Analysis of Monterey County River and Carmel Fires

In August of 2020, lightning storms ignited multiple fires across California. In Monterey County, two fires started near Mount Toro and burned over 50,000 acres before it was fully contained on September 4, 2020.

```
import arcgis
from arcgis import *
from arcgis.mapping import MapImageLayer
gis = GIS("home")
```

```
/opt/conda/lib/python3.11/site-packages/arcgis/gis/__init__.py:731:
UserWarning: You are logged on as bcase257 with an administrator role,
proceed with caution.
  warnings.warn(
```

```
from ipywidgets import *

postfire =
MapImageLayer('https://tiles.arcgis.com/tiles/DO4gTjwJVIJ7O9Ca/arcgis/
rest/services/Digital_Globe_Imagery_Dec_11th/MapServer')

def side_by_side(address):
    location = geocode(address)[0]

    satmap1 = gis.map(location)
    satmap1.basemap = 'satellite'

    satmap2 = gis.map(location)
    satmap2.add_layer(postfire)

    satmap1.layout=Layout(flex='1 1', padding='6px', height='450px')
    satmap2.layout=Layout(flex='1 1', padding='6px', height='450px')

    box = HBox([satmap1, satmap2])
    return box

side_by_side('Mount Toro, CA')
```

```
{"model_id":"89248b69af7741d39659c78983cda5e5","version_major":2,"vers
ion_minor":0}
```

```
landsat_item = gis.content.get('d9b466d6a9e647ce8d1dd5fe12eb434b')
landsat = landsat_item.layers[0]
landsat_item
```

```
<Item title:"Multispectral Landsat" type:Imagery Layer owner:esri>
```

```
aoi = {'spatialReference': {'latestWkid': 3857, 'wkid': 102100},
'type': 'extent',
       'xmax': -13560090, 'xmin': -13480000, 'ymax': 4400000, 'ymin':
4310000}

arcgis.env.analysis_extent = {"xmin":-
13490000,"ymin":42320000,"xmax":-13550000,"ymax":4390000,
                                "spatialReference":
{"wkid":102100,"latestWkid":3857}}

landsat.extent = aoi

import pandas as pd
from datetime import datetime

selected = landsat.filter_by(where="(Category = 1)",
                             time=[datetime(2020, 6, 1),
datetime(2020, 9, 30)],

geometry=arcgis.geometry.filters.intersects(aoi))

df = selected.query(out_fields="AcquisitionDate, GroupName,
CloudCover, DayOfYear",
                    order_by_fields="AcquisitionDate").sdf
df['AcquisitionDate'] = pd.to_datetime(df['AcquisitionDate'],
unit='ms')
df.tail(64)
```

	OBJECTID	AcquisitionDate	\
0	363100	2020-06-06 18:45:38	
1	363121	2020-06-06 18:46:02	
2	4477202	2020-06-14 05:55:02	
3	4477357	2020-06-14 05:55:26	
4	2955536	2020-06-15 18:39:33	
5	2955558	2020-06-15 18:39:57	
6	363101	2020-06-22 18:45:48	
7	363122	2020-06-22 18:46:11	
8	4477203	2020-06-30 05:55:10	
9	4477358	2020-06-30 05:55:34	
10	2955537	2020-07-01 18:39:41	
11	2955559	2020-07-01 18:40:05	
12	363102	2020-07-08 18:45:55	
13	363123	2020-07-08 18:46:19	
14	4477204	2020-07-16 05:55:16	
15	4477359	2020-07-16 05:55:40	
16	2955538	2020-07-17 18:39:47	
17	2955560	2020-07-17 18:40:11	
18	363103	2020-07-24 18:46:00	
19	363124	2020-07-24 18:46:24	
20	4477205	2020-08-01 05:55:21	

```
21   4477360 2020-08-01 05:55:45
22   2955539 2020-08-02 18:39:51
23   2955561 2020-08-02 18:40:15
24    363104 2020-08-09 18:46:03
25    363125 2020-08-09 18:46:27
26   4477206 2020-08-17 05:55:26
27   4477361 2020-08-17 05:55:50
28   2955540 2020-08-18 18:39:57
29   2955562 2020-08-18 18:40:20
30    363105 2020-08-25 18:46:11
31    363126 2020-08-25 18:46:35
32   4477207 2020-09-02 05:55:34
33   4477362 2020-09-02 05:55:57
34   2955541 2020-09-03 18:40:04
35   2955563 2020-09-03 18:40:28
36    363106 2020-09-10 18:46:18
37    363127 2020-09-10 18:46:42
38   4477208 2020-09-18 05:55:39
39   4477363 2020-09-18 05:56:03
40   2955542 2020-09-19 18:40:10
41   2955564 2020-09-19 18:40:34
42    363107 2020-09-26 18:46:23
43    363128 2020-09-26 18:46:47

                                          GroupName  CloudCover
DayOfYear  \
0   LC08_L1TP_044034_20200606_20200824_02_T1_MTL      0.0658
34
1   LC08_L1TP_044035_20200606_20200824_02_T1_MTL      0.4789
35
2   LC08_L1GT_141209_20200614_20200823_02_T2_MTL        <NA>
209
3   LC08_L1GT_141210_20200614_20200823_02_T2_MTL        <NA>
210
4   LC08_L1TP_043034_20200615_20200823_02_T1_MTL      0.5196
34
5   LC08_L1TP_043035_20200615_20200823_02_T1_MTL      0.2254
35
6   LC08_L1TP_044034_20200622_20200823_02_T1_MTL      0.3514
34
7   LC08_L1TP_044035_20200622_20200823_02_T1_MTL      0.9178
35
8   LC08_L1GT_141209_20200630_20200823_02_T2_MTL        <NA>
209
9   LC08_L1GT_141210_20200630_20200823_02_T2_MTL        <NA>
210
10  LC08_L1TP_043034_20200701_20200913_02_T1_MTL      0.0175
34
11  LC08_L1TP_043035_20200701_20200913_02_T1_MTL      0.3329
```

```
35
12  LC08_L1TP_044034_20200708_20200912_02_T1_MTL       0.249
34
13  LC08_L1TP_044035_20200708_20200912_02_T1_MTL      0.8159
35
14  LC08_L1GT_141209_20200716_20200901_02_T2_MTL        <NA>
209
15  LC08_L1GT_141210_20200716_20200901_02_T2_MTL        <NA>
210
16  LC08_L1TP_043034_20200717_20200911_02_T1_MTL      0.0151
34
17  LC08_L1TP_043035_20200717_20200911_02_T1_MTL      0.2889
35
18  LC08_L1TP_044034_20200724_20200911_02_T1_MTL      0.3822
34
19  LC08_L1TP_044035_20200724_20200910_02_T1_MTL      0.9216
35
20  LC08_L1GT_141209_20200801_20200914_02_T2_MTL        <NA>
209
21  LC08_L1GT_141210_20200801_20200914_02_T2_MTL        <NA>
210
22  LC08_L1TP_043034_20200802_20200914_02_T1_MTL       0.001
34
23  LC08_L1TP_043035_20200802_20200914_02_T1_MTL       0.226
35
24  LC08_L1TP_044034_20200809_20200917_02_T1_MTL      0.3304
34
25  LC08_L1TP_044035_20200809_20200917_02_T1_MTL      0.9022
35
26  LC08_L1GT_141209_20200817_20200920_02_T2_MTL        <NA>
209
27  LC08_L1GT_141210_20200817_20200920_02_T2_MTL        <NA>
210
28  LC08_L1TP_043034_20200818_20200823_02_T1_MTL        0.04
34
29  LC08_L1TP_043035_20200818_20200823_02_T1_MTL      0.0268
35
30  LC08_L1TP_044034_20200825_20200905_02_T1_MTL      0.3948
34
31  LC08_L1TP_044035_20200825_20200905_02_T1_MTL       0.897
35
32  LC08_L1GT_141209_20200902_20200904_02_T2_MTL        <NA>
209
33  LC08_L1GT_141210_20200902_20200904_02_T2_MTL        <NA>
210
34  LC08_L1TP_043034_20200903_20200918_02_T1_MTL      0.0013
34
35  LC08_L1TP_043035_20200903_20200918_02_T1_MTL      0.2098
35
```

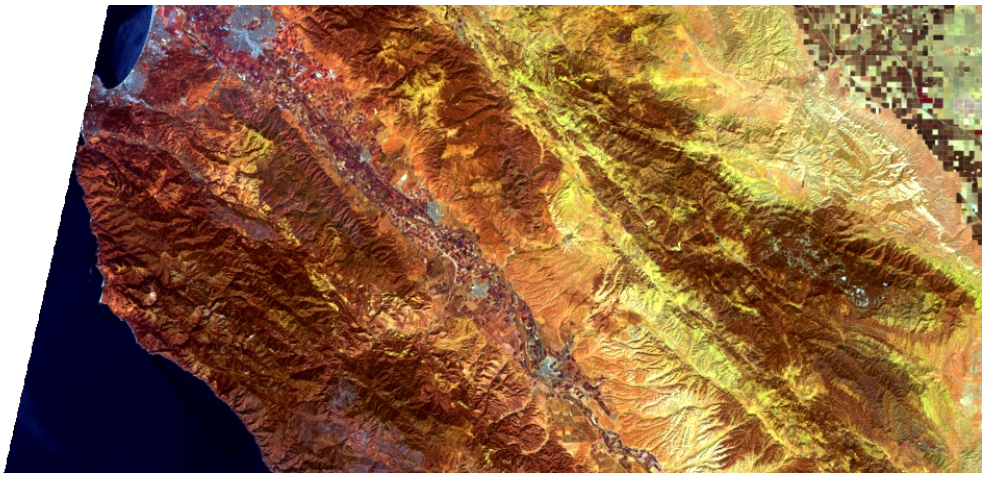
```
36  LC08_L1TP_044034_20200910_20200919_02_T1_MTL      0.9371
34
37  LC08_L1TP_044035_20200910_20200919_02_T1_MTL      0.9591
35
38  LC08_L1GT_141209_20200918_20201007_02_T2_MTL        <NA>
209
39  LC08_L1GT_141210_20200918_20201007_02_T2_MTL        <NA>
210
40  LC08_L1TP_043034_20200919_20201006_02_T1_MTL      0.0047
34
41  LC08_L1TP_043035_20200919_20201006_02_T1_MTL      0.0064
35
42  LC08_L1TP_044034_20200926_20201008_02_T1_MTL      0.2149
34
43  LC08_L1TP_044035_20200926_20201008_02_T1_MTL      0.4753
35
```

```
                                                 SHAPE
0   {"rings": [[[-13452553.2099, 4595761.4978], [-...
1   {"rings": [[[-13502433.5232, 4395776.7236], [-...
2   {"rings": [[[-13699690.3422, 4455485.848499998...
3   {"rings": [[[-13750033.8588, 4656173.450599998...
4   {"rings": [[[-13281366.9751, 4596016.659599997...
5   {"rings": [[[-13330831.3831, 4395681.5383], [-...
6   {"rings": [[[-13453162.224399999, 4595790.9543...
7   {"rings": [[[-13503035.9888, 4395787.894900002...
8   {"rings": [[[-13700066.2559, 4455485.577699996...
9   {"rings": [[[-13750419.2267, 4656556.052199997...
10  {"rings": [[[-13281512.6603, 4596022.484700002...
11  {"rings": [[[-13330917.335099999, 4395708.7770...
12  {"rings": [[[-13453167.1984, 4595775.791100003...
13  {"rings": [[[-13503035.9888, 4395787.894900002...
14  {"rings": [[[-13699690.3422, 4455485.848499998...
15  {"rings": [[[-13750036.0203, 4656558.229900002...
16  {"rings": [[[-13281132.470800001, 4596007.2788...
17  {"rings": [[[-13330544.5933, 4395695.771899998...
18  {"rings": [[[-13452397.4625, 4595919.169699997...
19  {"rings": [[[-13502288.6882, 4395774.558499999...
20  {"rings": [[[-13698562.6009, 4455486.580300003...
21  {"rings": [[[-13748886.3992, 4656564.676799998...
22  {"rings": [[[-13279991.9145, 4595961.577], [-1...
23  {"rings": [[[-13329423.1395, 4395657.525399998...
24  {"rings": [[[-13451167.8091, 4595890.102300003...
25  {"rings": [[[-13500938.9313, 4395749.913599998...
26  {"rings": [[[-13697810.7731, 4455487.001000002...
27  {"rings": [[[-13748119.9838, 4656568.902699999...
28  {"rings": [[[-13279846.6989, 4595955.434199996...
29  {"rings": [[[-13329338.650600001, 4395630.2245...
30  {"rings": [[[-13452170.325100001, 4595752.0675...
```

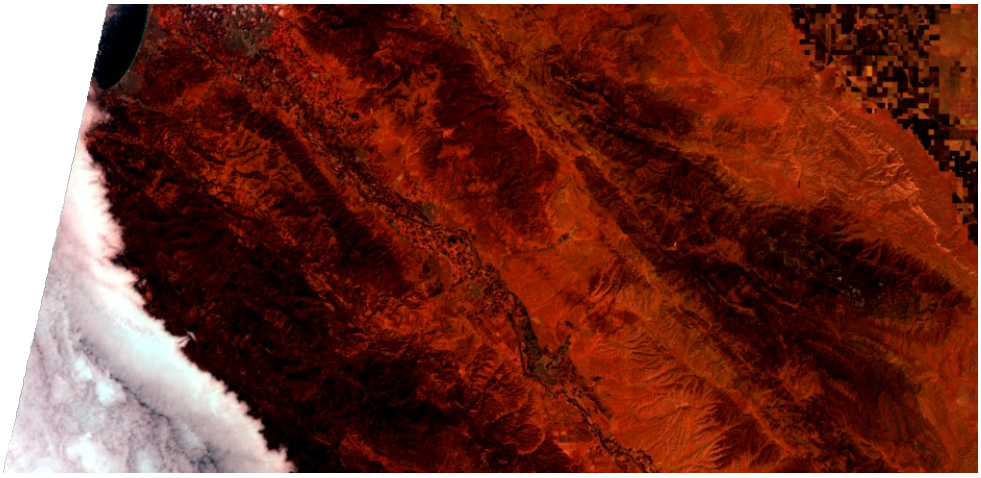
```
31  {"rings": [[[-13501999.683899999, 4395677.1102...
32  {"rings": [[[-13698938.5147, 4455486.349799998...
33  {"rings": [[[-13749269.6065, 4656562.542199999...
34  {"rings": [[[-13281367.4415, 4596016.363300003...
35  {"rings": [[[-13330687.8893, 4395700.261299998...
36  {"rings": [[[-13453461.309500001, 4595876.5079...
37  {"rings": [[[-13503267.626, 4395647.677699998]...
38  {"rings": [[[-13699690.3422, 4455485.848499998...
39  {"rings": [[[-13749652.8136, 4656560.393299997...
40  {"rings": [[[-13282418.7323, 4596058.667000003...
41  {"rings": [[[-13331805.6985, 4395738.291500002...
42  {"rings": [[[-13454214.9616, 4595960.975699998...
43  {"rings": [[[-13504072.8611, 4395805.888300002...
```

```
prefire = landsat.filter_by('OBJECTID=' + str(df['OBJECTID'][11])) #
2020-07-01
postfire = landsat.filter_by('OBJECTID=' + str(df['OBJECTID'][41])) #
2020-09-19

## In the LandSat imagery below, you can make out the gray burn scars
along the south side of the Salinas Valley (NW to SE green strip)

from arcgis.raster.functions import *

apply(postfire, 'Natural Color with DRA')
```

```
extract_band(postfire, [6,4,1])
```

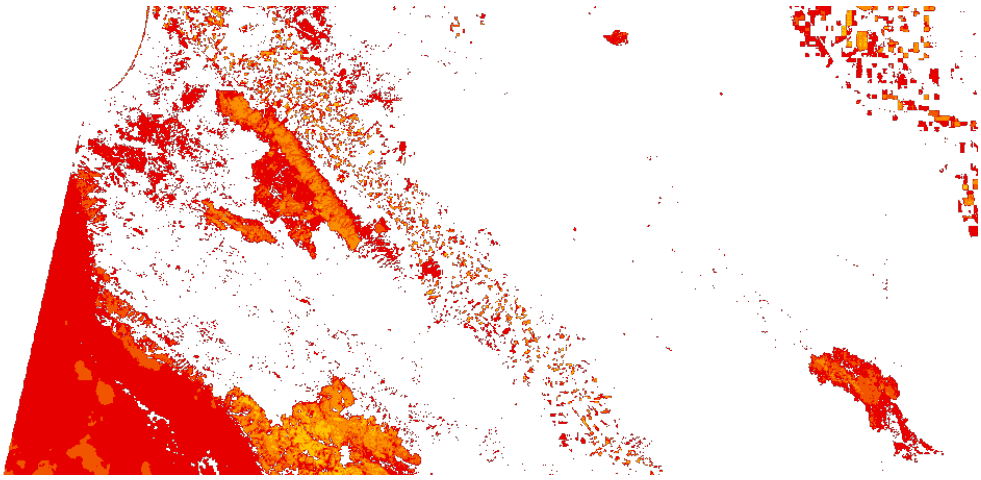


```
extract_band(prefire, [6,4,1])
```



```
nbr_prefire  = band_arithmetic(prefire, "(b5 - b7) / (b5 + b7+1000)")
nbr_postfire = band_arithmetic(postfire, "(b5 - b7) / (b5 + b7+1000)")

nbr_diff = nbr_prefire - nbr_postfire

burnt_areas = colormap(remap(nbr_diff,
                             input_ranges=[0.1,  0.27,  # low severity

                                           0.27, 0.44,  # medium
severity
                                           0.44, 0.66,  # moderate

severity
                                           0.66, 1.00], # high
severity burn
                             output_values=[1, 2, 3, 4],

                             no_data_ranges=[-1, 0.1], astype='u8'),
```

```
                                colormap=[[4, 0xFF, 0xC3, 0], [3, 0xFA,
0x8E, 0], [2, 0xF2, 0x55, 0], [1, 0xE6, 0,    0]])

# Visualize Burnt Areas

burnt_areas
```



In the image below taken from the living Atlas, you can more clearly see the burn scars in brown.

```
from IPython.display import Image
Image("/arcgis/home/Monterey_BurnComparison.png")
```