24
## [190,]  193    24
## [191,]  194    24
## [192,]  195    24
## [193,]  196    24
## [194,]  197    24
## [195,]  198    24
## [196,]  199    24
## [197,]  200    24
## [198,]  201    24
## [199,]  202    24
## [200,]  203    24
## [201,]  204    24
## [202,]  205    24
## [203,]  206    24
## [204,]  207    24
## [205,]  208    24
## [206,]  209    24
## [207,]  210    24
## [208,]  211    24
## [209,]  212    24
## [210,]  213    24
## [211,]  214    24
## [212,]  215    24
## [213,]  216    24
## [214,]  217    24
## [215,]  218    24
## [216,]  219    24
## [217,]  220    24
## [218,]  221    24
## [219,]  222    24
## [220,]  223    24
## [221,]  224    24
## [222,]  225    24
## [223,]  226    24
## [224,]  227    24
## [225,]  228    24
## [226,]  229    24
## [227,]  230    24
## [228,]  231    24
## [229,]  232    24
## [230,]  233    24
## [231,]  234    24
## [232,]  235    24
## [233,]  236    24
## [234,]  237    24
## [235,]  238    24
## [236,]  239    24
## [237,]  240    24
## [238,]  241    24
## [239,]  242    24
## [240,]  243    24
## [241,]  244    24
## [242,]  245    24
## [243,]  246    24
## [244,]  247    24
## [245,]  248    24
## [246,]  249    24
## [247,]  250    24
## [248,]  251    24
## [249,]  252    24
## [250,]  253    24
## [251,]  254    24
## [252,]  255    24
## [253,]  256    24
## [254,]  257    24
## [255,]  258    24
## [256,]  259    24
## [257,]  260    24
## [258,]  261    24
## [259,]  262    24
## [260,]  263    24
## [261,]  264    24
## [262,]  265    24
## [263,]  266    24
## [264,]  267    24
## [265,]  268    24
## [266,]  269    24
## [267,]  270    24
## [268,]  271    24
## [269,]  272    24
## [270,]  273    24
## [271,]  274    24
## [272,]  275    24
## [273,]  276    24
## [274,]  277    24
## [275,]  278    24
## [276,]  279    24
## [277,]  280    24
## [278,]  281    24
## [279,]  282    24
## [280,]  283    24
## [281,]  284    24
## [282,]  285    24
## [283,]  286    24
## [284,]  287    24
## [285,]  288    24
## [286,]  289    24
## [287,]  290    24
## [288,]  291    24
## [289,]  292    24
## [290,]  293    24
## [291,]  294    24
## [292,]  295    24
## [293,]  296    24
## [294,]  297    24
## [295,]  298    24
## [296,]  299    24
## [297,]  300    24
## [298,]  301    24
## [299,]  302    24
## [300,]  303    24
## [301,]  304    24
## [302,]  305    24
## [303,]  306    24
## [304,]  307    24
## [305,]  308    24
## [306,]  309    24
## [307,]  310    24
## [308,]  311    24
## [309,]  312    24
## [310,]  313    24
## [311,]  314    24
## [312,]  315    24
## [313,]  316    24
## [314,]  317    24
## [315,]  318    24
## [316,]  319    24
## [317,]  320    24
## [318,]  321    24
## [319,]  322    24
## [320,]  323    24
## [321,]  324    24
## [322,]  325    24
## [323,]  326    24
## [324,]  327    24
## [325,]  328    24
## [326,]  329    24
## [327,]  330    24
## [328,]  331    24
## [329,]  332    24
## [330,]  333    24
## [331,]  334    24
## [332,]  335    24
## [333,]  336    24
## [334,]  337    24
## [335,]  338    24
## [336,]  339    24
## [337,]  340    24
## [338,]  341    24
## [339,]  342    24
## [340,]  343    24
## [341,]  344    24
## [342,]  345    24
## [343,]  346    24
## [344,]  347    24
## [345,]  348    24
## [346,]  349    24
## [347,]  350    24
## [348,]  351    24
## [349,]  352    24
## [350,]  353    24
## [351,]  354    24
## [352,]  355    24
## [353,]  356    24
## [354,]  357    24
## [355,]  358    24
## [356,]  359    24
## [357,]  360    24
## [358,]  361    24
## [359,]  362    24
## [360,]  363    24
## [361,]  364    24
## [362,]  365    24
## [363,]  366    24
## [364,]  367    24
## [365,]  368    24
## [366,]  369    24
## [367,]  370    24
## [368,]  371    24
## [369,]  372    24
## [370,]  373    24
## [371,]  374    24
## [372,]  375    24
## [373,]  376    24
## [374,]  377    24
## [375,]  378    24
## [376,]  379    24
## [377,]  380    24
## [378,]  381    24
## [379,]  382    24
## [380,]  383    24
## [381,]  384    24
## [382,]  385    24
## [383,]  386    24
## [384,]  387    24
## [385,]  388    24
## [386,]  389    24
## [387,]  390    24
## [388,]  391    24
## [389,]  392    24
## [390,]  393    24
## [391,]  394    24
## [392,]  395    24
## [393,]  396    24
## [394,]  397    24
## [395,]  398    24
## [396,]  399    24
## [397,]  400    24
## [398,]  401    24
## [399,]  402    24
## [400,]  403    24
## [401,]  404    24
## [402,]  405    24
## [403,]  406    24
## [404,]  407    24
## [405,]  408    24
## [406,]  409    24
## [407,]  410    24
## [408,]  411    24
## [409,]  412    24
## [410,]  413    24
## [411,]  414    24
## [412,]  415    24
## [413,]  416    24
## [414,]  417    24
## [415,]  418    24
## [416,]  419    24
## [417,]  420    24
## [418,]  421    24
## [419,]  422    24
## [420,]  423    24
## [421,]  424    24
## [422,]  425    24
## [423,]  426    24
## [424,]  427    24
## [425,]  428    24
## [426,]  429    24
## [427,]  430    24
## [428,]  431    24
## [429,]  432    24
## [430,]  433    24
## [431,]  434    24
## [432,]  435    24
## [433,]  436    24
## [434,]  437    24
## [435,]  438    24
## [436,]  439    24
## [437,]  440    24
## [438,]  441    24
## [439,]  442    24
## [440,]  443    24
## [441,]  444    24
## [442,]  445    24
## [443,]  446    24
## [444,]  447    24
## [445,]  448    24
## [446,]  449    24
## [447,]  450    24
## [448,]  451    24
## [449,]  452    24
## [450,]  453    24
## [451,]  454    24
## [452,]  455    24
## [453,]  456    24
## [454,]  457    24
## [455,]  458    24
## [456,]  459    24
## [457,]  460    24
## [458,]  461    24
## [459,]  462    24
## [460,]  463    24
## [461,]  464    24
## [462,]  465    24
## [463,]  466    24
## [464,]  467    24
## [465,]  468    24
## [466,]  469    24
## [467,]  470    24
## [468,]  471    24
## [469,]  472    24
## [470,]  473    24
## [471,]  474    24
## [472,]  475    24
## [473,]  476    24
## [474,]  477    24
## [475,]  478    24
## [476,]  479    24
## [477,]  480    24
## [478,]  481    24
## [479,]  482    24
## [480,]  483    24
## [481,]  484    24
## [482,]  485    24
## [483,]  486    24
## [484,]  487    24
## [485,]  488    24
## [486,]  489    24
## [487,]  490    24
## [488,]  491    24
## [489,]  492    24
## [490,]  493    24
## [491,]  494    24
## [492,]  495    24
## [493,]  496    24
## [494,]  497    24
## [495,]  498    24
## [496,]  499    24
## [497,]  500    24
## [498,]  501    24
## [499,]  502    24
## [500,]  503    24
## [501,]  504    24
## [502,]  505    24
## [503,]  506    24
## [504,]  507    24
## [505,]  508    24
## [506,]  509    24
## [507,]  510    24
## [508,]  511    24
## [509,]  512    24
## [510,]  513    24
## [511,]  514    24
## [512,]  515    24
## [513,]  516    24
## [514,]  517    24
## [515,]  518    24
## [516,]  519    24
## [517,]  520    24
## [518,]  521    24
## [519,]  522    24
## [520,]  523    24
## [521,]  524    24
## [522,]  525    24
## [523,]  526    24
## [524,]  527    24
## [525,]  528    24
## [526,]  529    24
## [527,]  530    24
## [528,]  531    24
## [529,]  532    24
## [530,]  533    24
## [531,]  534    24
## [532,]  535    24
## [533,]  536    24
## [534,]  537    24
## [535,]  538    24
## [536,]  539    24
## [537,]  540    24
## [538,]  541    24
## [539,]  542    24
## [540,]  543    24
## [541,]  544    24
## [542,]  545    24
## [543,]  546    24
## [544,]  547    24
## [545,]  548    24
## [546,]  549    24
## [547,]  550    24
## [548,]  551    24
## [549,]  552    24
## [550,]  553    24
## [551,]  554    24
## [552,]  555    24
## [553,]  556    24
## [554,]  557    24
## [555,]  558    24
## [556,]  559    24
## [557,]  560    24
## [558,]  561    24
## [559,]  562    24
## [560,]  563    24
## [561,]  564    24
## [562,]  565    24
## [563,]  566    24
## [564,]  567    24
## [565,]  568    24
## [566,]  569    24
## [567,]  570    24
## [568,]  571    24
## [569,]  572    24
## [570,]  573    24
## [571,]  574    24
## [572,]  575    24
## [573,]  576    24
## [574,]  577    24
## [575,]  578    24
## [576,]  579    24
## [577,]  580    24
## [578,]  581    24
## [579,]  582    24
## [580,]  583    24
## [581,]  584    24
## [582,]  585    24
## [583,]  586    24
## [584,]  587    24
## [585,]  588    24
## [586,]  589    24
## [587,]  590    24
## [588,]  591    24
## [589,]  592    24
## [590,]  593    24
## [591,]  594    24
## [592,]  595    24
## [593,]  596    24
## [594,]  597    24
## [595,]  598    24
## [596,]  599    24
## [597,]  600    24
## [598,]  601    24
## [599,]  602    24
## [600,]  603    24
## [601,]  604    24
## [602,]  605    24
## [603,]  606    24
## [604,]  607    24
## [605,]  608    24
## [606,]  609    24
## [607,]  610    24
## [608,]  611    24
## [609,]  612    24
## [610,]  613    24
## [611,]  614    24
## [612,]  615    24
## [613,]  616    24
## [614,]  617    24
## [615,]  618    24
## [616,]  619    24
## [617,]  620    24
## [618,]  621    24
## [619,]  622    24
## [620,]  623    24
## [621,]  624    24
## [622,]  625    24
## [623,]  626    24
## [6
```

## Landsat cloud mask layer

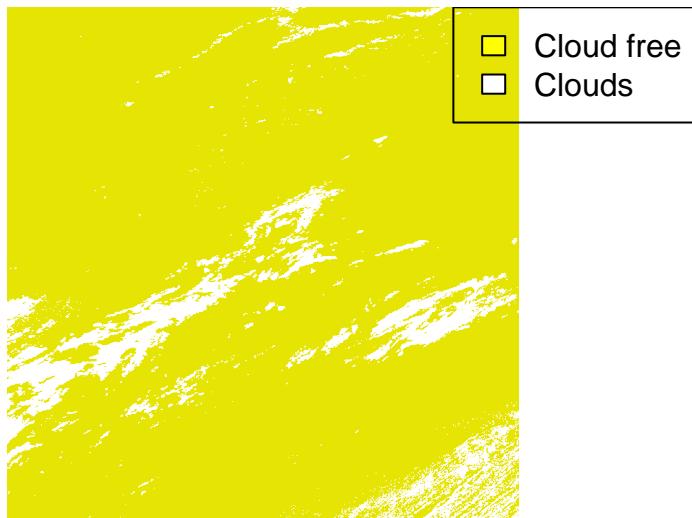


Figure 3: cloud mask plot

## MODIS data mask applied Cold springs fire AOI

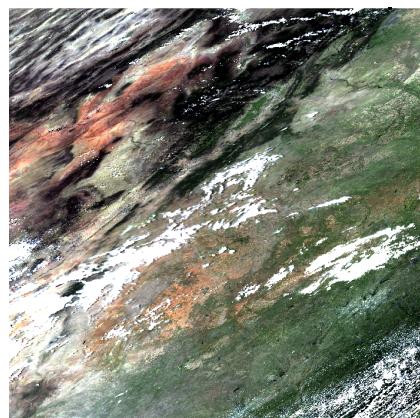


Figure 4: MODIS with cloud mask

**Final landsat masked data  
Cold Springs fire scar site**



Figure 5: cropped data

**MODIS NBR for the Cold Springs site**

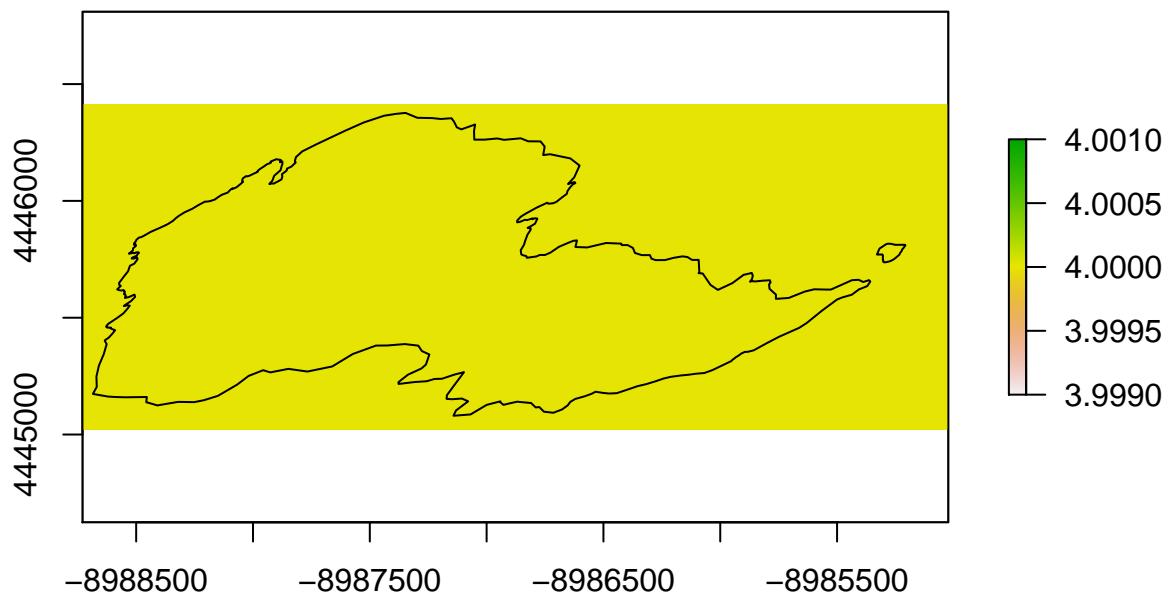


Figure 6: Classified pre fire NBR

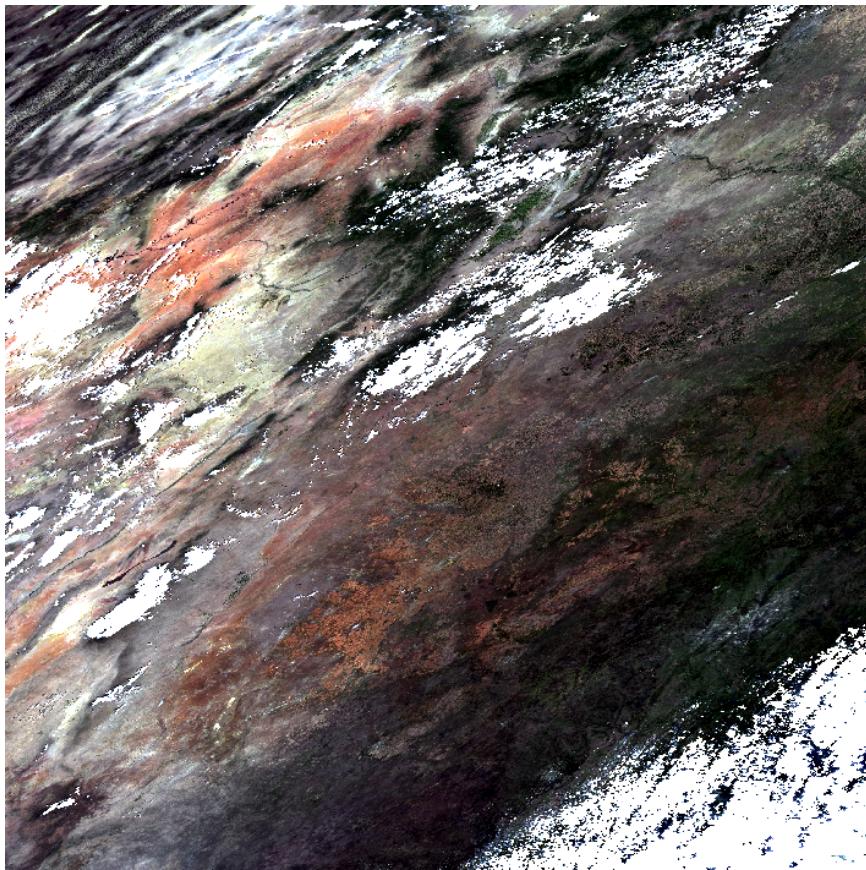


Figure 7: RGB post fire

### Distribution of burn values

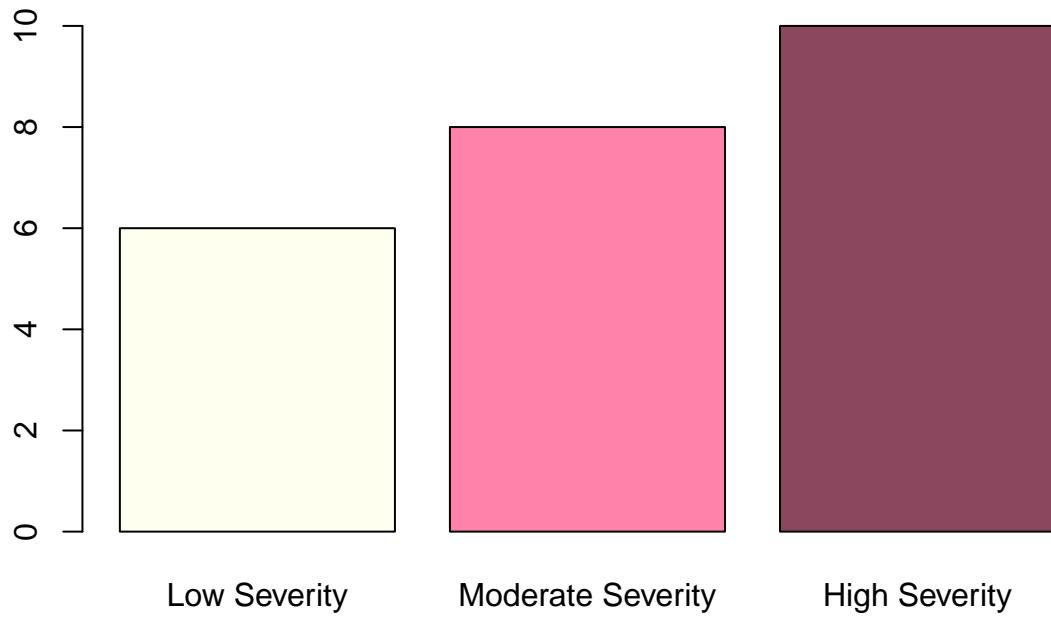


Figure 8: barplot of final post fire classified data.

## MODIS NBR for the Cold Springs site

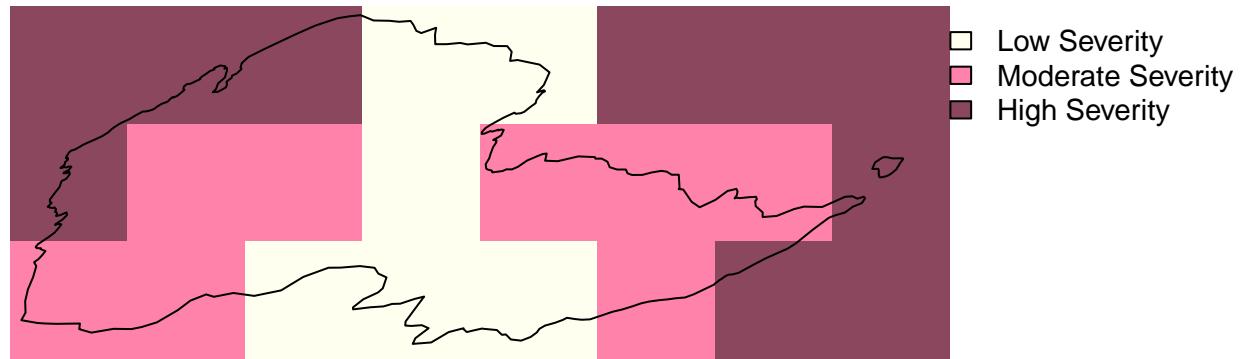


Figure 9:

Finally, plot the reclassified data. Note that we only have 3 classes: 2, 3 and 4.