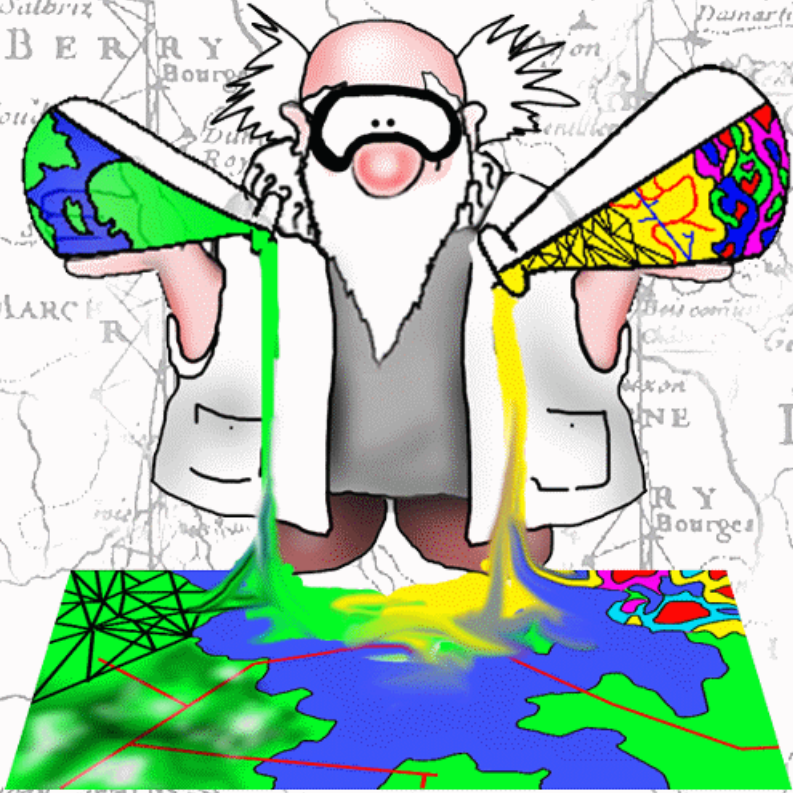**Tutorial**

Using Geospatial Formulas

in

TNTmips^Æ

TNTedit^ô
TNTview^Æ

Before Getting Started

This booklet introduces techniques for using GeoFormulasô in TNTmipsÆ, TNTeditô, and TNTviewÆ. Geospatial objects from TNT Project Files can be combined dynamically in the display process to achieve ìdata fusionî effects. This booklet introduces you to the basic GeoFormula tools in the Display / Spatial Data and Process / GeoFormula processes.

Prerequisite Skills This booklet assumes that you have completed the exercises in the tutorials *Displaying Geospatial Data* and *Navigating*. The exercises in those booklets present basic skills and techniques for selecting and viewing objects stored in Project Files, and getting around in TNTmips. Please consult those booklets and the TNTmips reference manual for any review you need. You will also find it helpful to complete the exercises in the *Writing Scripts with SML* tutorial, since GeoFormula constructions use SML syntax.

Sample Data The exercises presented in this booklet use sample data that is distributed with the TNT products. If you do not have access to a TNT products CD, you can download the data from MicroImagesí web site. In particular, this booklet uses objects in the CB_DATA and GEOFRMLA data collections. Make a read-write copy of these files on your hard drive; you may encounter problems if you work directly with the read-only sample data on the CD-ROM.

More Documentation This booklet is intended only as an introduction to data fusion with GeoFormulas. Consult the TNT reference manual on the 2D Display and separate GeoFormula processes for more information.

TNTmips and TNTliteô TNTmips comes in two versions: the professional version and the free TNTlite version. This booklet refers to both versions as ìTNTmips.î If you did not purchase the professional version (which requires a software license key), TNTmips operates in TNTlite mode, which limits object size.

The GeoFormula feature is also available in TNTedit and TNTview. The exercises can be completed in TNTlite using the sample geodata provided.

Keith Ghormley, 2 January 2004

It may be difficult to identify the important points in some illustrations without a color copy of this booklet. You can print or read this booklet in color from MicroImagesí web site. The web site is also your source for the newest tutorial booklets on other topics. You can download an installation guide, sample data, and the latest version of TNTlite:

http://www.microimages.com
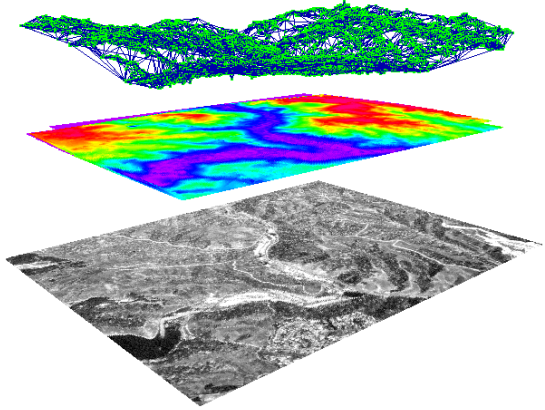
Introducing Geospatial Formulas

A GeoFormula is a computed display layer that uses one or more input objects to derive a result for display. It gives you a way to combine objects ìon the flyî rather than running separate processes to prepare output objects for display. A GeoFormula is a dynamic display layer that contains a ìvirtual object.î The GeoFormula layer does not create an output object that is saved in a Project File. Instead, it creates a display layer that releases all its system resources (such as disk space and memory) when you are finished with it.

One or more layers in a display may be dynamically computed from a **GeoFormula** that refers to several input objects.

For example, red and infrared bands of raster imagery can be combined to produce a Transformed Vegetation Index (TVI). Of course TNTmips offers a simple process that produces a TVI output raster object from selected input objects if you want to retain the TVI output for other uses. But if you just want to view the TVI result and do not care to keep the output object, you can use a GeoFormula display layer. (The exercise on page 6 provides a TVI GeoFormula script.)

A GeoFormula script can be saved as a reusable file. A GeoFormula layer can be combined with any number of other layers in the TNTmips display process to create a complex visualization of multiple geospatial objects.

The GeoFormula feature is primarily provided for dynamic visualization tasks in the display process. You can also run a separate GeoFormula process (Process / GeoFormula) to create permanent output objects for other uses (see page 18).

Geoformula display layers perform file access and multi-object processing on the fly. Thus you may notice that this processing overhead results in slower display times that may seem sluggish compared to other display layers.

Simple one-object GeoFormulas are introduced on pages 4 and 5. Pages 6-12 present a number of multi-raster scripts. The exercises on pages 13-15 show how to combine both raster and vector objects in a single GeoFormula.
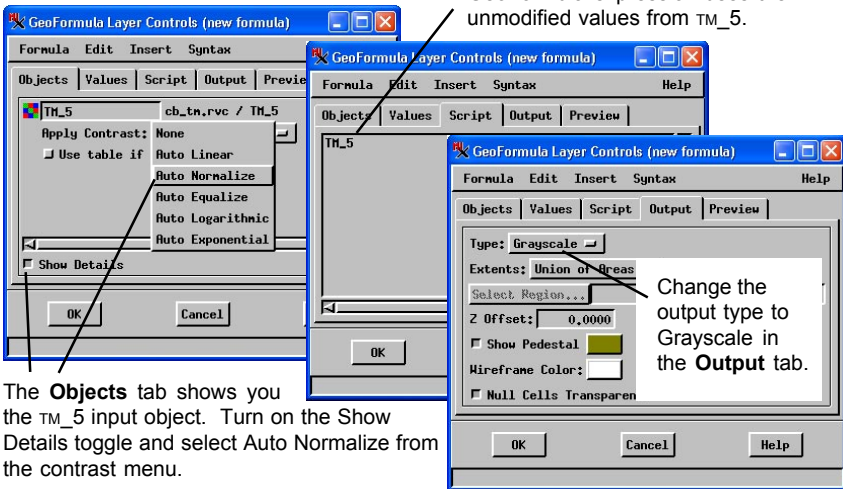
A Simple GeoFormula

STEPS
- ☑ open a new 2D Display group
- ☑ in the Group Controls window select Add GeoFormula Layer in the menu under the Add GeoFormula icon
- ☑ select Formula / New in the GeoFormula Layer Controls dialog
- ☑ select CB_DATA / CB_TM / TM_5 in the Select Objects dialog
- ☑ click the Show Details toggle in the Objects tab and select Auto Normalize for contrast
- ☑ select the Script tab and type in ìTM_5î
- ☑ select the Output tab and change the Type to Grayscale
- ☑ click [OK] to close the GeoFormula Layer Controls dialog
- ☑ click [No] in the Verify dialog that asks if you want to save changes

You add a GeoFormula layer just as you would add any other display layer in the Group Controls window of the Display process. Click the Add GeoFormula icon button to open the GeoFormula Layer Controls dialog. The GeoFormula Layer Controls dialog lets you create a new GeoFormula or open an existing one. Select New from the Formula menu. Since a GeoFormula must refer to at least one georeferenced object, the process prompts you to select one or more input objects in the standard Select Objects dialog. Select the TM_5 raster object from the CB_TM Project File in the CB_DATA data collection, and click [OK] to close the Select Objects dialog.

For this script, we will simply display the unmodified values of the TM_5 raster object in grayscale. Select the Object, Script, and Output tabs in turn and make the changes illustrated below. When you click [OK] after making the last change, the process closes the GeoFormula Layer Controls dialog and displays the GeoFormula layer.

in the **Script** tab, a very simple GeoFormula expression uses the unmodified values from TM_5.
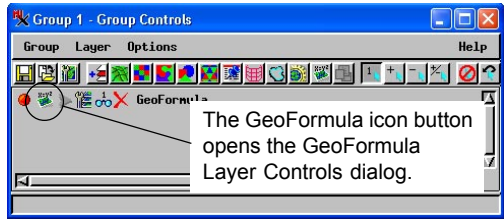
The **Objects** tab shows you the TM_5 input object. Turn on the Show Details toggle and select Auto Normalize from the contrast menu.

Change the output type to Grayscale in the **Output** tab.

Using Insert Symbol

For our next look at the GeoFormula controls, we will create a slightly more complex script. Open the GeoFormula Layer Controls dialog by clicking the GeoFormula icon button in the layer list of the Group Controls

The GeoFormula icon button opens the GeoFormula Layer Controls dialog.

window. Repeat the steps from the exercise on page 4 to create a new GeoFormula (start with Formula / New), and select the same TM_5 input raster object. Set the contrast to Auto Normalize in the Objects tab, and the output type to Grayscale in the Output tab.

In the Script tab, open the Insert Symbol dialog by selecting Symbol from the Insert menu. In the Insert Symbol dialog, change the Type to Numeric. The process automatically lists the nu-

meric variables available for the TM_5 input object. Select TM_5_Value and click [Insert]. Put your cursor in the Script panel and type in a plus operator (ì+î) after TM_5_Value, and then return to the Insert Symbol dialog and get the TM_5_X variable. Return to the Script tab and type in ì/ 4î to complete the expression. Your complete GeoFormula should be

```
TM_5_Value + TM_5_X / 4
```

Click [OK] to close the GeoFormula Layer Controls dialog and view the result.

The TM_5_Value variable is a ìprocessedî value: the cell value adjusted for display by the selected contrast table. The TM_5 value (used in the previous exercise) is a ìrawî input cell value that is not affected by the selected contrast table.

STEPS
- ☑ repeat the steps from the previous exercise to create a new script with CB_TM / TM_5 input
- ☑ select Insert / Symbol
- ☑ insert TM_5_Value from the Numeric symbol list
- ☑ edit the script and select TM_5_X from the symbol list to complete the expression illustrated

Adding TM_5_X / 4 to the output value creates a vignetting effect, increasing display intensities as the X coordinate value increases.
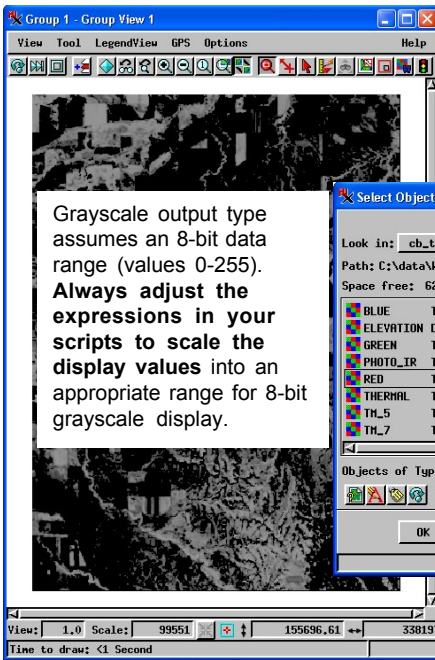
A Two-Band Vegetation Index

A .**gsf** file contains the parameters and definitions used in a GeoFormula. It automatically records the changes you make in the GeoFormula Layer Controls dialog.
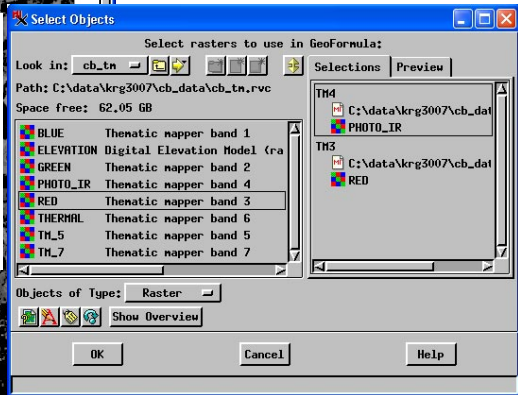
STEPS
- ☑ select Formula / Open in the GeoFormula Layer controls dialog
- ☑ select GEOFRMLA / TVI.GSF
- ☑ select PHOTO_IR and RED from the CB_TM Project File
- ☑ if the background color shows through in the view, turn off the Null Cells transparent toggle in the Output tab of the GeoFormula Layer Controls

The strength of the GeoFormula feature in the Display Process is that it lets you perform operations on multiple input objects ìon the fly.î For example, to view a Transformed Vegetation Index (TVI) result (showing vegetation vigor computed from near-infrared and red spectral bands), you could run Process / Raster / Combine / Predefined, select input objects, create an output raster, and view the result. By contrast, the GeoFormula feature lets you view the TVI result dynamically in a ìvirtual object,î without running a separate process to create a raster object.

Open the GeoFormula Layer Controls dialog and select Open from the Formula menu. Use the Select Objects dialog to select the TVI.GSF script. The process opens the script and immediately puts you into the Select Objects dialog, prompting you for the input objects that the script wants. Select PHOTO_IR and RED from the CB_TM Project File.

The TVI.GSF script scales the TVI value with a multiplier of 100. If the display looks too dark, edit the script to increase the multiplier.

Grayscale output type assumes an 8-bit data range (values 0-255). **Always adjust the expressions in your scripts to scale the display values** into an appropriate range for 8-bit grayscale display.

Select PHOTO_IR and RED from CB_TM.

A First Look at Color

In the previous exercises, the GeoFormula scripts have been simple expressions that yield numeric values for grayscale display. When the output type is grayscale, the numeric expression is used directly for 8-bit grayscale display intensity. (**Always scale grayscale GeoFormula values to the 0-255 range**.)

When you change the output type to color, the process automatically creates three color component variables: Output_Blue, Output_Green, and Output_Red. For color output, your script must assign 8-bit values to each of the output component variables.

For a simple case, open the GeoFormula Layer Controls dialog and select Formula / New. Select RED, GREEN, and BLUE from the CB_TM Project File as input objects, and Auto Normalize for each object's contrast. In the Output tab, select Color for type. In the Script tab, type in the script illustrated below. (You can use the Insert Symbol dialog to pick the symbols from a list.)

The Insert Symbol list automatically adjusts for component color output.

STEPS
- ☑ Open the GeoFormula Layer controls dialog and select Formula / New
- ☑ select RED, GREEN, and BLUE from the CB_TM Project File
- ☑ select Auto Normalize for contrast and Color for Output Type
- ☑ type in the script illustrated below

The simple script illustrated here achieves the same display result as the direct RGB color display option in the Display process.

Capitalization matters. Type in the script with exactly the same use of upper and lower case illustrated.
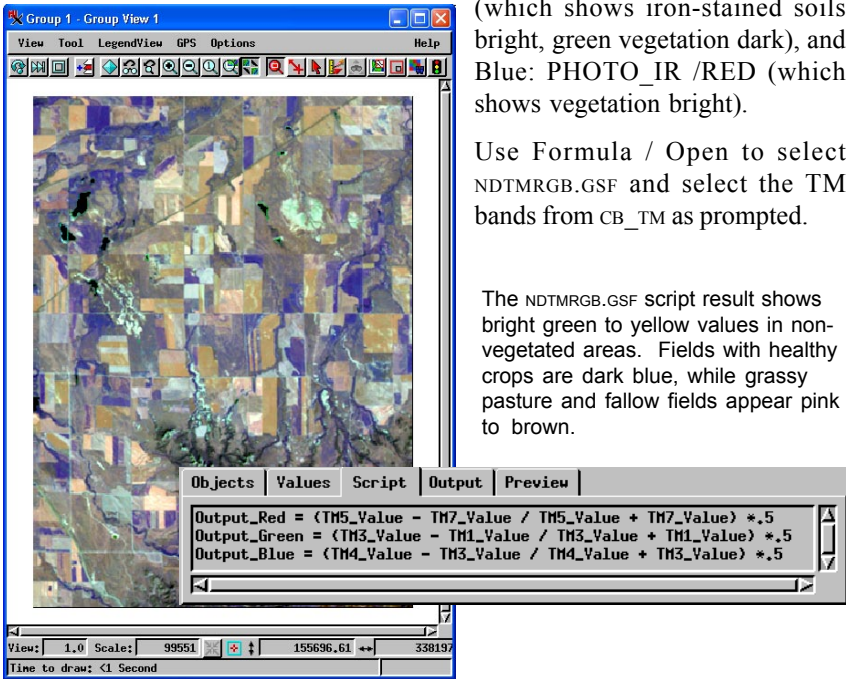
Band Ratios for Composite Color

- ☑ open the GeoFormula Layer Controls dialog
- ☑ select Formula / Open and select GEOFRMLA / NDTMRGB.GSF
- ☑ for input, select the CB_TM Project File
- ☑ select BLUE, RED, PHOTO_IR, TM_5, and TM_7 for the input objects as prompted
- ☑ click [OK] to close the Select Objects dialog
- ☑ click [OK] to close the GeoFormula Layer Controls dialog

The previous exercise showed how simple input values and expressions can be assigned to RGB color components in a GeoFormula. For a slightly more complex example, we will use computed values for RGB color components.

You may be familiar with the Normalized Difference band ratio from an introductory image processing course. (Also refer to the tutorial booklet *Combining Rasters* for a brief introduction to Normalized Difference ratios.) A Normalized Difference ratio of two bands can supply a value that can be used for grayscale display, just as the TVI example did on page 6. In this exercise, we use 6 bands in 3 ratios to produce values for RGB component display. The TM imagery in the CB_TM Project File can be combined for: Red: TM_5/TM_7 (which shows bare soils bright, green vegetation dark), Green: RED/BLUE (which shows iron-stained soils bright, green vegetation dark), and Blue: PHOTO_IR /RED (which shows vegetation bright).

Use Formula / Open to select NDTMRGB.GSF and select the TM bands from CB_TM as prompted.

The NDTMRGB.GSF script result shows bright green to yellow values in non-vegetated areas. Fields with healthy crops are dark blue, while grassy pasture and fallow fields appear pink to brown.


```
Output_Red = (TM5_Value - TM7_Value / TM5_Value + TM7_Value) *.5
Output_Green = (TM3_Value - TM1_Value / TM3_Value + TM1_Value) *.5
Output_Blue = (TM4_Value - TM3_Value / TM4_Value + TM3_Value) *.5
```

Open the Brovey GeoFormula

A more complex use of color implements the Brovey transform to enhance low resolution color imagery with high resolution grayscale imagery. Open the GeoFormula Layer Controls dialog, select Formula / Open, and select BROVEY1.GSF in the GEOFRMLA data collection.
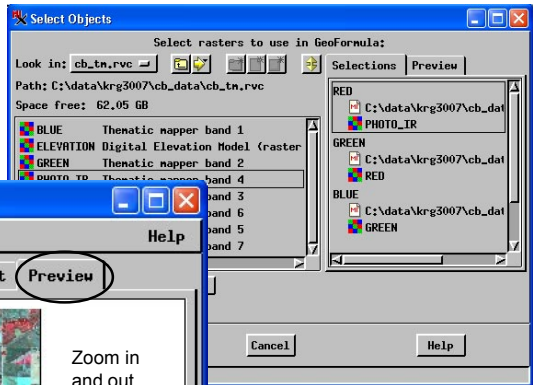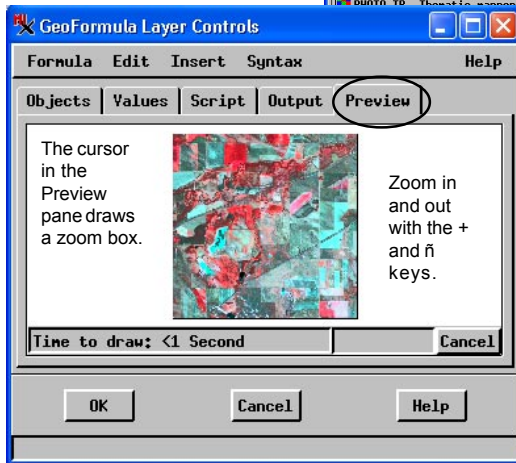
BROVEY1.GSF enhances the display of three color component bands of low resolution imagery by using one band of high resolution grayscale imagery. The sample data in the CB_TM Project File offers 7 bands of 30-meter TM imagery, while the CB_SPOT Project File contains 1 band of 10-meter SPOT imagery. The GeoFormula can combine TM with SPOT for a synthetic 10-meter resolution for the color TM data.

Select PHOTO_IR, RED, and GREEN from CB_TM for the RED, GREEN, and BLUE inputs. Select CB_SPOT / SPOT_PAN for the HIGHRES input.

STEPS
- ☑ open the GeoFormula Layer Controls window
- ☑ select Formula / Open in the GeoFormula Layer Controls window
- ☑ use the standard Select Objects process to select GEOFRMLA / BROVEY1.GSF
- ☑ for input, select the CB_TM Project File and PHOTO_IR, RED, and GREEN for the input objects
- ☑ select CB_SPOT / SPOT_PAN for the HIGHRES input object
- ☑ select the Preview tab to see a quick rendering

A full redraw may be slow for complex scripts that use large input objects. The Preview tab offers a small, quicker rendering.

By default, the GeoFormula process treats only the overlap area of input objects that have different spatial extents. Thus, the display confines the extents to the smaller area of CB_SPOT and does not show the whole area of CB_TM.

The Brovey GeoFormula Results

The Brovey formula is quite simple. Assume a RGB display of bands B5, B4, B2 (such as the TM bands 4, 3, 2) being sharpened with band S1 (such as SPOT). The formula is:
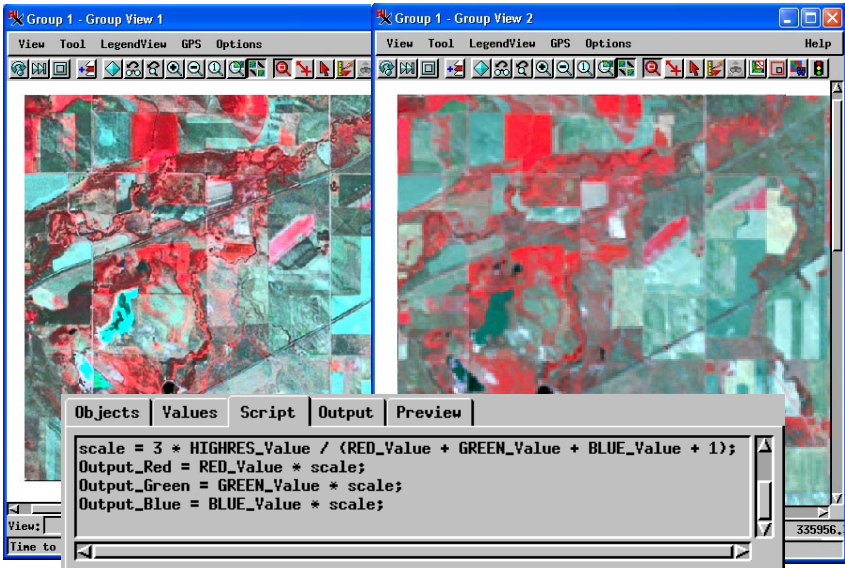
  R = B5 / (B5+B4+B2) * S1
  G = B4 / (B5+B4+B2) * S1
  B = B2 / (B5+B4+B2) * S1

Some simple algebraic equivalence manipulations and the introduction of a scale factor (to improve display intensity) can be observed in the form of the BROVEY1 script illustrated below.

The Display process renders the BROVEY1.GSF GeoFormula layer in the Group View window. Use the standard zoom and position tools to examine the display image. For comparison, open a second group view and add the same three TM input images as an RGB raster layer to compare the display results. As illustrated below, the Brovey GeoFormula (left) shows greatly enhanced feature detail compared to the straight TM RGB image (right).

The Brovey transform does two things. First, it normalizes the data by dividing the band being displayed by the summation of all bands being displayed. Second, it sharpens the image by multiplying the normalized result by the high resolution data. The implementation in the TNTmips GeoFormula also multiplies by a scale factor to increase display intensity.

The Brovey GeoFormula takes color information from the low-resolution TM images and feature detail from the high-resolution SPOT image and automatically presents a color image with simulated high resolution. Left: Brovey result. Right: TM/SPOT inputs.


```
scale = 3 * HIGHRES_Value / (RED_Value + GREEN_Value + BLUE_Value + 1);
Output_Red = RED_Value * scale;
Output_Green = GREEN_Value * scale;
Output_Blue = BLUE_Value * scale;
```

Brovey Enhancements to Band Ratios

Our last exercise in this progression shows some of the powerful complexity of the GeoFormula layer by combining the band ratio computations from the exercise on page 8 with the Brovey resolution enhancement (pages 9 and 10).
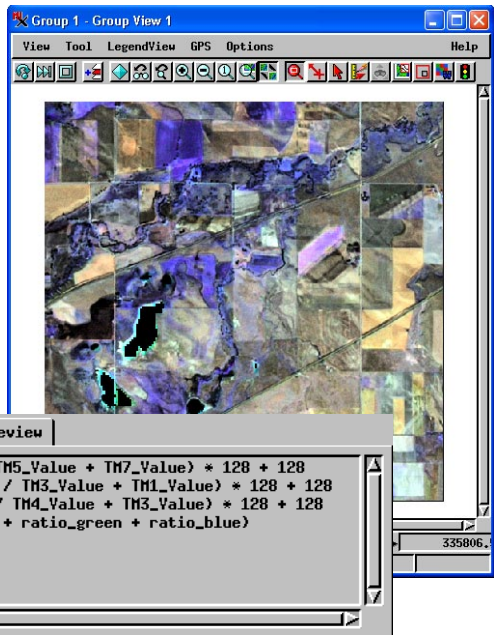
Use Formula / Open to select NDRATBRV.GSF and select the TM bands from CB_TM.RVC as prompted. The script applies the TM5 / TM7, TM3 / TM1, and TM4 / TM3 ratios to the low resolution TM bands, and then multiplies the result by the SPOT image to get the high resolution enhancement.

Look at the script for the basic Brovey GeoFormula (page 10) and for the band ratio GeoFormula (page 8) and observe how the two were combined for this script. The first three lines come with only slight modification from NDRGB.GSF, while the last four lines come from BROVEY1.GSF. In the same way, many complex GeoFormulas can be built from simpler scripts, and the wise user will develop and test GeoFormula components in simple scripts before using them in complex scripts.

The NDRATBRV.GSF script combines the Normalized Difference ratio computations on lower resolution TM bands with the Brovey resolution enhancement from the higher resolution SPOT image. The result shows the spectral information from TM sharpened by the resolution information from SPOT.

STEPS
- ☑ open the GeoFormula Layer Controls dialog
- ☑ select Formula / Open and select GEOFRMLA / NDRATBRV.GSF
- ☑ Select BLUE, RED, PHOTO_IR, TM_5, and TM_7 from the CB_TM Project File
- ☑ select SPOT_PAN from CB_SPOT
- ☑ click [OK] to close the Select Objects dialog
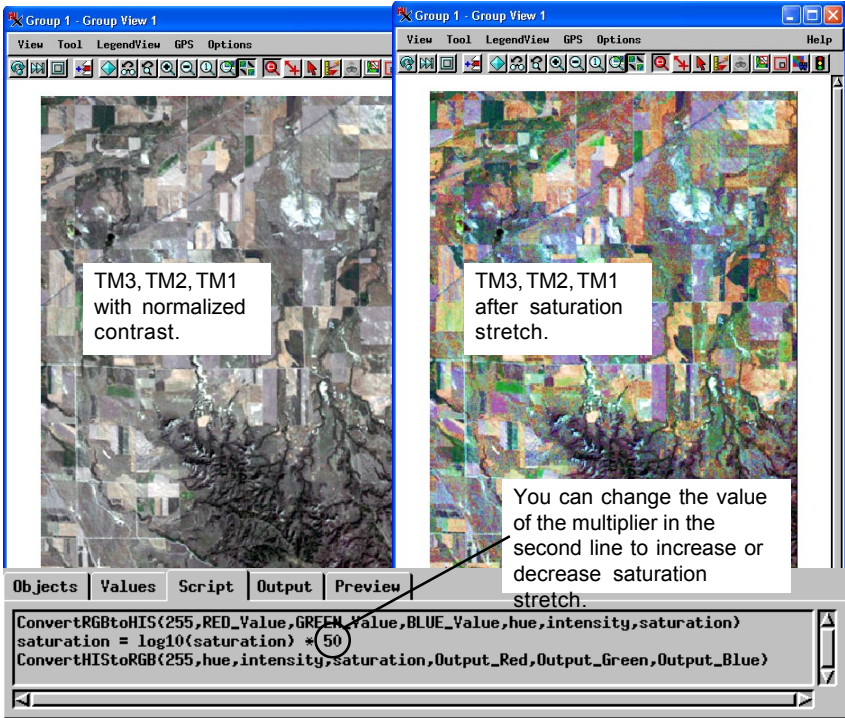- ☑ click [OK] to close the GeoFormula Layer Controls dialog


```
ratio_red = (TM5_Value - TM7_Value/ TM5_Value + TM7_Value) * 128 + 128
ratio_green = (TM3_Value - TM1_Value / TM3_Value + TM1_Value) * 128 + 128
ratio_blue = (TM4_Value - TM3_Value / TM4_Value + TM3_Value) * 128 + 128
scale = 3 * SPOT_Value / ( ratio_red + ratio_green + ratio_blue)
Output_Red = scale * ratio_red
Output_Green = scale * ratio_green
Output_Blue = scale * ratio_blue
```

A Saturation Stretch

STEPS

- ☑ open the GeoFormula Layer Controls dialog
- ☑ select Formula / Open and select GEOFRMLA / STRETCH2.GSF
- ☑ for input, select RED, GREEN, and BLUE from CB_TM
- ☑ click [OK] to close the Select Objects dialog
- ☑ click [OK] to close the GeoFormula Layer Controls dialog

A GeoFormula layer can be used to apply color conversion manipulations. In this example, RGB input components are converted to the equivalent HIS (Hue-Intensity-Saturation) values. Then a logarithmic stretch is applied to saturation values and the HIS components are converted back to RGB values for display. The new RGB set has brighter, more vivid colors than the subdued colors in the original. An HIS saturation stretch has an advantage over alternative RGB manipulations. When RGB manipulations are used, they often create problems of color drift (such as red hues drifting towards orange). By way of contrast, HIS manipulations make it easier to brighten colors without changing their hue.

Follow the steps listed on this page to view the STRETCH2.GSF GeoFormula.

TM3, TM2, TM1 with normalized contrast.

TM3, TM2, TM1 after saturation stretch.

You can change the value of the multiplier in the second line to increase or decrease saturation stretch.

```
ConvertRGBtoHIS(255,RED_Value,GREEN_Value,BLUE_Value,hue,intensity,saturation)
saturation = log10(saturation) * 50
ConvertHIStoRGB(255,hue,intensity,saturation,Output_Red,Output_Green,Output_Blue)
```

Vector Objects in GeoFormulas

Vector objects can be used in a GeoFormula. When you select a vector object as input, you can access the object coordinate values in the form object_x and object_y. You can also access values from associated attribute tables in the form

OBJECT.poly.TABLE.FIELD,
OBJECT.line.TABLE.FIELD, and
OBJECT.node.TABLE.FIELD.

Note: precise use of upper and lowercase is essential. If a table is named in uppercase characters, as in ìYIELD,î then the process will not find it if you use lowercase characters, ìyield.î Likewise, the element type keywords must be entered in lowercase: ìpoly, î ìline,î and ìnode.î

Create a new GeoFormula for grayscale output and access the CBSOILS_LITE YIELD_OATS table for polygons as illustrated (exact uppercase/lowercase).

CBSOILS_Lite.poly.YIELD_OATS.OATS * 5

STEPS
☑ open the GeoFormula Layer Controls dialog
☑ select Formula / New and select CB_DATA / CB_SOILS / CBSOILS_LITE as the single input object
☑ select the Script tab in the GeoFormula Layer Controls dialog and type in the expression illustrated (use the Insert Field dialog to pick the field name)
☑ select the Output tab and change the output type to grayscale
☑ click [OK] to close the GeoFormula Layer Controls dialog

The surest and easiest way to specify the elements in an attribute table is to insert them from the Insert Field dialog.

A multiplier of 5 is used to boost the intensity for grayscale display.

Using Both Vectors and Rasters

STEPS
- ☑ open the GeoFormula Layer Controls dialog
- ☑ select Formula / New and select CBSOILS_LITE and TM_5 as input
- ☑ type in the script illustrated
- ☑ change the output type to grayscale, turn on the Null Cells Transparent toggle, and view the result
- ☑ select Formula / Open and select YIELD431.GSF with CB_TM and CBSOILS_LITE inputs
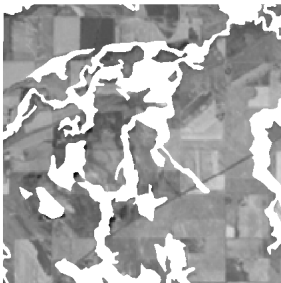- ☑ click [OK] to close the GeoFormula Layer Controls window

The GeoFormula feature offers a great deal of potential for complex combinations of objects of different types. You can construct an endless number of expressions and statements that reference attributes and values from multiple input objects of different types.

In this exercise the CBSOILS_LITE vector object is combined with one band of the TM imagery from CB_TM. The vector expression is similar to the expression in the previous exercise, with the addition of a conditional structure. Make a new GeoFormula for grayscale output, select TM_5 and CBSOILS_LITE for input, and type in the expression
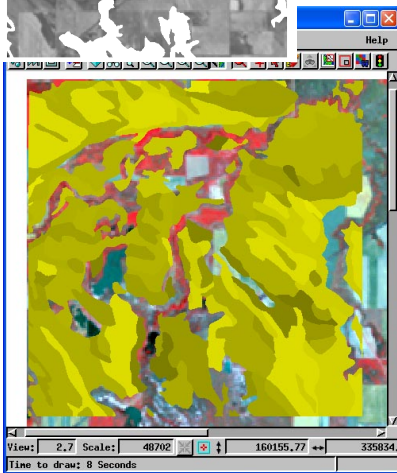
    if (CBSOILS_Lite.poly.YIELD_OATS.OATS > 0)
    TM_5_Value else 255

That expression works like a mask, taking the display value from TM_5 except where the YIELD_OATS.OATS value is zero.

For a more complex GeoFormula, open YIELD431.GSF which displays the YIELD_OATS.OATS values where they are larger than 1, and the composite color 431 bands of TM imagery elsewhere.

The # character marks a line as a comment. Use # to make the process ignore a line.

```
if (CBSOILS.poly.YIELD_OATS > 0)
{Output_Red = CBSOILS.poly.YIELD_OATS * 5
Output_Green = CBSOILS.poly.YIELD_OATS * 5
#Output_Blue = CBSOILS.poly.YIELD_OATS * 5
}

else {
Output_Green = TM_3_Value
Output_Blue = TM_1_Value
Output_Red = TM_4_Value
}
```

The color composite image of Crow Butte TM bands 431 is visible where YIELD_OATS.OATS has no value. The color spread is achieved by assigning the same value to the red and green output color components. Modify the script to remove a different color component and view the effect.

Universal Soil Loss Equation (USLE)

The Universal Soil Loss Equation is used to create a soil erosion map from data that include conservation practices, soil types, surface slope, and rainfall amounts. The basic form of the equation is:

$$A = R * K * LS * C * P$$

A GeoFormula script (USLE.GSF) implements the Universal Soil Loss Equation for the Crow Butte map quadrangle. It uses the CBSOILS_LITE vector object to access soil erodibility (K = LAYER.kfact) and slope-length factor (LS = COMPON.slopel). It uses three raster objects for the remaining inputs: RAINFALL (R), MANAGEMENT (C), and CONSERVATION (P), all found in the CB_DATA / LANDUSE Project File.

The resulting display layer is a grayscale map of erosion effects. Darker areas indicate lower erosion, and bright areas show higher soil loss.
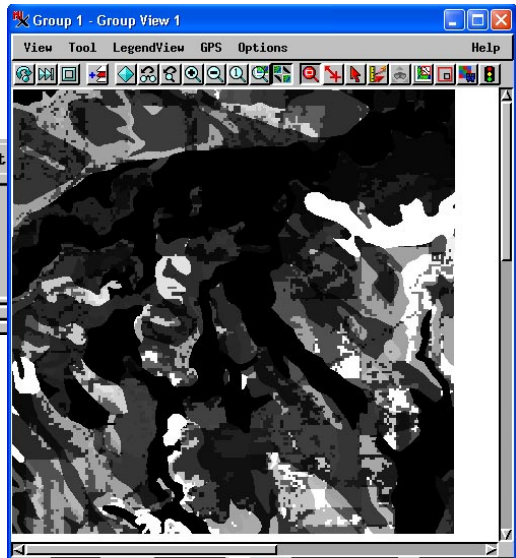
Follow the steps listed on this page and run the USLE script. You can modify the script to brighten the grayscale display by adding a multiplier after the Rainfall factor.

STEPS
- ☑ open the GeoFormula Layer Controls dialog
- ☑ select Formula / Open and select GEOFRMLA / USLE.GSF
- ☑ select input rasters LITEDATA / CB_DATA / LANDUSE / RAINFALL, MANAGEMENT, and CONSERVATION
- ☑ select input vector object LITEDATA / CB_DATA / CB_SOILS / CBSOILS_LITE
- ☑ click [OK] to close the Select Objects dialog
- ☑ click [OK] to close the GeoFormula Layer Controls dialog


```
Objects | Values | Script | Output

CBSOILS.poly.LAYER.kfact *
CBSOILS.poly.COMPON.slopel *
Conservation *
Management *
Rainfall
```

USLE.GSF is a good candidate for use in the stand-alone GeoFormula process (Process / GeoFormula). You can examine the output raster object to quantify erosion estimates, and create color maps for display.

❌ *Remove the USLE GeoFormula layer before going on to the next exercise.*

Background Layers and DataTips

STEPS

☑ add PHOTO_IR and GREEN as background

☑ open the Raster Layer Display Controls dialog and define DataTips for both background layers

☑ deselect the Hide/Show checkbox in the LegendView for both background layers

☑ turn on DataTips for all layers with Options / DataTips / All Layers

☑ click Add GeoFormula and select DIVIDE.GSF with PHOTO_IR and GREEN as input

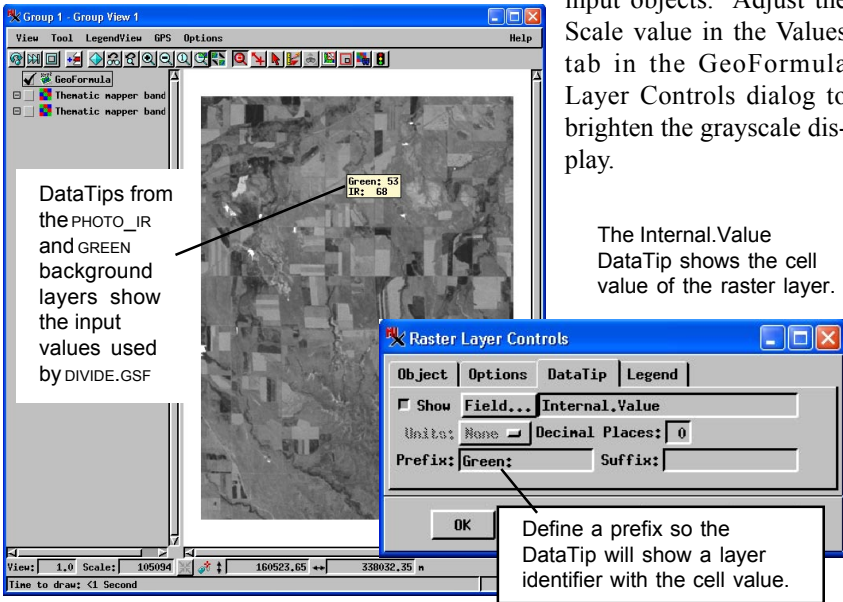☑ open the GeoFormula Layer Controls dialog and increase the Scale value in the Values tab for brighter display

The TNTmips Raster Combinations process (Process / Raster / Combine / Predefined) offers a number of standard ìraster algebraî manipulations. GeoFormulas have been prepared to duplicate many of these combinations (refer to page 8). You can enhance your use of GeoFormulas by using DataTips with background layers or multiple Views to examine the input values for the GeoFormula.

For this exercise, we will display a simple grayscale band ratio (refer to the tutorial *Combining Rasters*, page 5). Add PHOTO_IR and GREEN from the CB_TM Project File as background layers. Define a DataTip (Internal.Value) for each layer with the Raster Layer Display Controls dialog, and deselect both Hide/Show checkboxes in the LegendView. Turn on DataTips for all layers with Options / DataTips / All Layers in the View window.

Click the Add GeoFormula icon tool, and select DIVIDE.GSF, with GREEN and PHOTO_IR for the A and B input objects. Adjust the Scale value in the Values tab in the GeoFormula Layer Controls dialog to brighten the grayscale display.

The Internal.Value DataTip shows the cell value of the raster layer.

DataTips from the PHOTO_IR and GREEN background layers show the input values used by DIVIDE.GSF

Define a prefix so the DataTip will show a layer identifier with the cell value.

Interactive Script Development

The GeoFormula feature provides a useful developerís environment. It is an excellent place to work as you begin to assemble the pieces of a GeoFormula, SML script, or even an APPLIDAT. By using the GeoFormula feature, you can see the results of script changes immediately.
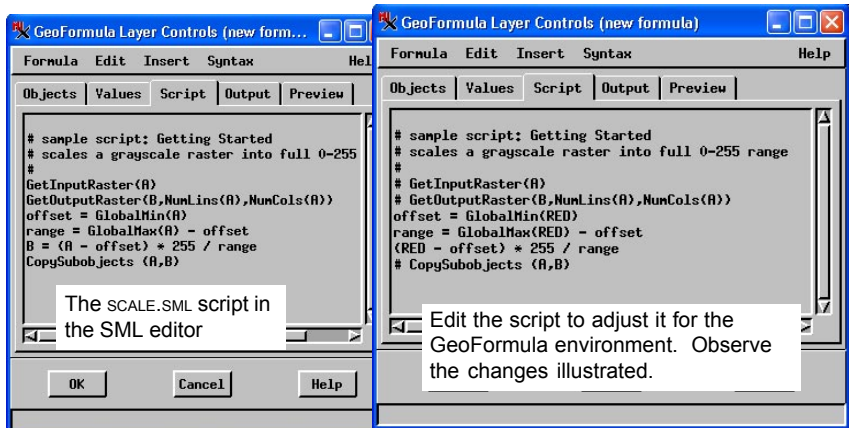
Build and test pieces of a larger develpment project as a GeoFormula and then, when you are satisfied with the results, select Save As from the Formula menu. The Save As option creates an output text file that you can incorporate into an SML script, or modify to invoke from SML as an $include file.

You can also use a GeoFormula for interactive debugging of a script you have been developing in the SML process. For example, if you are getting results from an SML script that seem to be wrong, look for pieces of the script that could work as a GeoFormula. Then create a quick GeoFormula script to test each piece and view the results it produces. Select Insert File from the Edit menu and select any SML script.

Consider the differences between the SML and GeoFormula environments, and be sure to make appropriate changes to the GeoFormula.

STEPS
- ☑ click Add GeoFormula / Add GeoFormula Layer
- ☑ choose New from the Formula menu
- ☑ select LITEDATA / CB_DATA / CB_TM / RED as a single object to process
- ☑ select the Script tab and choose Insert File from the Edit menu
- ☑ select LITEDATA / SML / SCALE.SML
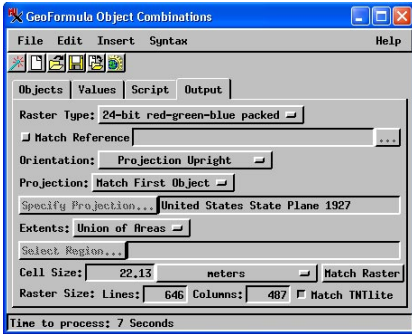- ☑ make the editing changes illustrated below and click the Preview tab

Select Edit / Insert File to get the SCALE.SML script into the GeoFormula Script panel.

Saving GeoFormula Output

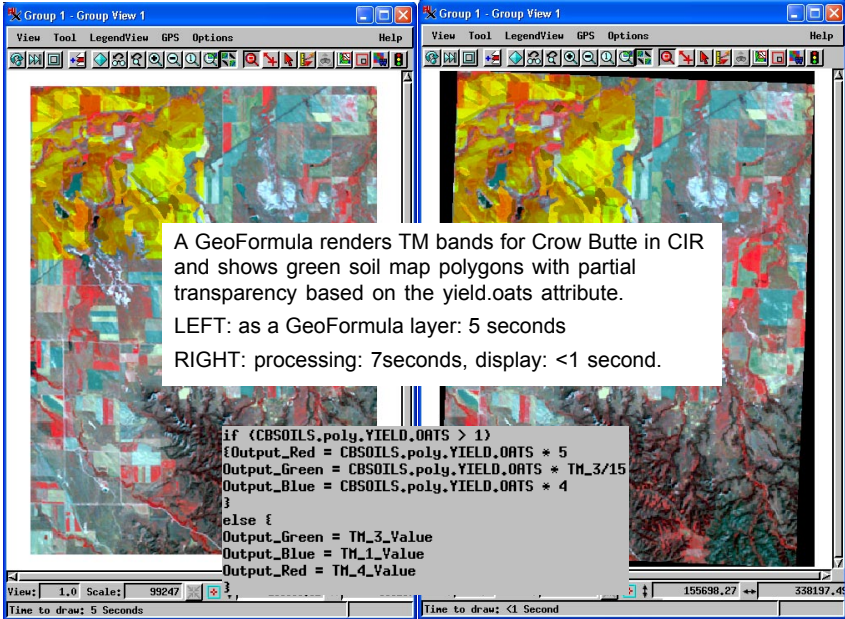The Output panel lets you specify options for the output raster object.

The TNTmips GeoFormula Object Combinations process (Process / GeoFormula) lets you save GeoFormula output as a raster object in a Project File. You may want to save GeoFormula results as a raster object after you have used interactive techniques to refine a complex GeoFormula in the display process. You may also want to gain the speed benefits of preprocessing rather than waiting for a complex GeoFormula to re-process its input objects every time a View is rendered. A single raster layer typically displays in less than one second, whereas most GeoFormula layers take a couple of seconds or more to display.

Pre-processing a GeoFormula reduces rendering time in the display process.

The GeoFormula Object Combinations window differs from the GeoFormula Layer Controls window, in that it has no Preview tab, and that the Output panel lets you specify output raster options.

A GeoFormula renders TM bands for Crow Butte in CIR and shows green soil map polygons with partial transparency based on the yield.oats attribute.

LEFT: as a GeoFormula layer: 5 seconds

RIGHT: processing: 7seconds, display: <1 second.

Speeding Up GeoFormula Display

Geoformula display layers perform file access and multi-object processing on the fly. This processing overhead results in slower display times that may seem sluggish compared to other display layers. This exercise introduces some standard programming techniques that help reduce display times.

Display times vary with the complexity of the GeoFormula and the size and number of input objects. The comparison times listed below show only sample speed improvements.

Use the Preview Pane. The Preview pane in the GeoFormula Layer Controls window presents a small preview image quickly. Use the Preview pane especially as you compare the effects of different variable values and other script changes during development.

Preview pane: 1 second
View window: 3 seconds

Reduce the View Window Size. Just as the small image in the Preview pane displays quickly, so does a small View window. The GeoFormula process samples its input objects according to the size of the View window, so a small View results in less input data to process.

Small View: 2 seconds
Large View: 9 seconds

Calculate Values Once. Find ways to optimize your script. See if you can pre-calculate a value so that it is derived once rather than repeatedly. For example, in BROVEY1.GSF (see p. 9), a **scale** variable is calculated once rather than with each output statement.

> **scale** = 3 * HIGHRES_Value / (RED_Value + GREEN_Value + BLUE_Value + 1);
> Output_Red = RED_Value * **scale**;
> Output_Green = GREEN_Value * **scale**;
> Output_Blue = BLUE_Value * **scale**
>
> BROVEY1.GSF computes the **scale** value once at the beginning rather than in each output statement.

*With **scale**: 3 seconds*
*Without **scale**: 4 seconds*

Use Nested If/Else. Test multiple logical conditions with nested if/else statements, always putting the most likely cases first and the least likely cases last. When the script encounters a true condition, it skips the rest of the conditions. By contrast, if you use a simple sequence of if statements, the process tests every condition, every time.

> if ((SPOT_PAN >=36) and (SPOT_PAN < 47)) 128
> else if ((SPOT_PAN >=32) and (SPOT_PAN < 36)) 86
> else if ((SPOT_PAN >=47) and (SPOT_PAN < 50)) 170
> else if ((SPOT_PAN >=19) and (SPOT_PAN < 32)) 42
> else if ((SPOT_PAN >=50) and (SPOT_PAN < 54)) 212
> else if (SPOT_PAN < 19)) 0
> else if (SPOT_PAN >= 54) 255
>
> NESTEDIF.GSF puts higer-probabilty conditions earlier.

Likely first: 4 seconds
Likely last: 6 seconds

Advanced Software for Geospatial Analysis

MicroImages, Inc. publishes a complete line of professional software for advanced geospatial data visualization, analysis, and publishing. Contact us or visit our web site for detailed product information.

TNTmips   TNTmips is a professional system for fully integrated GIS, image analysis, CAD, TIN, desktop cartography, and geospatial database management.

TNTedit   TNTedit provides interactive tools to create, georeference, and edit vector, image, CAD, TIN, and relational database project materials in a wide variety of formats.

TNTview   TNTview has the same powerful display features as TNTmips and is perfect for those who do not need the technical processing and preparation features of TNTmips.

TNTatlas   TNTatlas lets you publish and distribute your spatial project materials on CD-ROM at low cost. TNTatlas CDs can be used on any popular computing platform.

TNTserver   TNTserver lets you publish TNTatlases on the Internet or on your intranet. Navigate through geodata atlases with your web browser and the TNTclient Java applet.

TNTlite   TNTlite is a free version of TNTmips for students and professionals with small projects. You can download TNTlite from MicroImagesí web site, or you can order TNTlite on CD-ROM.

Index

MicroImages, Inc.

11th Floor ñ Sharp Tower
206 South 13th Street
Lincoln, Nebraska 68508-2010 USA

Voice: (402)477-9554
FAX: (402)477-9559

email: info@microimages.com
Internet: www.microimages.com