



Create Band Ratios



Remote Sensing For Ranger Districts Using Image Analysis for ArcGIS

Document Updated: June, 2005



Assumptions of Creating Band Ratios:

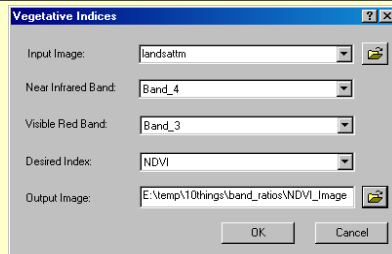
- 1) You have a Landsat TM image **covering your project area** with the **Thermal Band removed**.
- 2) We recommend that your Landsat TM image is in an **ESRI GRID** format for this application.



A **NDVI Image** is used to enhance vegetation discrimination.



Ensure the Spatial Analysis extension and toolbar are enabled: 1) Select **Tools | Extension** from **ArcMap's Main Menu** and check **Image Analysis**, 2) select **View | Toolbars** from **ArcMap's Main Menu** and check **Image Analysis**, and 3) dock the **Image Analysis toolbar** if necessary.



This graphic illustrates the **Vegetation Indices** dialog and its appropriate set-up to create a **NDVI Image**.

Objective

- To create band ratios from Landsat TM (Thematic Mapper) imagery.

Required Data

- A Landsat TM image.

Introduction and Overview of Procedure Steps

A band ratio is created by dividing spectral values of one band by spectral values of another band from a multispectral image. This document describes how to create two commonly used band ratios derived from Landsat TM imagery—NDVI (Normalized Difference Vegetation Index) and NBR (Normalized Burn Ratio). These ratios are used to extract vegetation and burn information, respectfully. The major topics are:

1. Create a NDVI Image
 - A. Set-up NDVI Parameters and Create a NDVI Image
 - B. Convert (Rescale) the Data Type
 - C. Inspect the Results
 - D. Convert your NDVI Image Format to ERDAS Imagine (Optional)
 - E. Convert your NDVI Image Format to ESRI GRID (Optional)
2. Create a NBR Image
 - A. Load Landsat TM Bands and Set-up Parameters
 - B. Create a NBR Image
 - C. Convert (Rescale) the Data Type
 - D. Inspect the Results

I. Create a NDVI Image

A. Set-up NDVI Parameters and Create a NDVI Image

1. Launch **ArcMap** from the **Start** menu (**Start | Programs | ArcGIS | ArcMap**).
2. Select the **Add Data** button from **ArcMap's Standard** toolbar.
3. Navigate to and select a **Landsat TM Image**.
4. Select **Add** to load the **Landsat TM Image** into **ArcMap's Table of Contents**.
5. Ensure the **Image Analysis** toolbar and extension are enabled (see note to left).
6. Select **Image Analysis | Spectral Enhancement | Vegetation Indices** from the **Image Analysis** toolbar to open the **Vegetation Indices** dialog. Set the following parameters in the **Vegetation Indices** dialog:
 - **Input Image:** your **Landsat TM Image**



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Number of rows:	628	Number of columns:	758
Number of bands:	1		
X cellsize:	30.155545	Y cellsize:	30.155545
Source type:	continuous	Compression:	Default
Data type:	floating point	Data depth (bits):	32
Colormap:	absent	Pyramids:	present

Statistics

Band: Layer_1

Minimum:	-0.5714	Maximum:	0.7222
Mean:	0.4353	Std dev:	0.1120
Classes:	0		

This graphic illustrates a portion of the NDVI Image's Source tab. Important information that you should document includes: Data Type, Data Depth (bits), and the Data Range (Minimum and Maximum).



Why is it important to convert your image from 32-bit, floating point to 8-bit, unsigned integer?

- 1) Reduce file size.
- 2) May be required for subsequent analysis (data normalization).

Why must you use a work-around solution to convert the data? When performing image processing with ArcGIS 8.3, the default data depth and type is typically 32-bit, floating point even when input data is 8-bit, unsigned integer. Other software programs (e.g., Imagine) allow the user to specify the output data type and depth.

- **Near Infrared Band:** *Band_4*
 - **Visible Red Band:** *Band_3*
 - **Desired Index:** *NDVI*
 - **Output Image:** *select the Yellow Folder button, navigate to an appropriate output directory, set the Save As Type to ESRI GRID, type in the Output File Name, and select Save.*
 - Select **OK** to run the process. Your NDVI Image will automatically display in the **Data View** once finished.
7. Select **OK** to dismiss the **Pixel Type Warning** error (some of you may not get this error).
 8. Inspect the **NDVI Image** in the **Data View**. Toggle the **NDVI Image** and compare to the **Land-sat TM Image** from which the **NDVI Image** was derived.
 9. Double-click your **NDVI Image** in the **Table of Contents**.
 10. Select **OK** to dismiss the **Warning**.
 11. Select the **Source** tab from the **Layer Properties** dialog.
 12. Inspect the **Data Type** and **Data Depth (bits)** which should be *Floating Point* and *32-bit*, respectively. Note that it is most efficient to convert your **NDVI Image** to an **Unsigned Integer Data Type** and an *8-bit Data Depth* (see comments to the left).

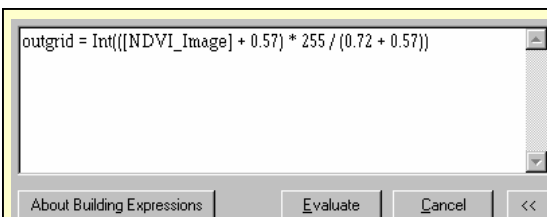
B. Convert (Rescale) the Data Type

1. Write down the **Minimum** and **Maximum** values (on scratch paper) from the **Statistics** section of the **Layer Properties' Source** tab.
2. Select **OK** to close the **Layer Properties** dialog.
3. Select **Spatial Analyst | Options** from the **Spatial Analyst** toolbar, and ensure that the **General** tab is displayed in the **Options** dialog.
4. Select the **Yellow Folder** button associated with the **Working Directory**, and navigate to an appropriate output directory to set your **Working Directory** (this is where outputs from the **Raster Calculator** will be saved).
5. Select **OK** to close **Choose a Working Directory** dialog.
6. Select **OK** to close the **Options** dialog.
7. Select **Spatial Analyst | Raster Calculator** from the **Spatial Analyst** toolbar.
8. Type the following **Expression** in the **Formula Area** of the **Raster Calculator** dialog:

$$\text{cvtNDVI}^a = \text{Int}^b([\text{your NDVI Image}^c] + X^d) * 255 / (Y - X^e)$$
 where;
 - ^a = Type your output file name here
 - ^b = **Int** stands for Integer
 - ^c = Type in the file name of your **NDVI Image** that you wish to convert
 - ^d = Type in the additive inverse of your **Minimum** value (e.g., the additive inverse of -0.57 is 0.57)



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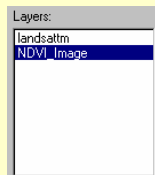


This graphic illustrates the **Formula Area** of the **Raster Calculator**, and represents an example of a conversion formula to an 8-bit, unsigned integer format.



Tips on writing expressions using the Raster Calculator.

- 1) Put spaces between operators (e.g., +, -, etc.)
- 2) Ensure your output file name is less than 13 characters
- 3) Double-click (instead of typing) your input (NDVI Image) file name (see graphic to right)



What is happening if your converted NDVI Image is still a 16-bit, signed integer even after converting?

ArcMap interprets NoData values as -9999. This number is beyond the data range of an 8-bit format, and thus, automatically defaults to a 16-bit format. Refer back to page 2 to determine if you would like to continue...

- = Type in the data range—subtract the **Minimum** value (X) from the **Maximum** value (Y) (e.g., if the maximum value is 0.72 and the minimum value is -0.57, then $0.72 - (-0.57) = 0.72 + 0.57$)
9. Select the **Evaluate** button from the **Raster Calculator**. **cnvtNDVI Image** should automatically display in the **Data View**.

C. Inspect the Results

1. Double-click your **cnvtNDVI Image** in the **Table of Contents**, and select the **Source** tab from the **Layer Properties** dialog.
2. Write down your **Data Type**_____ and **Data Depth (bits)**_____ of your **cnvtNDVI Image**. You should have:
 - **Data Type:** *signed integer or unsigned integer*
 - **Data Depth (bits):** *16-bit or 8-bit*
3. If you have an **8-bit, unsigned integer** you are done! If you have a **16-bit, signed integer** you may continue (if you wish). See comments to the left to determine if you would like to continue.

D. Convert your NDVI Image Format to ERDAS Imagine (Optional)

Note: when you export your GRID image to an ERDAS Imagine format, the file will automatically rescale to 8-bit by default.

1. Launch **ArcToolbox** from the **Start** menu (**Start | Programs | ArcGIS | ArcToolbox**).
2. Select **Conversion Tools | Export from Raster | Grid to Image** to open the **Grid to Image** dialog. Set the following parameters in the **Grid to Image** dialog:
 - **Input Grid:** *select the Yellow Folder button, navigate to and select your cnvtNDVI Image, and select Open*
 - **Image Format:** *Imagine*
 - **Output Image:** *select the Yellow Folder button, navigate to an appropriate output directory, type in the File Name, and select Save*
 - Select **OK** to run the process
3. Select the **Add Data** button from **ArcMap's Standard** toolbar.
4. Navigate to and select your **new NDVI Image (.img)**.
5. Select **Add** to load your **new NDVI Image (.img)** into **ArcMap's Table of Contents**.
6. Double-click your **new NDVI Image (.img)** in the **Table of Contents**, and select the **Source** tab from the **Layer Properties** dialog.
7. Write down your **Data Type**_____ and **Data Depth (bits)**_____ (they should be unsigned integer and 8-bit, respectively).



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E. Convert your NDVI Image Format to ESRI GRID (Optional)

1. Launch **ArcCatalog** from the **Start** menu (**Start** | **Programs** | **ArcGIS** | **ArcCatalog**).
2. Navigate to and right-click on your **new NDVI Image (.img)** in the **Catalog Tree**.
3. Select **Export** | **Raster to a Different Format**.
4. Navigate to an appropriate output directory, set the **Save as Type** to **ESRI GRID**, type in the **File Name**, and select **Save**.



In review, you...

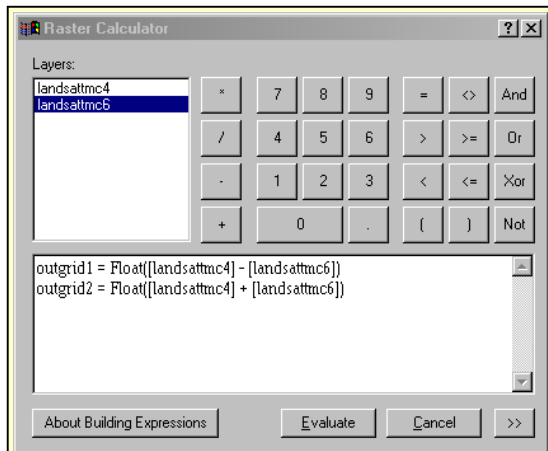
- 1) *Created a NDVI Image using Image Analysis,*
- 2) *Inspected the NDVI Image,*
- 3) *Converted data type properties of the NDVI Image using the Raster Calculator, and*
- 4) *Inspected the Converted NDVI Image;*

and if you deemed necessary, you...

- 5) *Made file format conversions to create an 8-bit, unsigned integer NDVI Image.*



A **NBR Image** is used to enhance discrimination of burned areas.



This graphic illustrates a portion of the **Raster Calculator** with some of the appropriate expressions used to create a **NBR Image**.

II. Create a NBR Image

A. Load Landsat TM Bands and Set-up Parameters

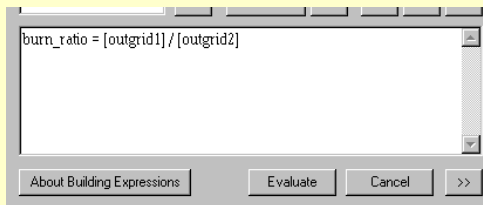
1. Launch **ArcMap** from the **Start** menu (**Start** | **Programs** | **ArcGIS** | **ArcMap**).
2. Select the **Add Data** button from **ArcMap's Standard** toolbar.
3. Navigate to and select **band_4** and **band_6** from your **Landsat TM Image**.
4. Select **Add** to load **band_4** and **band_6** into **ArcMap's Table of Contents**.
5. Select **Spatial Analyst** | **Options** from the **Spatial Analyst** toolbar, and ensure that the **General** tab is displayed in the **Option** dialog.
6. Select the **Yellow Folder** button associated with the **Working Directory**, and navigate to an appropriate output directory to set your **Working Directory** (default location for Raster Calculator outputs).
7. Select **OK** to close **Choose a Working Directory** dialog.
8. Select **OK** to close the **Options** dialog.

B. Create a NBR Image

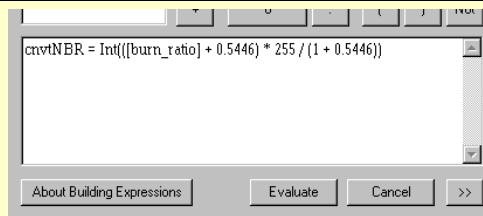
1. Select **Spatial Analyst** | **Raster Calculator** from the **Spatial Analyst** toolbar to open the **Raster Calculator**.
2. Type the following **Expressions** in the **Formula Area** of the **Raster Calculator** dialog:
OutGrid1 = Float([your Landsat TM Band 4 Image^a] - [your Landsat TM Band 6 Image^b])
OutGrid2 = Float([your Landsat TM Band 4 Image] + [your Landsat TM Band 6 Image])



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This graphic illustrates the **Formula Area** of the **Raster Calculator**—this expression calculates a **NBR Image**.



This graphic illustrates the **Formula Area** of the **Raster Calculator**—this expression converts (or rescales) the **NBR Image** to an **8-bit data format**.

- ^a = Your **Landsat TM Band 4** file name
 - ^b = Your **Landsat TM Band 6** file name
3. Double-check your expressions; then select **Evaluate** from the **Raster Calculator**. **Outgrid1** and **Outgrid2** will automatically display in the **Data View** once the process is complete.
 4. Select **Spatial Analyst | Raster Calculator** from the **Spatial Analyst** toolbar to open the **Raster Calculator** (again).
 5. Type in the following **Expression** in the **Formula Area** of the **Raster Calculator** dialog (left): **BurnRatio = [OutGrid1] / [OutGrid2]**
 6. Select the **Evaluate** button from the **Raster Calculator**. Your **BurnRatio Image** will automatically display in the **Data View**.

C. Convert (Rescale) the Data Type

1. Double-click your **BurnRatio Image** in **ArcMap's Table of Contents**, and select the **Source** tab from the **Layer Properties** dialog.
2. Write down your **BurnRatio Image's**:
 - **Data Type**: _____
 - **Data Depth (bits)**: _____
 - **Maximum**: _____
 - **Minimum**: _____
 - Note that the **Data Type** and **Depth** should be **Floating Point** and **32-bit**, respectively. You should convert these values to **Unsigned Integer** and **8-bit**.
3. Select **Spatial Analyst | Raster Calculator** from the **Spatial Analyst** toolbar to open the **Raster Calculator**.
4. Type in the following **Expression** in the **Formula Area** of the **Raster Calculator** dialog: **cnvtNBR^a = Int^b(([your BurnRatio Image^c] + X^d) * 255 / (Y - X^e))**
where;
 - ^a = Type your output file name here
 - ^b = **Int** stands for Integer
 - ^c = Type in the file name of your **BurnRatio Image** that you wish to convert
 - ^d = Type in the additive inverse of your **Minimum** value (e.g., the additive inverse of -0.57 is 0.57)
 - ^e = Type in the data range—subtract the **Minimum** value (X) from the **Maximum** value (Y) (e.g., if the maximum value is 0.72 and the minimum value is -0.57, then 0.72 - (-0.57) = 0.72 + 0.57)
5. Select the **Evaluate** button from the **Raster Calculator**. **cnvtNBR Image** should automatically display in the **Data View**.



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D. Inspect the Results

1. Double-click your **cnvtNBR Image** in the **Table of Contents**, and select the **Source** tab from the **Layer Properties** dialog.
2. Write down your **Data Type**_____ and **Data Depth (bits)**_____ of your **cnvtNBR Image**.
You should have:
 - **Data Type:** *signed integer or unsigned integer*
 - **Data Depth (bits):** *16-bit or 8-bit*
3. If you have an **8-bit, unsigned integer** you are done! If you have a **16-bit, signed integer** you may continue (if you wish). See tips from pages 2 and 3 to determine if you would like to continue. If you do continue, follow sections **D** and **E** from instructions on how to **Create a NDVI Image**.