

Title:	Fire Mapping using ASTER
	Part I: The ASTER instrument and fire damage assessment
	Part II: Calculate radiance and reflectance
	Part III: Calculate the Normalized Burn Ratio (NBR) and difference Normalized Burn Ratio (dNBR)
Product Type:	Curriculum
Developer:	Helen Cox (Professor, Geography, California State University, Northridge): helen.m.cox@csun.edu Laura Yetter (Research Asst., Institute for Sustainability, California State University, Northridge)
Target audience:	Undergraduate or Graduate
Format:	Tutorial (pdf document)
Software requirements* :	ArcMap 9 or higher (ArcGIS Desktop) (Part III), ERDAS Imagine 2010 or higher (Parts I, II, III)
Data:	All data required are obtained within the exercise. Data is provided for those wishing to carry out Part III alone.
Estimated time to complete:	All parts: 10 hrs
	Part I: 3.5 hrs. - 4 hrs.
	Part II: 3 hrs. - 3.5 hrs.
	Part III: 3 hrs.
Alternative Implementations:	<ul style="list-style-type: none"> • Parts I and III together provide a standalone exercise of an approximate assessment of burn severity and fire damage for the Old Fire which burned in southern California in October 2003. • Parts I and II together provide a standalone exercise on how to download ASTER data and convert to reflectance • Parts I, II and III together provide a standalone exercise giving a more accurate assessment of burn severity and fire damage for the Old Fire as radiometric corrections are made (raw data is converted to reflectance) • Part III can be carried out as a standalone exercise if the optional data set is used
Learning objectives:	Part I: <ul style="list-style-type: none"> • Learn about the ASTER instrument and data • Learn how to assess burn severity and fire damage using initial and extended assessments • Download fire maps from the Monitoring Trends in Burn Severity (MTBS) project • Download ASTER data for initial and extended fire damage assessments • Prepare data for analysis by stacking layers, projecting and subsetting imagery using ERDAS Imagine
	Part II: <ul style="list-style-type: none"> • Calculate radiance from ASTER Level 1B pixel data • Calculate reflectance from the radiance data
	Part III: <ul style="list-style-type: none"> • Calculate the Normalized Burn Ratio (NBR)

	<ul style="list-style-type: none">• Calculate the difference Normalized Burn Ratio (dNBR)• Evaluate fire damage and fire recovery and compare to MTBS data
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*Tutorials may work with earlier versions of software but have not been tested on them

Fire Mapping using ASTER

Part III: Calculate the Normalized Burn Ratio (NBR) and difference Normalized Burn Ratio (dNBR)

Objectives:

- Calculate the Normalized Burn Ratio (NBR)
- Calculate the difference Normalized Burn Ratio (dNBR)
- Evaluate fire damage and fire recovery and compare to MTBS data

In this exercise we are using the ASTER instrument to study fire damage and recovery through a study of the Old fire, which was a part of the "2003 firestorm" or "fire siege of 2003" in October 2003 when 8 wildfires simultaneously burned southern California (Piru, Verdale, Simi, Grand Prix, Roblar, Paradise, Cedar, Otay fires).



After completing Part I of this exercise you should have the following: 4 stacked (VNIR and SWIR) subsetting ASTER images of the fire area (initial assessment pre- and post- fire and extended assessment pre- and post- fire).

It is preferable to use reflectance rather than radiance spectra for these exercises so that the effects of seasonal sunlight changes are accounted for. Some ASTER data is available as level 2 (L2) surface reflectance data for download. However that is not the case for the images we used here. It is possible to calculate radiance and reflectance from the level 1B (L1B) data by using a script or a model, and you are encouraged to do that. Instructions are provided in Part II. However, should you wish to skip that you may simply use the raw L1B images from Part I which will yield sufficient accuracy for our purposes.

1. Calculate the Normalized Burn Ratio (NBR)

$$\text{NBR} = (\text{ASTER band 3} - \text{ASTER band 6}) / (\text{ASTER band 3} + \text{ASTER band 6})$$

Band 3 (0.78 - 0.86 μm) in the near infrared and band 6 (2.185 - 2.225 μm) in the shortwave infrared are used to map burn areas because they are less susceptible to atmospheric interference and more sensitive to burns than visible bands. The signatures of these bands show that SWIR band 6 increases and VNIR band 3 decreases after a fire. The index has possible values between + and - 1. On an NBR image a fire will appear as a dark area with a low NBR value.

It is preferable to use reflectance to calculate the NBR because the amount of incoming radiation is different for each band (and for each date) but the bands need to be standardized so they can be compared on the same scale (<http://burnseverity.cr.usgs.gov/overview/nbr/index.php>). However if reflectance data is unavailable, raw DN data will suffice for a qualitative assessment.

dNBR is the difference between the NBR images pre and post fire. The initial dNBR measures the immediate change after the fire and shows the burned areas. It is often used to draw the fire perimeter.

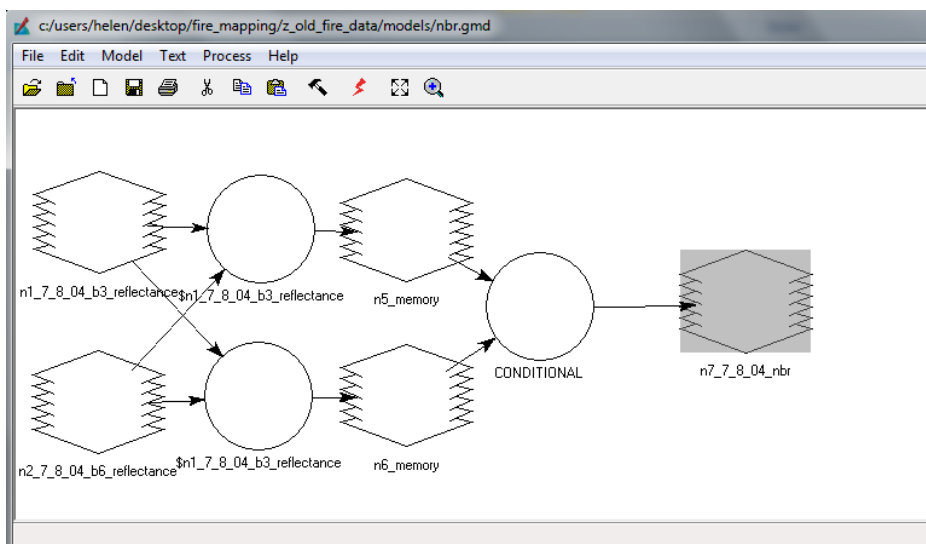
The extended dNBR measures the regrowth of the vegetation by comparing the amount of vegetation before and after the fire. We will use Model Maker to calculate the NBR for the initial and extended pre- and post- fire imagery, and then again to calculate the dNBR images.

You can build the model yourself or you can use the one we have pre-built for you.

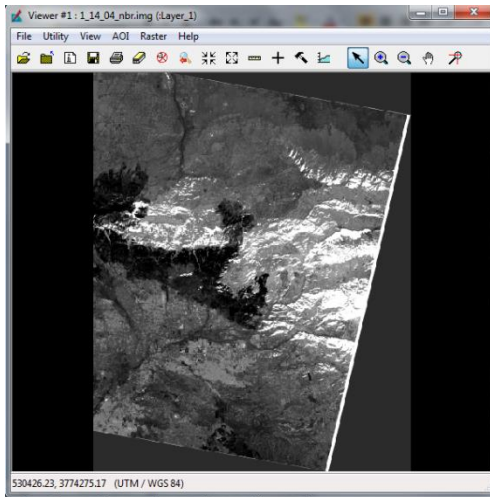
If you choose to build your own model, make sure you add a conditional statement that if the denominator is zero do not calculate the NBR. (Conditional (denominator != 0) numerator/denominator, and be sure that the output data type is 'Float Single'.)

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CONDITIONAL { ($n6_memory!=0) $n5_memory / $n6_memory }
```

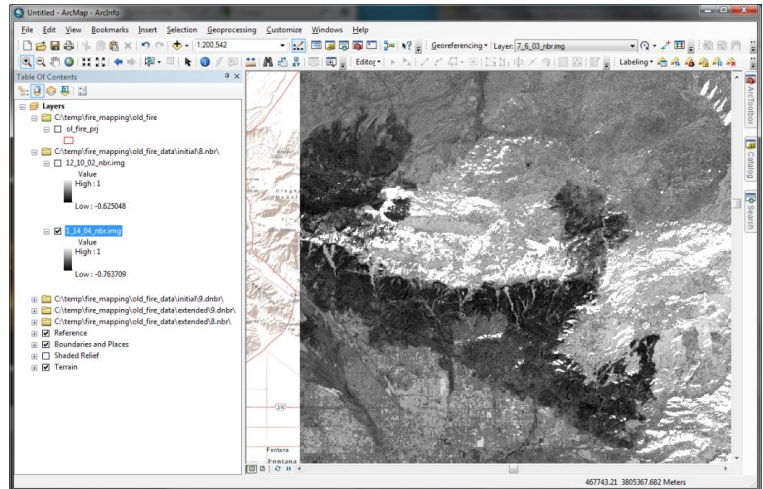
Open Model Maker from the Modeler icon on the toolbar and use the tools to create the model as shown below, or if using the existing one, go to File -> Open and locate the nbr.gmd. You can run the model by clicking the lightning bolt.



Create NBR images for the initial assessment pre-fire, post-fire and extended assessment pre-fire, post-fire images (four images in total) and then examine the results in ArcMap or Imagine. (Do not worry if your images are dark. The darkness in the appearance on the screen is simply a function of the contrast settings. You can change these and the data in the images will not change.)



Initial assessment post-fire NBR in Imagine

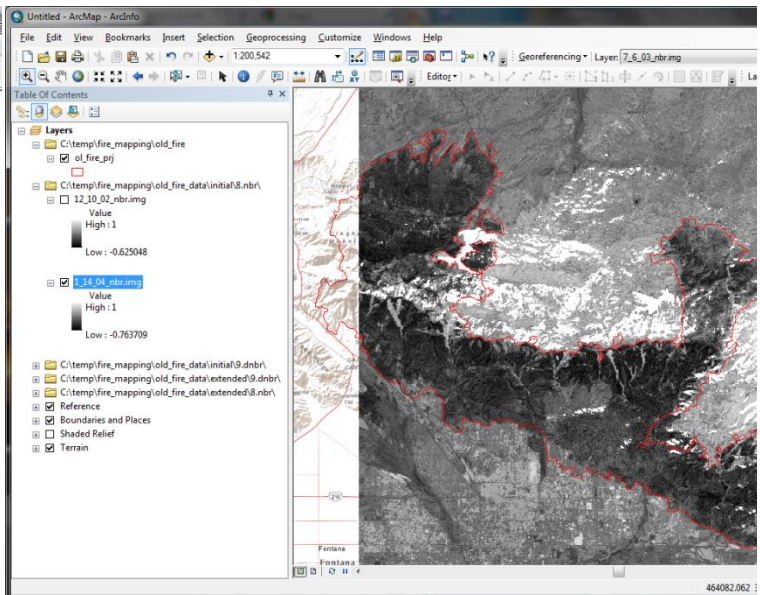
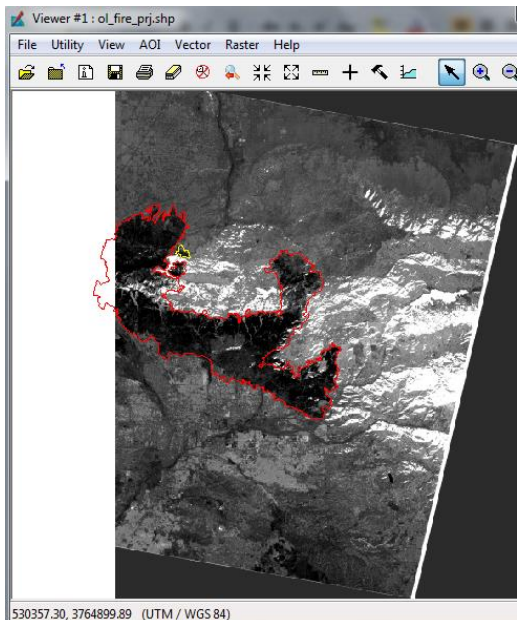


Initial assessment post-fire NBR in ArcMap

The NBR values should be between -1 and +1. Look at the initial assessment post-fire NBR, dark areas indicate burned areas, the reflectance in band 6 is high. Vegetation that is alive has a high reflectance in band 3 and is light colored (see <http://burnseverity.cr.usgs.gov/overview/nbr/index.php>).

On the post- fire image can you identify the fire perimeter?

Overlay the fire perimeter shapefile you downloaded from the MTBS site on top of your image. (In ArcMap just drag it to the LH panel. In Imagine, Open a Vector layer and turn off the Clear Display option under the Vector Options tab.



2. Calculate the difference Normalized Burn Ratio (dNBR)

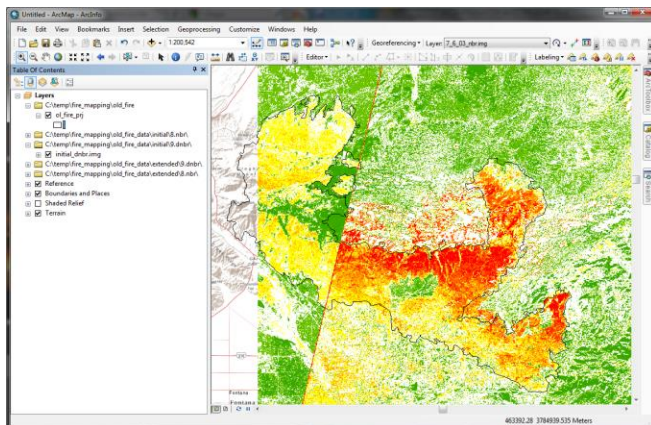
In Imagine use model maker to calculate the dNBR from the initial assessment pre- and post- fire NBR images. (You may run the dNBR model provided.)

$$\text{dNBR} = \text{pre fire NBR} - \text{post fire NBR}$$

The dNBR looks at the change from pre-fire to post-fire image and identifies how severely an area was burned. It measures the amount of change over time due to the fire. The result is a gray scale image, with values between -2 and + 2. Light or positive values indicate that the pre-fire NBR was a lot greater than the post-fire value suggesting that the area was severely burned. (Be careful with interpretation where clouds or snow can give a false reading.) Negative values of dNBR indicate that vegetation has re-grown, possibly better than before the fire. (<http://burnseverity.cr.usgs.gov/overview/nbr/index.php>)

Open the initial assessment dNBR image in ArcMap. Change the symbology to 'Classified' using the following chart (http://burnseverity.cr.usgs.gov/pdfs/LAV4_BR_CheatSheet.pdf and http://wiki.landscapetoolbox.org/doku.php/remote_sensing_methods:normalised_burn_ratio):

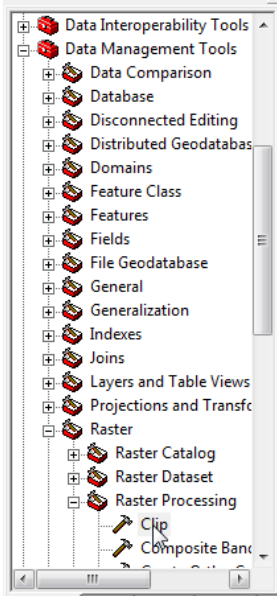
	dNBR	Burn Severity
	< -0.25	High post-fire re-growth
	-0.25 to -0.1	Low post-fire re-growth
	-0.1 to 0.1	Unburned
	0.1 to 0.27	Low severity burn
	0.27 to 0.44	Moderate- low severity burn
	0.44 to 0.66	Moderate- high severity burn
	> 0.66	High severity burn



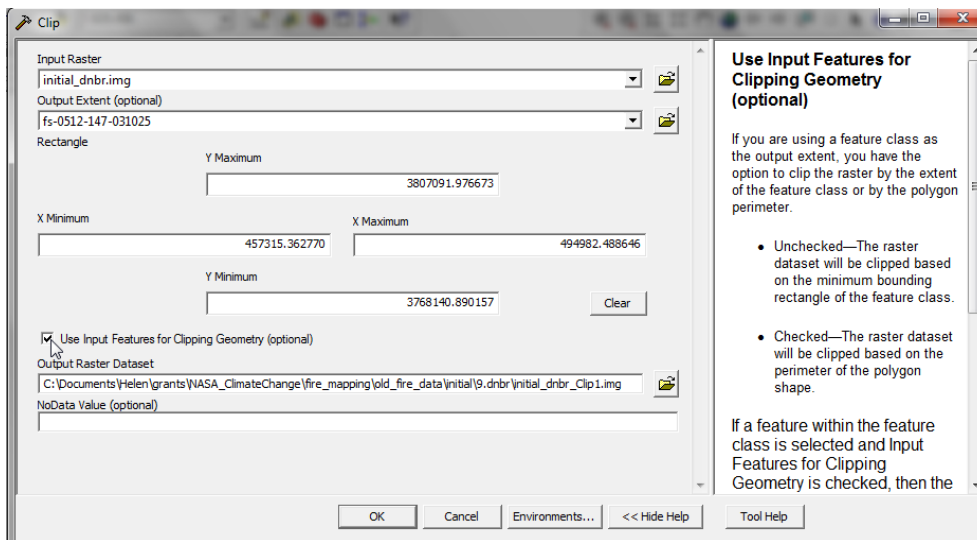
Repeat the above steps for the extended assessment pre- and post- fire images.

3. Compare to MTBS results

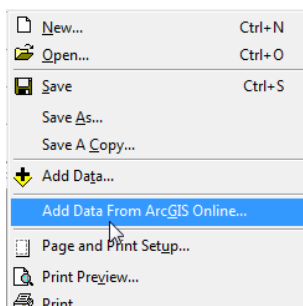
Open the dNBR for the initial assessment and extended assessment in ArcMap and add the fire perimeter layer that you downloaded from MTBS. From the Toolbox -> Data Management Tools -> Raster -> Raster Processing, choose Clip and clip the dNBR images to the fire perimeter layer:



In the Clip box make sure you check the “Use Input Features for Clipping Geometry” option.



From ArcGIS Online, add a base map for reference.





Shaded Relief

This LYR file combines the World Shaded Relief map service and two reference overlay services in one convenient group layer.

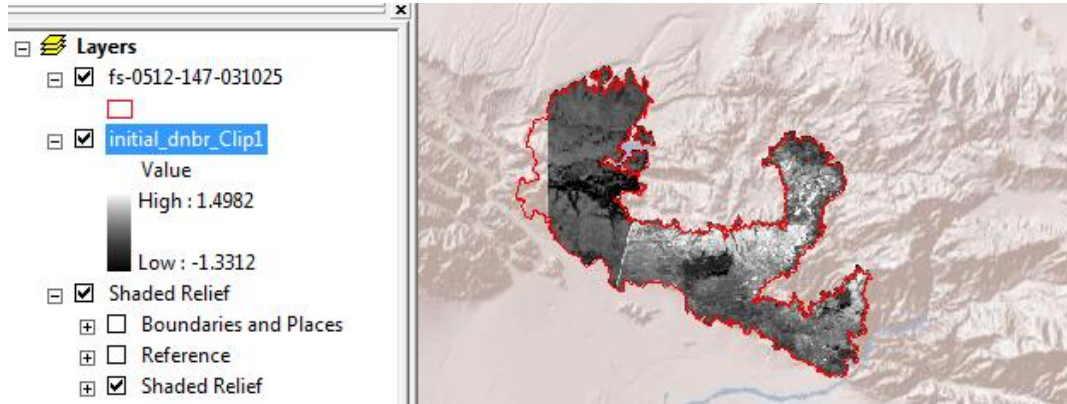
◆ Layer by esri

Last Modified: January 16, 2012

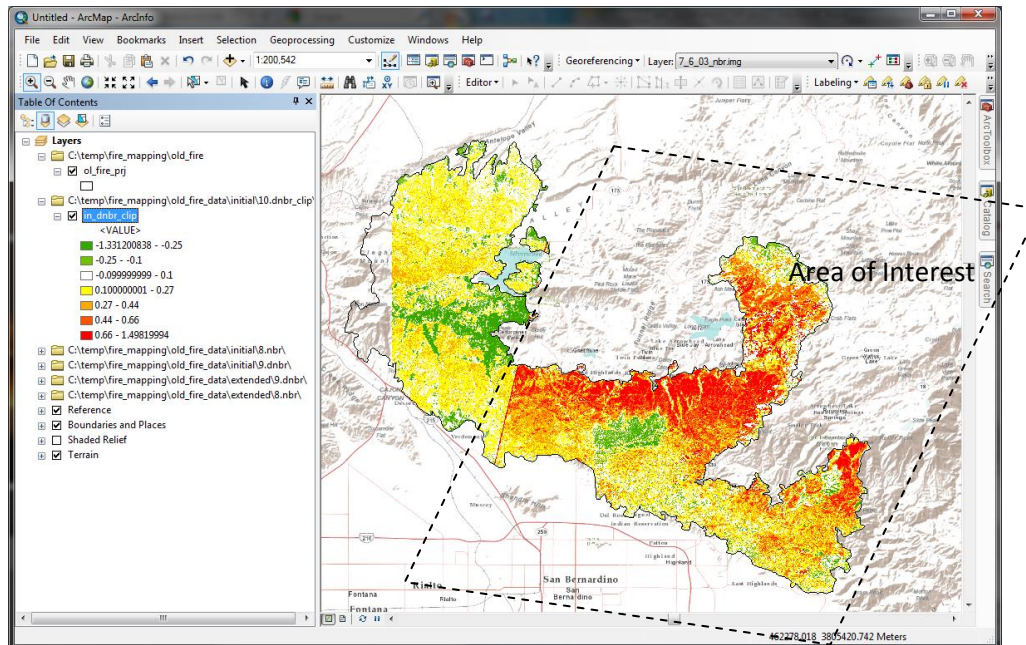
Open ▾

Details

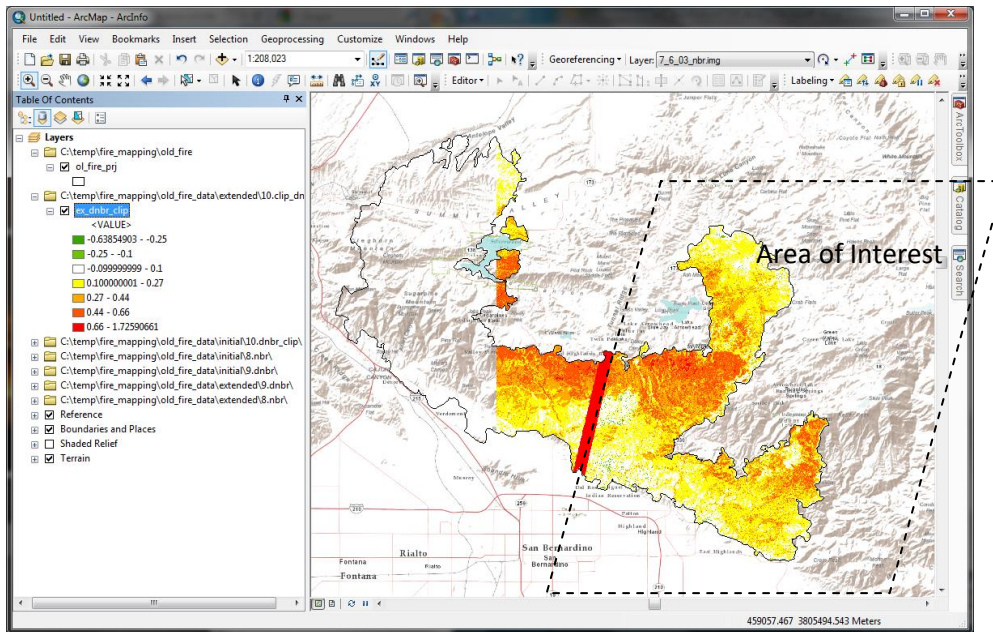
Open in ArcGIS For Desktop (1 rating, 0 comments, 25,391 downloads)



Shown below is the initial assessment dNBR that identifies the severity of the burn right after the fire (Dec 10, 2002, and Jan 14, 2004).



This can be compared to the MTBS results that were downloaded earlier.



Make a screen shot showing your initial assessment dNBR image.

The extended fire dNBR assessment (July 6, 2003 and July 8, 2004) identifies re-growth. The area outside the area of interest is where the pre- and post- fire images did not overlap.

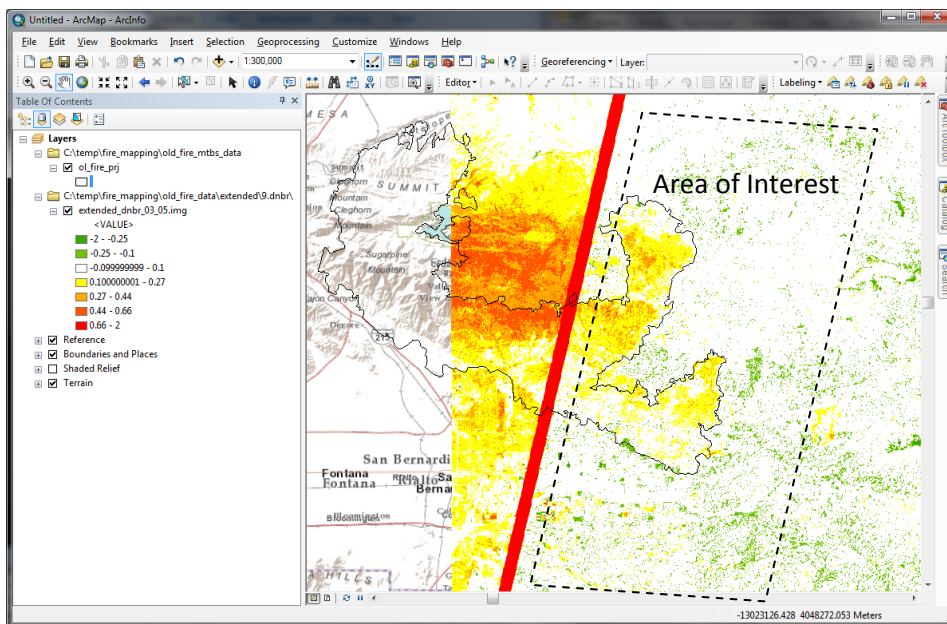


Image above shows extended fire assessment for July 6, 2003 and July 11, 2005. Note the amount of recovery that has taken place by 2005.