

Tutorial



Getting Good Color



with

TNTmips®

TNTedit™

TNTview®

Before Getting Started

Color is an important element that helps you visualize the information in geodata that you display or print with TNTmips®. The exercises in this booklet introduce you to the many tools provided in TNTmips for manipulating and enhancing image color in screen displays and for adjusting color translation to the printed page.

Prerequisite Skills This booklet assumes that you have completed the exercises in the tutorial booklets entitled *Displaying Geospatial Data* and *TNT Product Concepts*. Those exercises introduce essential skills and basic techniques that are not covered again here. Please consult those booklets for any review you need.

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 DVD, you can download the data from MicroImages' web site. In particular, this booklet uses sample files in the COLOR data collection.

More Documentation This booklet is intended only as an introduction to Getting Good Color. Details of the processes described here can be found in a variety of tutorial booklets, Technical Guides, and Quick Guides, which are all available from MicroImages' web site.

TNTmips® Pro and TNTmips Free TNTmips (the Map and Image Processing System) comes in three versions: the professional version of TNTmips (TNTmips Pro), the low-cost TNTmips Basic version, and the TNTmips Free version. All versions run exactly the same code from the TNT products DVD and have nearly the same features. If you did not purchase the professional version (which requires a software license key) or TNTmips Basic, then TNTmips operates in TNTmips Free mode.

The display color enhancement tools described here are available in all TNT products. Color conversion is not available in TNTedit, TNTview, or TNTatlas. Printing using the Hardcopy Layout tools is also not available in TNTatlas. All of the exercises can be completed in TNTlite using the sample geodata provided.

Randall B. Smith, Ph.D., 3 September 2013
©MicroImages, Inc., 1998—2013

You can print or read this booklet in color from MicroImages' web site. The web site is also your source for the newest Getting Started booklets on other topics. You can download an installation guide, sample data, and the latest version of TNTmips Free.

<http://www.microimages.com>

Welcome to Getting Good Color

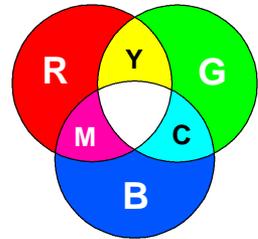
Color is an important characteristic of many raster images, scanned maps, and other forms of spatial data that you may work with using TNTmips. Good color quality makes it easier to understand and interpret the data, both for you and for the final users of your project results. Achieving good color requires subjective judgement, and in some cases you can manipulate color to emphasize particular features in an image.

This booklet is intended to help you enhance the color content of images that you display on your computer screen or print on a hardcopy output device. We will discuss how color is created on the computer screen, the ways in which color information can be stored in Project Files, and how colors are created when you print.

To begin, let's review two basic color models. Both models use sets of three primary colors that can be mixed in varying proportions to produce a wide spectrum of colors. The RGB model applies when light of different colors is mixed, as in your computer monitor, scanner, and digital camera. When two of the three primary colors (red, green, and blue) are mixed, they add together to produce intermediate colors. Examples are yellow (red + green), cyan (green + blue), and magenta (blue + red). An equal mixture of all three additive primaries produces white light.

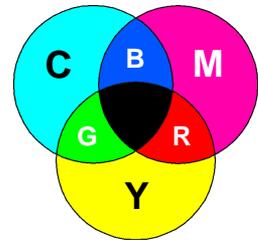
The CMY model (for cyan, magenta, and yellow) applies to color produced by mixing or overlaying translucent inks, dyes, or glass filters. When one of these materials is illuminated by white light, certain wavelengths are absorbed (subtracted from white), and the remaining reflected wavelengths determine the color. Pairs of subtractive primaries can be mixed to produce blue, red, and green. An equal mixture of all three yields black. The CMY color model is applicable to the printing process.

RGB Model



Additive mixing:
computer display

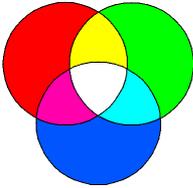
CMY Model



Subtractive mixing:
printing

The exercises on pages 4-26 introduce you to the manipulation of color in screen displays. Topics covered include contrast enhancement for RGB displays, use of color composite rasters, working with color palettes, color transparency for raster and vector objects, and RGBI display. Page 27 is an overview of the Raster Color Conversion process. Color adjustments in the printing process are discussed on pages 28-37 including color profiles, color balancing, adjusting gamma contrast, and printing test strips.

Color on Your Computer Screen



STEPS

- launch TNTmips
- select Main / Display from the TNTmips menu
- on the Display Manager window, choose Display / New / Empty 2D

NOTE: Adjusting the global brightness and contrast settings on your monitor has a major effect on the appearance of color images on your screen, independent of color adjustments made in the TNTmips Display process.

The colors on your color computer screen are specified using the additive RGB color model. Each picture element (or pixel) in a desktop monitor or laptop display is made up of separate light-emitting elements for red, green, and blue light. The amount of light emitted can be varied individually for each of the color elements making up a pixel. In the simplest case, with each color element either fully on or off, this system could produce the eight basic colors: red, green, blue, cyan, magenta, yellow, white (all three color elements on), and black (all three color elements off). In reality, modern color displays can produce 256 intensity levels for each color element, which in varying combinations can produce over 16 million colors.

The trio of intensity settings for each screen pixel are stored in memory on your computer's graphics display adapter. Providing the full color range described above (sometimes called "true color") requires 24 bits of memory per pixel ($8 \text{ bits} = 2^8 = 256$ levels per color element). Modern graphics boards support "32-bit color", which actually means 24-bit color with an additional 8 bits representing an alpha channel that serves as a mask for controlling the transparency/opacity of particular image areas.

In a general sense, the RGB color model that describes computer display colors also describes our perception of color. Three types of receptors in the retina of the human eye have peak sensitivities corresponding to these three primary colors. However, many other physiological and environmental factors also influence color perception. In addition, computer displays produce red, green, and blue primaries that are less pure (saturated) than those that can be perceived by humans, so we can see a wider range (or *gamut*) of colors than a monitor can produce.

Three-Raster RGB Display

A color screen image can be created from several types of raster objects or sets of raster objects. You have the greatest flexibility to adjust color when you use the RGB raster display option. Each of the three selected raster objects is used to control the intensity of one of the display color components. In most cases the component rasters will be 8-bit grayscale objects, but you can also use 16-bit or floating-point rasters as RGB display components.

If your input image is a scanned photograph or map, assigning each of the red, green, and blue component rasters to its corresponding display channel produces a screen display that can closely replicate the colors of the original. However, you can also choose a set of bands from a multispectral image source, such as a 7-band Landsat Thematic Mapper image, SPOT image, or multipolarization radar image. The resulting false-color images can be used to analyze and interpret the characteristics of different image areas.

The RGB raster set for this exercise represents a natural-color photograph acquired in 1994 by the crew of NASA's Space Shuttle over Mount St. Helens volcano in southwestern Washington, USA. If your computer is in 24-bit display mode, you will see a true 24-bit color image. If your computer is in 16-bit or 8-bit display mode, the display process automatically produces a reduced range of colors that provides an optimal representation of the 24-bit color range provided by the RGB raster objects.

STEPS

- click the Add Raster icon  button on the Display Manager window and choose Red-Green-Blue from the dropdown menu
- use the standard Select Object window to select rasters RED, GREEN, and BLUE from the STHELENS Project File in the COLOR data collection



The dark forested slopes in the lower part of image contrast with the barren, ash-covered area devastated by the 1980 eruption of the volcano.

NOTE: To produce valid results in the RGB display process, each component raster must be a **grayscale** raster object. This means that the order of raster values must have some numerical significance, such as recording increasing brightness for a measured wavelength band of light. **Categorical rasters**, in which raster values are merely arbitrary labels for different classes or groups, should not be used as RGB display components.

Raster Contrast Enhancement Window

STEPS

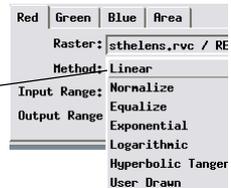
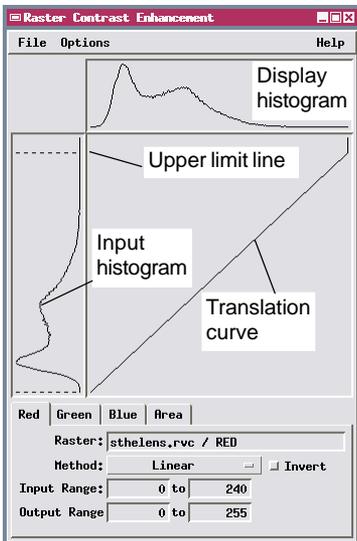
- ☑ right-click on the raster layer's name or icon in the Display Manager window
- ☑ choose Enhance Contrast from the dropdown menu
- ☑ in the Raster Contrast Enhancement window, open the Options menu and turn on the Envelope option (toggle button in)
- ☑ open the Options menu again and select Input Limits / Data Values
- ☑ examine the input and display histograms for the Red component (shown by default)
- ☑ click the tab for the Green component to view its histograms
- ☑ repeat for the Blue component

You can adjust the display of each RGB component raster individually using the Contrast Enhancement process. The raw values in each input raster can be translated to a new set of display values to enhance brightness and contrast for each band. In RGB display mode these individual adjustments can be used to improve the overall brightness, contrast, and color balance of the image. A look-up table that maps each input value to an adjusted brightness value can be saved as a Contrast Table subobject for each input raster. The last-used table for each raster is then used automatically by the Display process to determine the screen display values.

When you are displaying an RGB raster set, the Raster Contrast Enhancement window shows Input and Display histograms for one color component at a time. Choose the color component you wish to adjust by clicking the corresponding tab in the lower part of the window. The tabbed panel for each component also shows the current upper and lower limit settings for the input and output, and includes an option button that allows you to choose an enhancement method.

The input histogram is shown vertically along the left edge of the window and the display histogram horizontally across the top. You can choose to show the display histogram as a filled bar graph, or as a curve (envelope). The translation curve graphs the function used to convert input raster values to display values. Some enhancement methods allow you to directly manipulate the shape of the translation curve.

The Method option button on each tabbed panel lets you choose an enhancement method for that display color.



Keep the Raster Contrast Enhancement window open and continue to the next page.

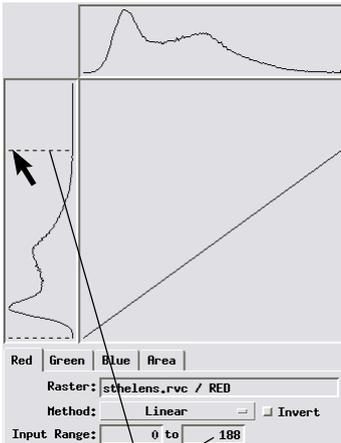
Adjust Linear Image Contrast

Each of the three raster components of the Mount St. Helens image already has a Linear contrast table that maps input raster values to display values using a simple linear function. These tables were applied based on stored display parameters when you displayed the image. The image shows good color balance, but is somewhat dark and has low contrast.

The input histograms show that most cell values in the three rasters fall in the lower part of the 8-bit data range, and none of them has a significant number of cells with high values. We can therefore improve the image appearance by lowering the maximum input limit for each color component. Lowering these limits by roughly similar amounts shifts the display means to higher values, which brightens the image without adversely affecting the color balance. It also spreads the remaining set of input values over a wider range of display values, increasing the contrast. Cells with input values above the upper limit in all three rasters display as white. These cells correspond to the area of snow around the summit of the mountain, which of course should appear white.

STEPS

- click the tab for the Red component
- use the mouse cursor to drag the upper limit line for the Red input histogram down until the upper Input Limit value is 188
- click the tab for the Green component and change its upper input limit to 171
- repeat for the Blue component, setting an upper input limit of 151
- click the Redraw icon button on the View window 
- choose Save All from the File menu on the Raster Contrast Enhancement window to save changes for all three contrast tables



You can change input limits by moving the limit lines manually, or by typing a new value in the corresponding text box.



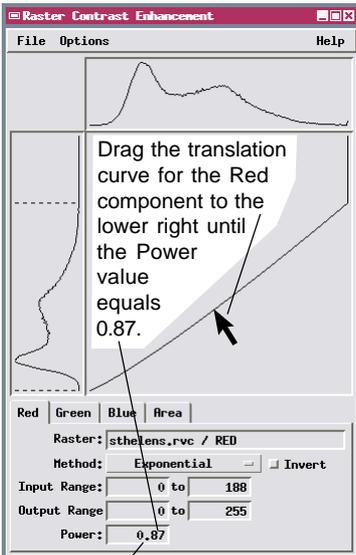
Keep the Raster Contrast Enhancement window open and continue to the next exercise.

Adjust Exponential Image Contrast

STEPS

- ☑ click the tab for the Red component and select Exponential from the Method option menu
- ☑ use the mouse cursor to drag the translation curve toward the lower right until the Power value is 0.87
- ☑ choose Save As from the File menu and save a new contrast table for Red with the default name Exponential
- ☑ repeat the last two steps for the Green component, setting a Power value of 0.90
- ☑ click the Redraw icon button on the Group View window

After the contrast adjustments you made in the previous exercise, the brighter, nonvegetated areas in the Mount St. Helens image show good contrast. The forested areas, however, are still somewhat dark and lacking in detail. We can preferentially improve the brightness and contrast of the forested areas by using Exponential contrast enhancement. In this method, display brightness is an exponential function of the input value. You can vary the function graphically by manipulating the translation curve, or enter an exponent value in the Power text field. The default power value is 1.00, corresponding to a simple linear enhancement. Power values less than 1.00 increase the mean output brightness, but preferentially increase the brightness and contrast of the lower range of input values. Power values greater than 1.00 lower the mean brightness, but preserve contrast over the upper range of input values.



You can also enter the desired numerical value directly in the Power field.



Mount St. Helens image after exponential contrast enhancement of Red and Green. Forested areas are brighter and have better contrast; nonvegetated areas are more brown.

Choose Contrast Options

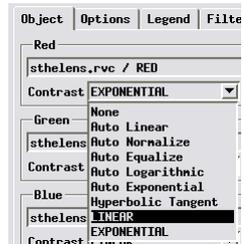
The Contrast menus on the Raster Layer Controls window allow you to choose contrast enhancement options for each of the raster objects used in the display layer. You can choose to use one of several automatic contrast enhancement methods, which use default settings to stretch or compress the range of input values to the 8-bit display range. Your choices are Auto Linear, Auto Normalize, Auto Equalize, Auto Logarithmic, and Auto Exponential. Any contrast tables you have saved for the raster are listed at the bottom of the menu. In the example for this exercise you have saved Linear and Exponential contrast tables.

You can save different contrast tables for different uses; you might create one contrast table that is best for grayscale display of the single raster, and another that is intended for use in an RGB display with certain other raster objects.

For 8-bit rasters you can choose None from the Contrast menu to display the raster object with no enhancement. (This option is not available for 16-bit and floating-point raster objects, as their wider numeric range needs to be mapped to the 8-bit range via a saved or auto contrast table for display.) Your choice of a contrast table or None is automatically saved in the display parameters stored with the raster object so that the raster will display in the same fashion the next time you view it. This is also true of your choice of color palette (see following pages) and other display parameters. If the raster layer is part of a saved group or layout, the display parameters set up within the group or layout are saved with those objects rather than with the raster object itself, and are only applied within that group or layout.

STEPS

- choose File / Close on the Raster Contrast Enhancement window
- left-click on the Layer Controls icon for the raster layer in the Display Manager window 
- in the Raster Layer Controls window Object Panel, click on the Contrast menu for Red, examine the choices, then choose Linear



- repeat for the Green, then click [OK]



Mount St. Helens image with the selected Linear contrast.

Auto Normalize Contrast Enhancement

STEPS

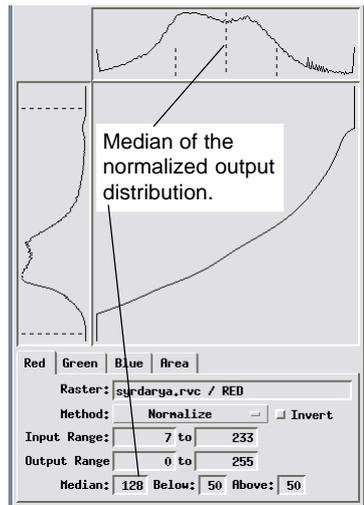
- ☑ right-click on the raster layer entry in the Display Manager and choose Remove Layer from the dropdown menu
- ☑ click the Add Raster icon button  on the Display Manager window and choose Red-Green-Blue from the dropdown menu
- ☑ select rasters RED, GREEN, and BLUE from the SYRDARYA Project File
- ☑ open the Raster Layer Controls window and choose Auto Normalize from the Contrast menu for the Red, Green and Blue rasters
- ☑ open the Raster Contrast Enhancement window

If no contrast table has been saved with a raster object, and it has not been displayed previously with the None option, then one of the auto contrast enhancement options is automatically used to display the raster. The method used by default is the last auto contrast option you chose for any raster layer in the Display process. In other words, this default option is global for the Display process rather than associated with a particular raster object. After the raster has displayed with an auto contrast method, you can open the Raster Contrast Enhancement window to modify (if desired) and then save a contrast table using that or any other contrast method. In order to ensure consistent display, it is best to set up and save a contrast table for any grayscale and RGB raster layers that you plan to use repeatedly.

The Auto Normalize contrast method attempts to rescale the input values to fit a normal (symmetrical bell-shaped) distribution of display values. The median of the normalized distribution is set to the middle of the output range (128).



Space Shuttle photograph of the semiarid Syr-Darya River region of Tajikistan, Kyrgyzstan, and Uzbekistan, displayed with auto-normalized contrast enhancement. Irrigated fields of the river valley are seen in the upper left.



Adjust Normalized Image Contrast

The auto-normalized display of the Syr-Darya shuttle image has a hazy appearance in some areas and an overall bluish tint. Because the automatic contrast enhancement methods stretch each color component independently, they can over-stretch one or more of the components and thus not produce an appropriate color balance in the RGB display. In this exercise you reduce the brightness of the blue component of the image and save a new set of contrast tables.

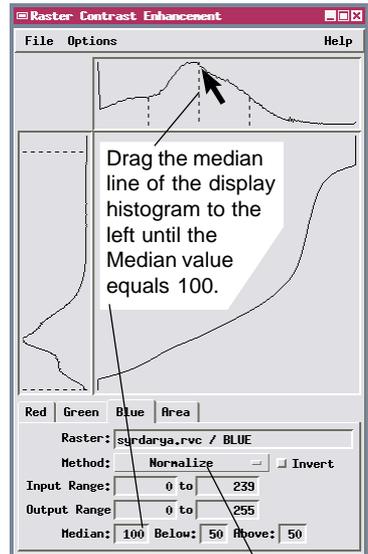
You can change the position and shape of the normalized display histogram by moving the vertical dashed lines. Moving the middle line (representing the median brightness) to the left shifts the histogram toward lower values, reducing the overall brightness for that component. You can also move the flanking deviation lines to increase (stretch) or reduce (compress) the contrast for the upper or lower parts of the input range.



Syr-Darya image after adjusting the auto-normalized contrast for the blue color component.

STEPS

- click the tab for the Blue color component
- click on the middle dashed line in the Display histogram and drag the line to the left until $M=100$
- redraw the display in the View window 
- select Save All from the File menu on the Raster Contrast Enhancement window and name each of the three new contrast tables



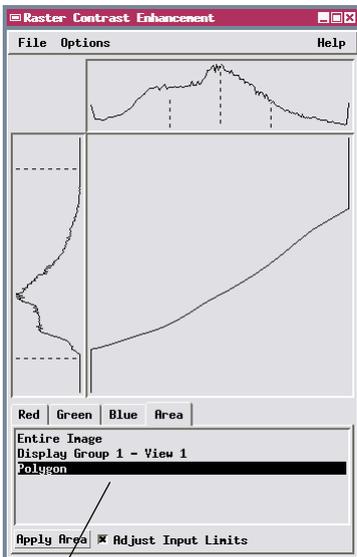
The default choice on each contrast method option menu is the method currently used to display that color component.

Contrast Based on Local Area

STEPS

- press the GeoToolbox icon 
- select the Polygon tool from the GeoToolbox toolbar 
- draw a polygon over the central part of the image as illustrated below
- right-click in the View and choose Add as Region from the pop-up menu
- expose the Area tabbed panel in the Raster Contrast Enhancement window
- click on Polygon in the list to select it
- press the Apply Area button below the list

The Area tabbed panel on the Raster Contrast Enhancement window lets you base contrast enhancement on any portion of the displayed image. The selection list on this panel includes entries for the Entire Image (the default) and any region that has been created or selected in the GeoToolbox. There is also an entry for each open view window, which allows you to simply zoom in to the desired local area. Choosing a list entry and pressing the Apply Area button immediately recomputes input and display histograms for all image bands based on the area selected. If the Adjust Input Limits toggle is turned on (the default), the Input Range limits are also automatically adjusted to match the ranges of the new input histograms.



The Area tabbed panel lets you base contrast enhancement on any portion of the displayed image.



Syr-Darya image with normalized contrast based on the histograms of the area outlined by the polygon.

Equalize Contrast Method

The Equalize contrast enhancement method attempts to produce a flat output brightness histogram, with an equal number of raster cells assigned to each brightness level. However, because all cells with the same raster value must be assigned to the same output brightness, and the input histograms of Earth surface images tend to have an approximately normalized shape, a completely flat output brightness histogram usually cannot be achieved.

With the Envelope option turned off for the output histogram, you can see in this example that the Equalize method tends to spread the central zone of more populated cell values over a much broader output brightness range, while the less populated cell values at the high and low ends are compressed together at the extremes of the display brightness range. The resulting image shows crisp though somewhat harsh contrast in comparison to the Normalize method.

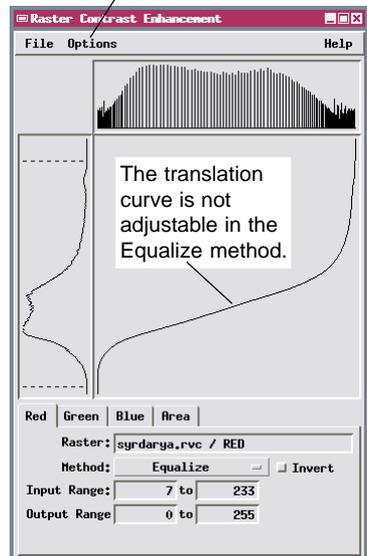


Syr-Darya image with equalized contrast enhancement.

STEPS

- in the GeoToolbox, reselect the Polygon tool and press the Clear icon button
- in the Raster Contrast Enhancement window, select Entire Image on the Area list and press [Apply Area]
- set the Method menu on the Red, Green and Blue tabbed panels to Equalize
- on the Options menu, turn off the Envelope option
- redraw the display in the View window 

The Options menu also lets you choose to show the histograms with either linear scaling (the default) or logarithmic scaling.



Raster Contrast Enhancement window with Envelope option turned off for Equalize method.

Hyperbolic Tangent Contrast Method

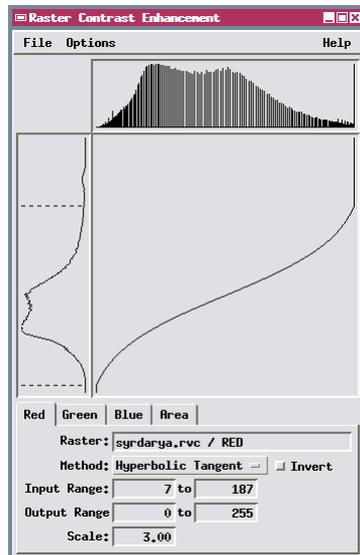
STEPS

- set the Method menu on the Red, Green and Blue tabbed panels to Hyperbolic Tangent
- on the Red tab, set the Input Range upper limit to 187 and the Scale value to 3.0
- on the Green tab, set the Input Range upper limit to 147 and the Scale value to 2.0
- on the Blue tab, set the Input Range upper limit to 131 and the Scale value to 1.0
- redraw the display in the View window 
- remove the RGB layer when you have completed this exercise

The Hyperbolic Tangent contrast enhancement method uses the hyperbolic tangent trigonometric function to produce a nonlinear translation of raster values to display values. This method is supplied with an adjustable scale parameter that you can use to fine-tune the amount of contrast enhancement. At low values of the Scale factor (less than 1) the translation curve is close to linear (see the curve set for the Blue band in this exercise). As the scale factor is increased, the translation curve flattens in the middle and steepens at either end (see the Green and Red translations curves). As a result, the midrange portion of the display histogram is stretched at the expense of both high and low values, increasing image contrast for midrange values without greatly shifting the mean brightness. You can adjust the input range limits along with the scale factor to modify brightness and contrast.



Syr-Darya image with hyperbolic tangent contrast enhancement.



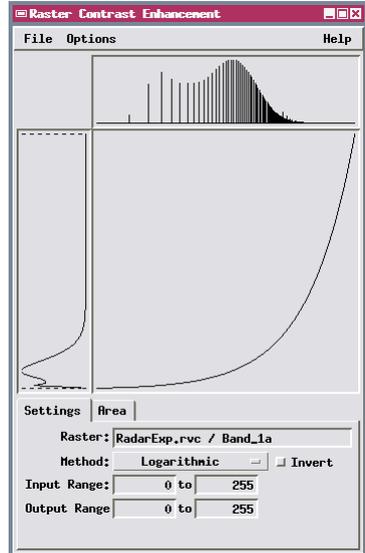
Hyperbolic tangent contrast settings for the Red band, with scale factor set to 3.0 to stretch the midrange display brightness.

Other Contrast Methods

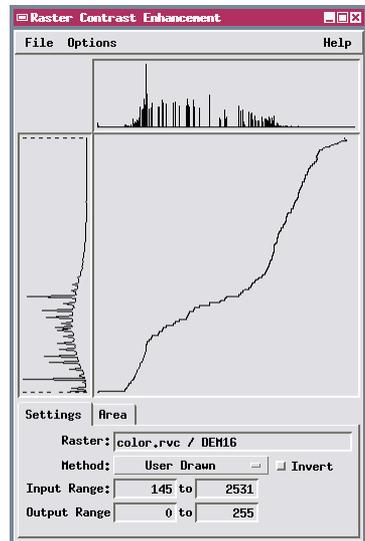
You should be able to create adequate contrast enhancement for most raster images using one or more of the enhancement methods described previously. Which method works best for a particular image depends upon the nature and variety of surface materials in the image, the parameters used in acquiring and processing the image, and how you intend to use it. You should experiment with different methods to find the one that produces the best brightness and contrast for each image.

The remaining two contrast enhancement methods, Logarithmic and User Drawn, are special-purpose methods. The Logarithmic method provides a translation curve in which the output brightness is a function of the logarithm of the input raster value. The translation curve is not adjustable (except for setting lower and upper limits). This method is most useful for images with a high proportion of low values, which is common in images from imaging radar systems. However, a logarithmic translation can also be set up using the Exponential method, in which you can vary both the limits and the power (exponent) to provide fine adjustments to the enhancement.

In the User Drawn method you can freely adjust the shape of the translation curve in two ways. You can use the mouse to redraw the translation curve itself, or to redraw the shape of the output histogram. You can use this method to selectively stretch some parts of the input range while compressing others to achieve special effects in the displayed image.



Logarithmic enhancement curve.



An example of a User-Drawn enhancement translation curve.

Single-Raster Composite Color

STEPS

- choose Single from the Add Raster icon button menu
- select raster object COMP24 from the COLOR Project File
- place the cursor over any part of the displayed image until the DataTip appears, and note the values
- remove the COMP24 raster layer
- repeat the first two steps, selecting the COMP16 object from the COLOR Project File

- remove the COMP16 layer when you have completed this exercise



Color information can also be stored in a single **composite color** raster object. TNTmips supports several types of composite color objects. The first object used in this exercise is a 24-bit color composite, which can reproduce any color created by an RGB display of three 8-bit raster objects. A 24-bit composite raster stores three values for each cell (one for each display color), with an 8-bit data range for each value. A 16-bit composite raster has a similar three-value format, but uses only a 5-bit data range (32 brightness values) for each display range (32 brightness values) for each display color, and so can represent over 32,000 separate colors. You will probably see no discernible loss in color quality between the 24-bit and 16-bit composite versions of most images.

When you display a three-value-per-cell composite color object, you can adjust and save the contrast for the three color components using the Raster Contrast Enhancement window in the same way as for a three-raster RGB image display.



24-bit and 16-bit composite color rasters store separate Red, Green, and Blue values for each raster cell.

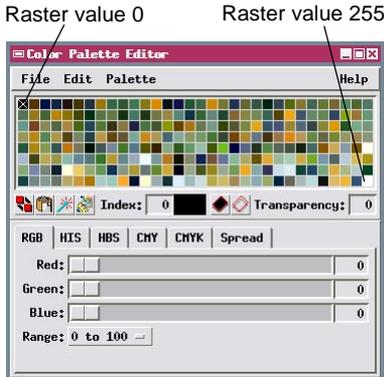


NASA Space Shuttle photograph of Alexandria, on the Mediterranean coast of Egypt. The green vegetation of the Nile River delta in the lower right contrasts with the barren sands of the Western Desert in the lower left.

Composite Color with Color Palette

A final option for color composite images is an 8-bit composite-color raster. This type of raster object can include up to 256 unique colors. The numeric values in the raster are arbitrary, and serve merely to assign display colors from a **color palette** (or **color map**) stored as a subobject of the raster. The color palette records a set of RGB values for each of the raster values in the 8-bit data range (0 to 255). A color map subobject is created automatically when you import an 8-bit color composite image, or when you use the Color Conversion process to create an 8-bit composite color raster from an RGB raster set or 24- or 16-bit composite raster.

The Color Palette Editor displays the array of assigned colors for the current composite raster object. Assignment of colors to particular raster values is arbitrary in this case, so there is no obvious order to the color palette for a composite color raster. Likewise, displaying the raster without the color map does not produce a meaningful grayscale image.



The Color Palette Editor window shows the color assigned to each possible raster value, from 0 in the upper left to 255 in the lower right. (Raster values increment from left to right in each row of the sample array).

STEPS

- choose Single from the Add Raster icon button menu
 - select raster object COMP8 from the COLOR Project File
 - select Edit Colors from the raster layer's right mouse button menu
 - after you have examined the color palette, select Close from the File menu
-
- remove the COMP8 layer when you have completed this exercise



Natural color image of South America from data acquired by the SeaWiFS satellite. The most cloud-free parts of images acquired over a 15-day period (18 September to 3 October 1997) were assembled to produce the final image.

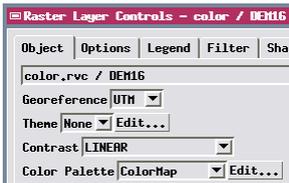
Grayscale Raster with Color Palette

STEPS

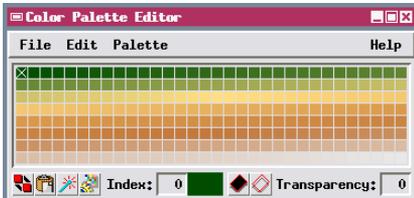
- choose Single from the Add Raster icon button menu
- select raster object DEM16 from the COLOR Project File
- open the Raster Layer Controls window and make sure that ColorMap is selected in the Color Palette option menu



A color palette can also be used to create a pseudocolor display from a grayscale raster object. When the raster values represent a smoothly varying surface, you can use a color palette with a similarly smooth gradation of colors to emphasize the characteristics of the surface. A color palette can be used with any type of grayscale raster object, but no more than 256 colors can be included in the palette. When you use a color palette with a 16-bit or floating-point raster object, the display process automatically partitions the range of raster values into 256 bins for purposes of color assignment. If you select a contrast option other than None, the contrast enhancement is applied before the color assignments are made from the color palette. You can use the Color Palette menu on the Raster Layer Controls window to choose any color palette that has been saved as a subobject of the raster (or None to view the raster without any palette).

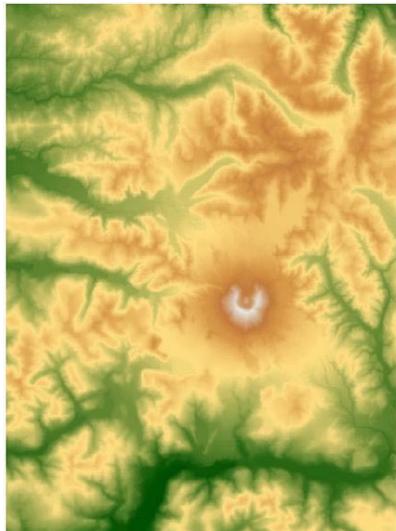
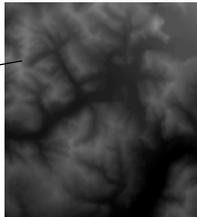


- press the Edit button next to the Color Palette menu



Digital elevation model of Mount St. Helens, Washington. The color palette portrays low elevations in green, grades up through yellow to brown, and shows the mountain summit in very light gray.

Portion of the DEM (a 16-bit raster) displayed without the color palette. Displaying the DEM with the color palette creates a more lively and interesting display and brings out more detail.

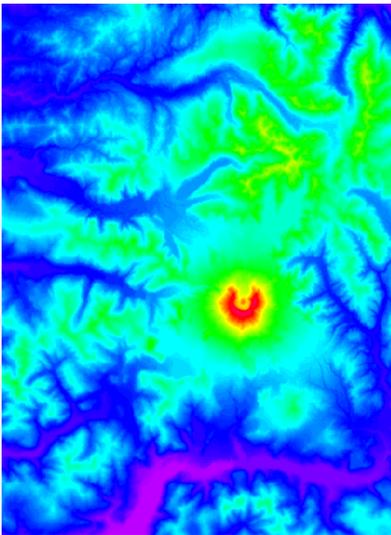


Keep the Color Palette Editor window open and continue to the next page.

Using Standard Color Palettes

The Color Palette Editor provides a number of standard color palettes that can be selected from the Palette menu for use with any grayscale raster object. For example, the Rainbow1 palette mimics the range of colors in a rainbow, from purple (index 0) through blue, green, yellow, red, and pink (index 255). The Gray, Red, Green, and Blue Scale palettes each have index 0 set to black, then progress through increasing levels of the respective color. The Random color palette has colors assigned randomly to the palette index values.

You can edit any standard palette to create a new color palette. After editing, you can choose Save As from the File menu to save the new palette as a subobject of the current raster. Alternatively, you can use the Save As option on the Palette menu to save the new palette as a standard palette. The new palette is added to the Palette menu, and so becomes available for use with any raster object.



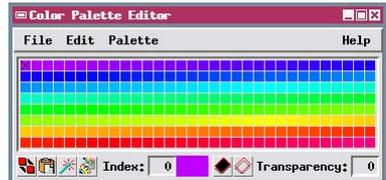
Mount St. Helens DEM displayed with the Rainbow1 color palette.

STEPS

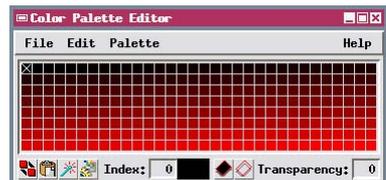
- choose Rainbow1 from the Palette menu in the Color Palette Editor; if that selection is not on the menu, choose More Palettes to open a dialog to select it



- click the Redraw icon button on the View window



Standard Rainbow 1 color palette.



Standard Red Linear color palette.



Random color palette.

Keep the Color Palette Editor window open and continue to the next page.

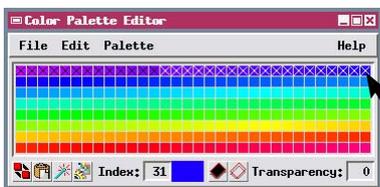
Editing Palette Colors

STEPS

- ☑ click on a color tile in the color palette array; note the X symbol that appears in the tile and the new value that appears in the Index numeric field
- ☑ click on the color tile in the upper left corner of the array (0 index)
- ☑ hold down the Shift key, then click on the tile in the upper right corner of the array (index 31)
- ☑ move the Green slider to set its value to 50 (changing all the selected tile colors)
- ☑ click the Copy icon button 
- ☑ click on the lower left color tile (index 224) and press the Paste icon button 

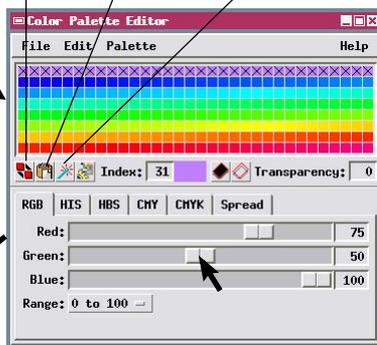
You can edit any color in the color palette by clicking on its sample (tile) in the palette array and using the sliders on the RGB tabbed panel to change its Red, Green, and Blue values. (Sliders that let you set values in the HIS, HBS, CMY, and CMYK color systems are found on their respective tabbed panels). The X symbol marks the selected tile in the palette array; a larger color sample and the index number of the selected tile are shown below the palette. The 0 index color is selected by default when the Color Palette Editor window opens.

You can manually select a range of color tiles by first selecting one tile, then holding down the Shift key while clicking on another tile; the entire range of tiles in between is then also selected. An icon button is also provided to automatically select a range of colors similar to the currently selected tile. When you have selected a range of tiles, any color changes you make are applied to all of the selected tiles. The Copy and Paste icon buttons allow you to quickly transfer a color from one tile to one or more other tiles.

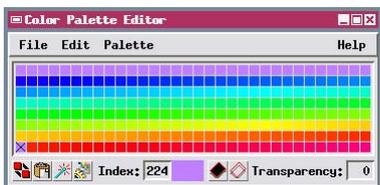


Holding down the Shift key while clicking on a color tile selects the entire color range from the tile selected previously (in this case, index 0) to the new tile (31).

Copy Paste Select Similar Colors



Palette after editing range of tiles.



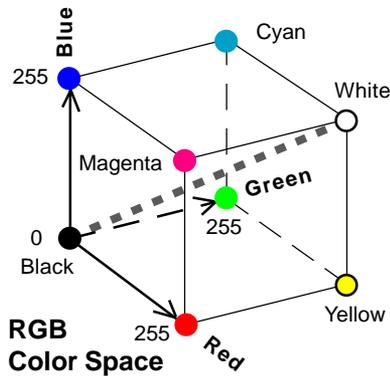
Palette after copy and paste operations.

Keep the Color Palette Editor window open and continue to the next page.

Color Spaces and Color Spreads

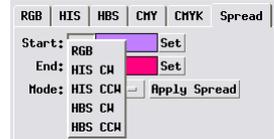
You can create your own smooth color gradations by applying a **color spread** to all or part of the palette. You first assign a color for the low and high ends of the selected value range, then select a color spread mode. Applying the spread then creates a gradual color variation across the range of intervening values.

Several color spread modes are available. Each mode uses a particular color model to represent ranges of colors. These color models are most easily understood if they are represented graphically as three-dimensional **color spaces**.

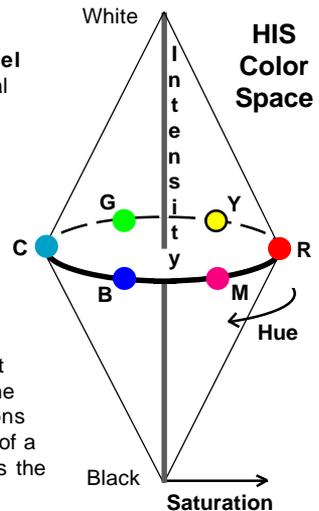


The **Hue-Intensity-Saturation (HIS)** color model represents colors within a double-cone space. The vertical axis is intensity, which represents variations in the lightness and darkness of a color. The 0 intensity level is black; full intensity is white. HIS values elsewhere along the intensity axis represent different levels of gray. On any horizontal slice through the model space, the hue (or "color" of the color) varies around the slice, and the saturation (the purity of the color) increases radially outward from the central intensity axis. Maximum saturation in this model is at the midpoint of the intensity range. (The closely-related HBS model uses a single-cone color space with maximum saturation at full brightness.) You can apply an HIS spread in either the clockwise (CW) or counterclockwise (CCW) directions around the cone. (The directions are defined in terms of a view upward along the intensity axis; the arrow shows the counterclockwise direction).

- click on the Spread tab in the Color Palette Editor, then click on the Mode option button to reveal the selection of available color spread models



The **RGB color model** represents colors within a cubic volume defined by orthogonal Red, Green, and Blue axes. Black is at the origin of the coordinate system ($R=G=B=0$), and white is at the opposite corner of the cube ($R=G=B=255$). The diagonal connecting the black and white corners (gray dashed line) contains the range of neutral gray levels. Complementary colors (such as blue and yellow) lie at opposite corners of the cube. An R-G-B color spread includes colors found on a straight line connecting the two end-member colors (for example, the edge connecting red and yellow).



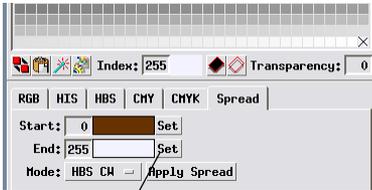
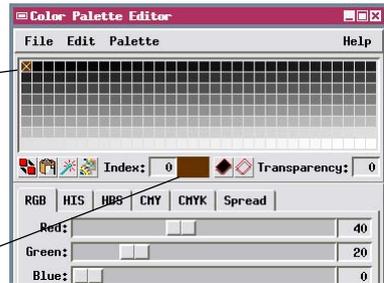
Creating a Color Spread

STEPS

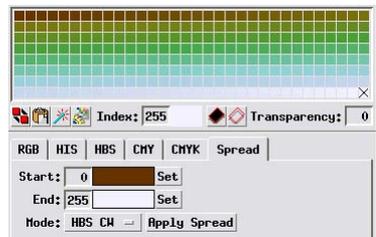
- ☑ choose Grayscale (linear) from the Palette menu
- ☑ on the RGB panel, move the Red slider to 40 and the Green slider to 20
- ☑ click on the color sample for 255, and move the Red and Green sliders to 95
- ☑ on the Spread panel, select HBS CW from the Mode option menu
- ☑ press [Apply Spread]
- ☑ close the Color Palette Editor window

Now let's try creating a clockwise HBS color spread from brown (for the 0 palette index) to bluish-white (for 255). This produces a smooth gradation from brown to green, light blue, to near-white.

Use the Red and Green sliders to change the color for palette index 0 to brown. The color tile next to the Index field shows the color for the current index value.



You can use the Set buttons on the Spread panel to designate any selected palette index as the start or end of a color spread (0 and 255 are the default values).



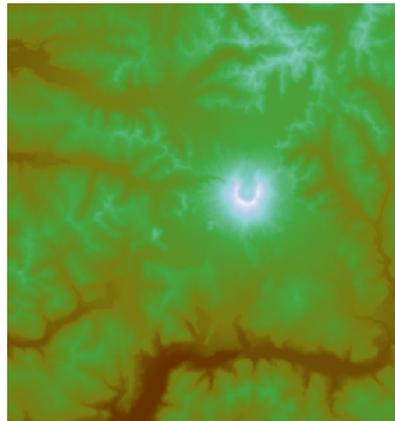
Color palette after pressing Apply Spread.

After you apply the spread you can choose Save As from the File menu to save the new color palette as a subobject of the current raster object.



- ☑ when you have completed this exercise, open the Raster Layer Controls window and choose ColorMap from the Color Palette menu and press [OK]
- ☑ choose Display / Close on the Display Manager

You can design complex color palettes (such as the initial ColorMap palette for the DEM16 raster) by specifying a number of intermediate colors, then creating color spreads between them.



Lower part of the Mount St. Helens DEM with the new color spread applied.

Using Raster Transparency

You can create interesting visual effects by setting a raster layer to be partially transparent so that its image blends visually with any layers below it in the display group. One common application of this technique visually blends a DEM displayed with a color palette and a shaded relief image of the DEM (created in the Topographic Properties process in TNTmips) to create a color shaded relief view. The Transparency field on the Options panel of the Raster Layer Controls window sets the same transparency level for all cells in the raster. You can set the



Transparency percentage to any integer value from 0 (completely opaque) to 100 (completely transparent). You can also use a separate toggle on the Options panel to have any null cells in the raster rendered completely transparent.

STEPS

- press the Open icon button on the Display Manager and select DEMGROUP from the COLOR Project File 
- click on the Layer Controls icon button for the DEM16 layer in the Display Manager 
- in the Raster Layer Controls window click on the Options tabbed panel
- enter 40 in the Transparency field and press [Apply]
- set a Transparency level of 70 and press [Apply]
- set the Transparency level back to 0 and press [OK] on the Raster Layer Controls window before proceeding to the next exercise



Mount St. Helens DEM with color palette from previous page, displayed with different transparency levels over a shaded-relief raster: left, 40% transparency; right, 70%.

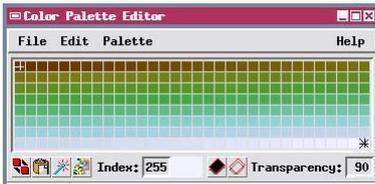
Using Transparency in Color Palettes

STEPS

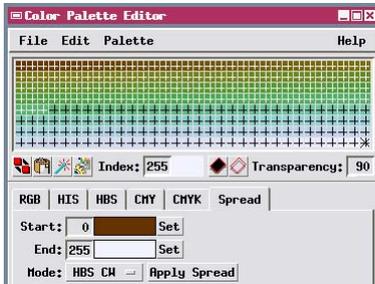
- right-click on the DEM16 layer entry in the Display Manager and choose Edit Colors from the dropdown menu
- In the Color Palette Editor, enter 10 in the Transparency field for the color tile in the upper left corner (Index 0)
- click on the tile in the lower right corner (index 255) and enter 90 in the Transparency field
- on the Spread tabbed panel, press [Apply Spread]
- redraw the display in the View window



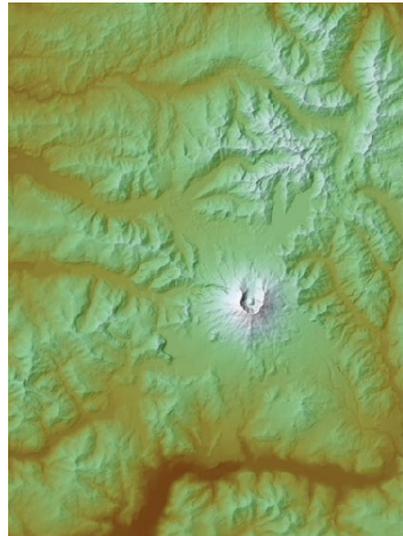
You also have control of raster transparency at the level of individual colors in a color palette. Use the Transparency field in the Color Palette Editor window to set a transparency percentage for the currently selected color tile (or set of tiles). When you apply a color spread to a range with transparency set for one or both ends of the range, gradually varying transparency values are applied across the entire range. In this exercise you reapply the HBS CW color spread used to create the original palette, but with transparency values set for the bottom and top of the range. This action doesn't alter the colors in the palette; instead it applies a gradual increase in transparency from the 0 index color to the 255 index color.



Palette with transparency values set for the 0 and 255 index colors (each marked by a cross symbol).



Palette with spread applied to create gradually varying transparency values.



Mount St. Helens DEM with color palette transparency varying from 10% for brown color at lowest elevation to 90% for white at the highest elevation.

- close the Color Palette Editor window and close the current group when you have completed this exercise (answer No when you are asked whether to save changes).

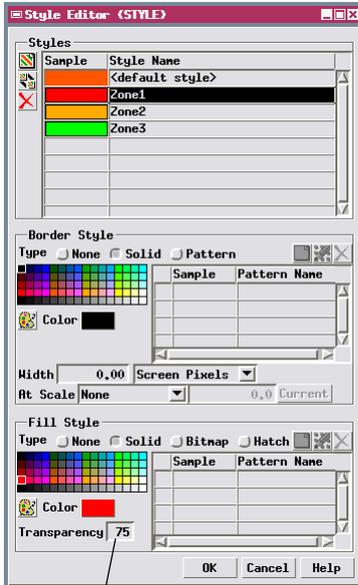
Vector Polygon Fill Transparency

Solid color fill styles that you create for vector or CAD polygons or for TIN triangles also can be displayed with varying degrees of transparency. The object with transparent fills can then be displayed over another object (such as a raster image) and the information conveyed by both layers is easily visible. Once you have set a transparency value as part of the definition of a fill style, the transparency effect is used automatically whenever the object is displayed using that style in a 2D or 3D view. For more information on vector display styles, consult the tutorial booklet entitled *Creating and Using Styles*. Transparency effects for all types of spatial

objects are also applied automatically when you print layouts.

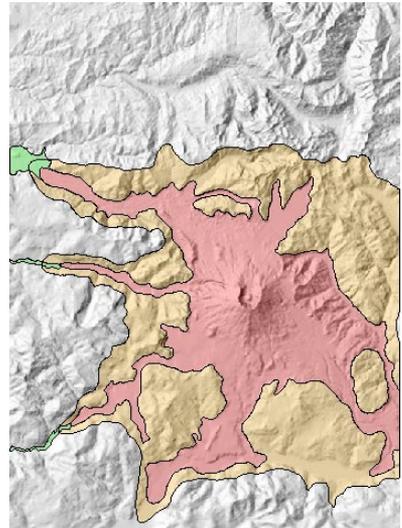
STEPS

- choose Display / Open from the Display Manager and select HAZGROUP from the COLOR Project File
- click the Layer Controls icon  button for the HazZones layer in the Display Manager
- click the Polygons tab in the Vector Layer Controls window, then click the Edit button next to the Style menu
- on the Assign Styles by Attribute window that opens, press [Edit Styles...]



You can set a Transparency percentage for solid polygon fills in the Style Editor window (0% = completely opaque fill, while 100% = fully transparent = no color fill).

- click [OK] to close the Style Editor, the Assign Styles by Attribute window, and Vector Layer Controls window, then close the current group



Shading raster created from the Mount St. Helens DEM overlaid by a vector hazard zonation map. The polygon fills are solid colors with 75% transparency, so the underlying terrain remains visible.

RGBI Raster Display

STEPS

- click the Add Raster icon  button on the Display Manager toolbar and choose Red-Green-Blue-Intensity from the dropdown menu
- from the RGBI Project File, select raster object TM5R for Red, TM4R for Green, TM3R for Blue, and SPOTPAN for Intensity
- click on the Layer Controls icon  for the raster layer in the Display Manager
- on the Options tabbed panel of the Raster Layer Controls window, choose HIS from the Color Blending Mode menu, then press [OK]
- close the display group when you have completed this exercise

The RGBI raster display mode uses four raster objects to produce an enhanced color display. The rasters selected as Red, Green and Blue components provide color information that is then combined with the Intensity raster for display. You can choose from several color blending modes, including HIS, HBS, Ratio, and Brovey.

All selected objects must have the same cell size and extents. This means that if you want to visually combine color and Intensity images with different cell size (such as pan-sharpening multispectral satellite image bands with a higher-resolution panchromatic band), you must first resample the color component rasters (using the Raster Resampling process: Raster / Resample and Reproject / Automatic) to match the extents and cell size of the Intensity raster before using them for RGBI display. See the tutorial booklet entitled *Rectifying Images* for more information about resampling.



Part of RGB display of objects TM5R, TM4R, and TM3R. (These objects were produced by resampling to the 10-m cell size and extent of the SPOT panchromatic image.)



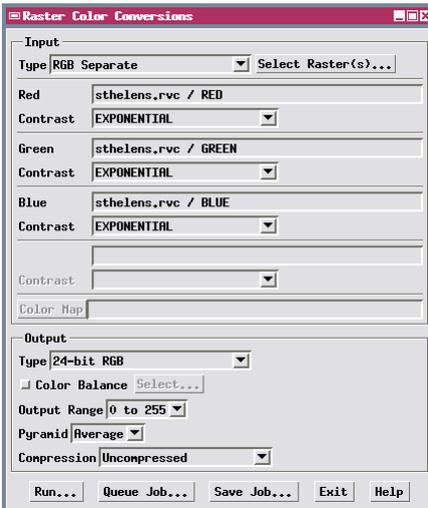
RGBI display of the same three TM rasters with object SPOTPAN as Intensity. The resulting display combines the high spatial resolution of the SPOT panchromatic image with the spectral content of the TM bands.

NOTE: You can use the Multiresolution Fusion process to permanently pan-sharpen multispectral image bands. See the tutorial *Combining Rasters* for more information.

Color Conversion Process

The Color Conversion process allows you to change the storage mode or color space of a color image. You can convert from or to a single color composite raster, an RGB raster set, or Hue-Intensity-Saturation (or related variant) raster set. With RGB input rasters you can select contrast tables or automatic contrast enhancements to be applied during conversion.

When you have an RGB image that is dark but has good color balance, conversion to the HIS color space can provide an easy means of enhancing the color. You can display the output Intensity raster, adjust its brightness and contrast, and select the resulting contrast table for use during the reconversion from HIS to RGB. The resulting RGB raster set will show improved brightness and contrast while retaining its original hues.



24-bit composite color raster created from RED, GREEN, and BLUE.

- click Exit to close the Raster Color Conversions window

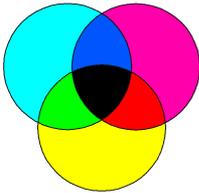
STEPS

- choose Image / Combine / Convert Color from the TNTmips menu
- on the Raster Color Conversions window, select RGB Separate from the Input Type menu
- click [Select Raster(s)...] and select rasters RED, GREEN, and BLUE from the STHELENS Project File
- choose Exponential from the Contrast menu for each of these input rasters
- select Composite 24-bit from the Type menu
- select Average from the Pyramid menu
- press [Run]
- use the standard Select Object window to save the output raster object in the same Project File
- display the saved composite raster object



In a Dither about Printing

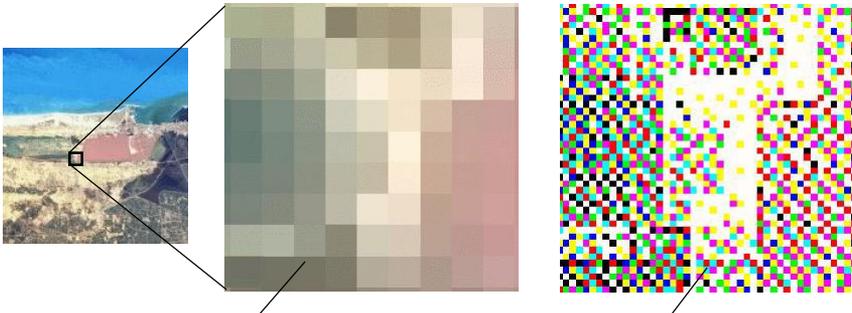
Low end printers use only cyan, magenta, and yellow inks. Four-color (CMYK) printers include a separate black ink supply (K) to produce pure black tones and reduce the use of the colored inks. Some desktop printers offer six or seven inks, including lighter hues of the primary ink colors.



Printer resolution is measured in dots per inch, abbreviated **dpi**. Typical desktop printers have print resolutions of 300 to 720 dpi. High-end desktop printers and those used by graphics service bureaus may have resolutions of 1200 or 2400 dpi.

Now that we have covered the basics of producing good colors when displaying images, we turn to the realm of printing color images. Let's begin by considering how printers reproduce colors. Most digital printers apply tiny dots of cyan, magenta, yellow, and black ink to the page. For most common printers (such as ink-jet and solid-ink types), these dots have a fixed size, and each ink color is either fully "on" or fully "off" for each dot. By overlaying the translucent inks on a single dot, these printers can also produce blue, green, and red dots. If no ink is applied for a dot position, it remains white.

Printers use these eight basic colors (or more, plus black) to simulate a much wider range of image colors. This is possible because of the printer's high spatial resolution. In other words, the ink dots are very tiny and very close together, which has two important consequences. First, a single image pixel is commonly represented by an array of ink dots. Second, we can't distinguish the individual dot colors, but instead perceive a blended color produced by groups of nearby dots. By varying the colors and placement of printer dots for each image cell (a process called **dithering**), the printer can produce the visual effect of the original colors in the image.



Highly magnified portion of the Alexandria Space Shuttle photo. A 24-bit color image includes very subtle cell-to-cell color variations.

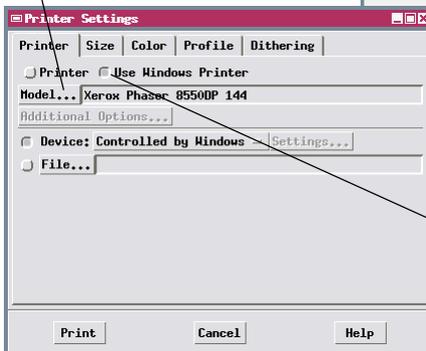
Same area dithered for printing. At this layout scale, each input raster cell is represented by a 5 x 5 array of printer dots. The dithering process uses different patterns of the available print colors to recreate the wide range of colors in the original image.

Printer Settings Window

To illustrate how color can be handled during printing, we will work with a sample page layout designed for printing to an 8.5" x 11" page in portrait orientation. You can print layouts up to 11" x 17" in size with TNTmips Free, TNTmips Basic, TNTview, or TNTedit. The professional version of TNTmips supports printing to a variety of page sizes (as large as current technology allows) and printing over multiple pages.

You make color adjustments for printing using the Printer Settings window, which comes in two versions. When you choose Page Setup from the Display menu, you can set up basic print parameters and save them by pressing the OK button without actually initiating printing. When you select Print from the Display menu, the Printer Settings window opens with a Print button in place of OK, but the remaining controls are identical. Pressing the Print button starts the printing process and closes the window.

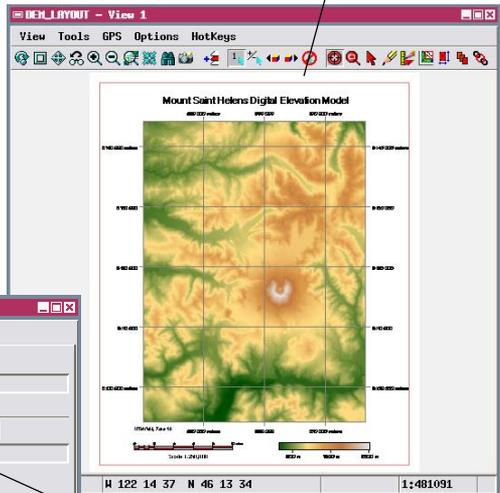
You should already have a printer set up from the Print exercise in the tutorial *Displaying Geospatial Data*. If not, use the controls on the Printer tabbed panel to select one.



STEPS

- choose Display / Open from the Display Manager and select DEM_LAYOUT from the COLOR Project File
- choose Display / Print from the Display Manager

The layout used in these exercises was created using standard tools available in the Page Layout environment. For an introduction to the use of the layout tools, consult the tutorial booklet *Making Map Layouts*.

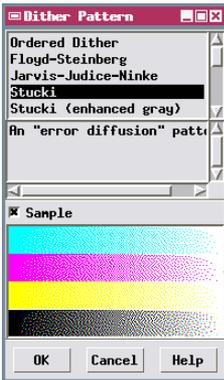


MicrolImages recommends that you turn on the Use Windows Printer radio button (or Use Macintosh Printer on Mac OS X) to use your operating system's printer selection dialog to choose a local or network printer and use its installed print driver to control printing.

Choose Dithering Options

STEPS

- ☑ click the tab for the Dithering panel and turn on the toggle labeled *Let TNT do the dithering*
- ☑ press [Raster Dither Pattern...]
- ☑ from the list in the Dither Pattern window that opens, select Stucki
- ☑ click [OK] to close the Dither Pattern window
- ☑ click [Print] on the Printer Settings window
- ☑ choose Display / Print on the Dithering panel, turn on the toggle *Let the Windows [Macintosh] printer driver do the dithering...*
- ☑ click [Print] on the Printer Settings window



Dye sublimation printers and film recorders are not limited to the eight basic dot colors produced by most printers. They are able to continuously vary the level of each color component used to reproduce the image pixels, resulting in true continuous-color output. Dithering is not required when you print to one of these devices, so the dither pattern controls are inactive.

Use the Dithering tabbed panel to set up dithering options. If you are printing to a Windows or Macintosh printer using the installed print driver, you have the choice of letting either the printer driver or TNTmips control the dithering. If you set the printer driver to control dithering, use your system printer setup dialog (opened from the Model button on the Printer panel) to set the printing quality (which controls how the print is dithered). This method takes best advantage of the printer's resolution and features and will usually give you the most reliable results.

If you choose to let TNT control the dithering, you can independently choose dither patterns for both raster and nonraster components of your print layout. The Floyd-Steinberg, Jarvis-Judice-Ninke, and Stucki patterns usually provide good results for color images on most printers, and the choice between them is a matter of personal preference. The sample in the lower part of the Dither Pattern window gives you some idea of how the pattern looks for different colors. The Stucki (enhanced gray) pattern provides the best results when you print a grayscale raster image. The default Vector pattern for nonraster components insures continuity of thin lines in vector, CAD, or TIN overlays, and those in map grids, scale bars, and legends.



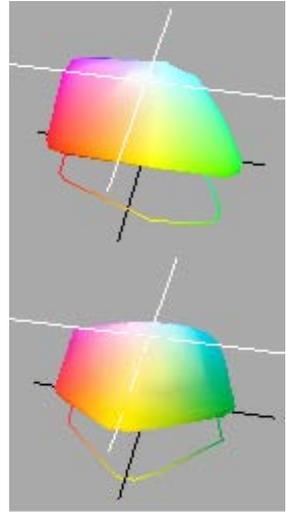
Color Management Using Profiles

As you work with creating and printing layouts, you may find that the colors in your prints do not match very well with the display colors that you carefully selected in designing your layout. The source of this problem is simple. Computer displays and printers use different color models and technologies to produce colors, and they typically cannot produce an identical range (gamut) of colors.

The solution to this problem is to use *color profiles* that define how the color characteristics of a computer display, printer, or other device translate to a reference color space. Profile files conforming to the International Color Consortium's standard format are referred to as either ICC or ICM files and can have either file extension. The TNT products allow you to utilize color profiles for displaying data in Views, for proofing to the screen, and for printing.

ICC/ICM profiles may have been installed along with the drivers for your display monitor and printer. If not, they may be available for you to download. In order for TNTmips to be able to use these profiles, they must be in a specific location in your directory structure (see the steps to the right for Windows). On platforms other than Windows, the profile files must be in your TNTmips directory.

The sRGB color space developed by Microsoft and Hewlett-Packard has become the standard reference color space for display monitors. You can set TNTmips to directly use a specific color profile to display colors, or to pass sRGB color information to the display driver to allow the driver and the operating system to jointly handle the color management. This choice requires you to separately set options for the operating system, the X-Server, and for the Display process, as explained by the Technical Guide entitled *Color Management for X Server and Views*.



3D projections of sample color gamuts from a monitor (top) and printer (bottom).

To install a downloaded ICC/ICM profile under Windows:

- copy the profile file to the following directory:
c:\windows\system32\spool\drivers\color\



- right-click on the profile file and choose Install from the popup menu to register the profile with the operating system

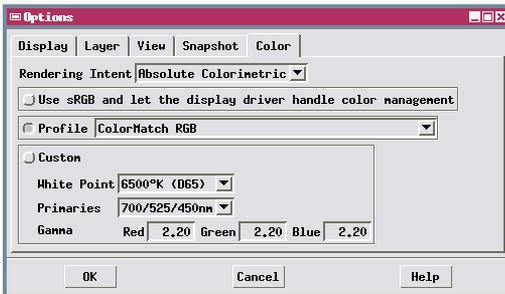
Proofing to the Screen

STEPS

- choose Options / View Options from the Display Manager
- click on the Color tab on the View Options window
- from the Rendering Intent menu choose Absolute Colorimetric
- turn on the Profile radio button
- press [OK] on the Options window

To ensure that your screen colors and print colors match, you can use the Proof to Screen option on the Profile tabbed panel of the Printer Settings window. When this option is turned on (and other required options are set properly, as outlined below), your printer's ICM profile is used to adjust the layout colors before they are rendered to your display to provide a preview of how the colors should look when printed.

To successfully proof to the screen, you must properly set the Options that govern how colors in general are

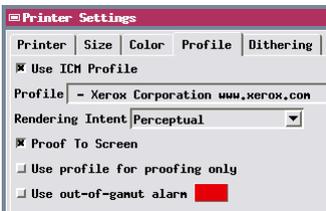


rendered to your computer display. These controls are found on the Color panel of the View Options window. You must choose Absolute Colorimetric from the Rendering Intent menu on the same panel. (We will discuss rendering intent further on the next page.) You can proof to the screen

- choose Display / Page Setup from the Display Manager
- on the Profile panel of the Printer Settings window, turn on the Use ICM Profile toggle
- choose an ICM profile from the Profile menu
- turn on the *Proof to screen* toggle button
- press [OK] on the Printer Settings window

using either the default color profile for your monitor (selected from the Profile menu), a custom profile that incorporates your specific monitor settings, or using sRGB and the display driver to handle color management.

With the View Options set, you can then turn on the Use ICM Profile toggle on the Profile tabbed panel of Printer Settings window and select the ICM color profile for your printer. When you press [OK] on the Printer Settings window, the layout will redraw with the proof colors.



NOTE: To ensure that the proof colors are printed without modification, you also may have to turn off your printer's color correction system. If you are using a system printer driver to control printing, use the Model button on the Printer panel of the Printer Settings window to access the system's printer settings. You may also have to turn on an option to use ICM profiles in printing.

Handling Out-of-Gamut Colors

Printers usually have significantly smaller color gamuts than computer displays. This means that there may be colors in your layout objects that display properly on screen but are outside the range of colors that your printer can produce. When you proof to the screen, you can turn on the *Use out-of-gamut alarm* toggle to find out whether such colors are present in your layout. The selected alarm color (default red) is then used to flag the locations of the out-of-gamut colors.

The Rendering Intent menu on the Profile panel of the Printer Settings window lets you choose how to translate out-of-gamut colors for printing. Of the rendering intents described below, Relative Colorimetric Rendering and Perceptual Rendering are most appropriate for translating the wide range of your layout colors to your printer's narrower color gamut. (Note that for some proof settings the page background may also be rendered in the alarm color.)

Absolute Colorimetric: source colors existing within the destination gamut are unchanged; those outside the destination gamut are replaced by the nearest available color at the outer limit of the destination gamut. White may or may not be reproduced exactly.

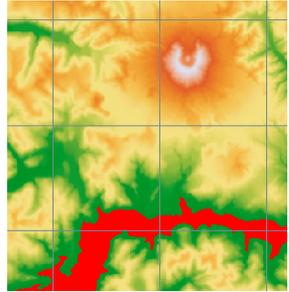
Relative Colorimetric: the brightness of all source colors is rescaled so that the source white (RGB) maps to the destination white (CMYK) and all other colors are adjusted accordingly.

Perceptual: transforms the input color gamut so its boundary maps on or close to the boundary of the destination gamut. This method compresses the source gamut while preserving the relationships between colors.

Saturation: modifies the source colors to fill the destination gamut by allowing hue changes in order to preserve the vividness of pure colors.

STEPS

- choose Display / Page Setup from the Display Manager
- on the Profile panel of the Printer Settings window, turn on the *Use out-of-gamut alarm* toggle
- press [OK] on the Printer Settings window



The darkest green colors are out-of-gamut for the printer profile shown on the previous page. You may get different results with your printer's ICM profile.

- choose Display / Page Setup from the Display Manager
- on the Profile panel of the Printer Settings window, turn off the *Use out-of-gamut alarm* toggle
- examine the choices on the Rendering Intent menu
- turn off the *Use ICM Profile* toggle
- press [OK] on the Printer Settings window

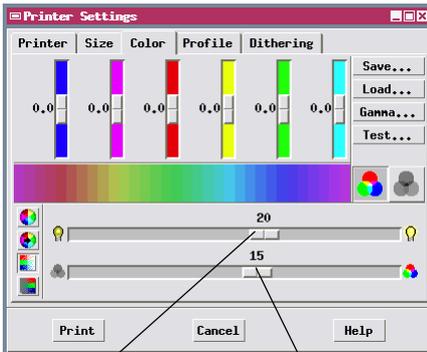
Adjusting Intensity and Saturation

STEPS

- ☑ choose Display / Print from the Display Manager
- ☑ click the Color tab on the Printer Settings window
- ☑ slide the Intensity slider back and forth and note the effect on the color sample bar above it
- ☑ repeat with the Saturation slider
- ☑ set the Intensity level to 20 and the Saturation level to 15
- ☑ press [Print] to print the layout and close the Printer Settings window

For routine printing tasks, you may not be concerned with producing an exact match between screen and print colors, but merely with producing a pleasing set of print colors. If that is the case, you can turn off the Printer Settings option to use an ICM profile for printing and experiment with the different color correction options offered by your system printer driver.

In addition, the Color panel of the Printer Settings window provides a number of controls that allow you to alter the manner in which image colors are translated to the printer. Using these controls you can adjust the colors produced in the print without altering the contrast tables, color palettes, and vector colors you have created for the objects in your layout.



Intensity slider

Saturation slider

NOTE: The intensity and saturation slider settings are saved temporarily when you print and when you press [OK] on the nonprinting Page Setup window. They can then be saved along with any other changes in the Layout object if desired.

The colors produced by inkjet printers are often darker and less saturated than the corresponding screen colors. The lower part of the Color panel includes two horizontal sliders that use the HIS color model to modify all of the colors in the print image simultaneously. Moving the upper slider to the right increases the intensity (brightness) of all colors. Moving the lower slider to the right increases the saturation of each hue at the expense of intervening pastel shades. The color sample bar above these sliders changes as you move the sliders, giving you a preview of their overall effects. Many natural color images benefit from modest increases in intensity and saturation during the print process. However, if part of the image is already very bright, increasing the overall intensity may “wash out” the color in this part, resulting in a local loss of detail.

Color Balancing

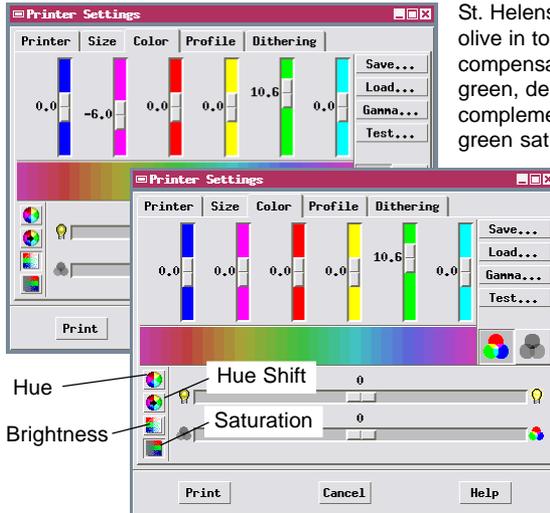
The controls you adjusted in the previous exercise influence all of the raster image colors in your print. However, all screen colors may not print equally well from a given layout. For example, green and blue typically print darker than other colors on inkjet printers, and deep blue colors on the screen often appear closer to purple when printed. You can use the vertical color sliders in the Color panel in conjunction with the four icon buttons in the lower left part of the panel to adjust individual output colors.

With the Brightness icon button turned on, moving a slider increases or decreases the intensity of its color. With the Saturation button turned on, move a slider up to increase the saturation (purity) of the color, or move the slider down to move the color toward gray. The color bar beneath the sliders previews the resulting effects. Slider positions can be saved by saving the layout object. You can also save these settings at any time in a color balance object by pressing the Save button, and recall saved settings using the Load button.

STEPS

- choose Display / Print from the Display Manager
- click the Color tab on the Printer Settings window
- with the Brightness icon button selected (the default) move the Green slider upward to a value of 10.6 and the Magenta slider downward to a value of -6.0
- press the Saturation icon button, and move the Green slider upward to a value of 10.6
- press [Save], use the File / Object Selection window to navigate to the COLOR Project File, and name a new color balance object
- press [Print] to print the layout and close the Printer Settings window

My printer produces greens in the Mount St. Helens DEM that are too dark and too olive in tone. The settings in this exercise compensate by increasing the intensity of green, decreasing the intensity of its complement, magenta, and increasing the green saturation.



The color sliders can also be used in conjunction with the Hue and Hue shift icon buttons to modify selected hues, but this is a tricky procedure that may produce unexpected results. You should be able to achieve a good color balance using only the Brightness and Saturation settings.

Adjusting Gamma Contrast

STEPS

- ☑ choose Display / Print from the Display Manager
- ☑ click the Color tab on the Printer Settings window
- ☑ click [Gamma...]
- ☑ in the Gamma Contrast window, use the mouse to highlight the Power text box for Green, and type in the value 1.4
- ☑ change the Power value for Blue to 1.2
- ☑ click [OK] to accept the values and close the Gamma Contrast window
- ☑ press [Print] to print the layout and close the Printer Settings window
- ☑ choose Display / Close on the Display Manager
- ☑ press [No] when you are asked whether to save changes to the layout

The Gamma Contrast window provides an alternative means of selectively adjusting how object colors are translated to print colors. The relationship between the brightness variation of a source color and the brightness variation of that color in a screen display or print is typically not a linear one. Instead, it is approximately a power function. That is, the screen or print brightness equals the source color brightness raised to some exponent. In computer graphics, the Greek letter “gamma” is the symbol used for the numerical exponent in the power function.

The Gamma Contrast window has for each color component a Power text box in which you can enter a value for the gamma exponent (the default is 1.00, which defines a linear brightness translation). The Mode option button allows you to choose between RGB (display color) or CMY (ink color) modes for specifying gamma values. Although color printing uses CMY, it is easier to visualize the results using RGB mode. Entering a gamma value greater than 1.0 for red, green, or blue brightens the low to middle intensity range of the color in the print; entering a value less than one has the opposite effect.



Red-Green-Blue is the default color mode.

The gamma values used in this exercise are designed to brighten the green colors in the print without brightening red. Green areas should appear brighter in the print, and brown areas should contain less red.

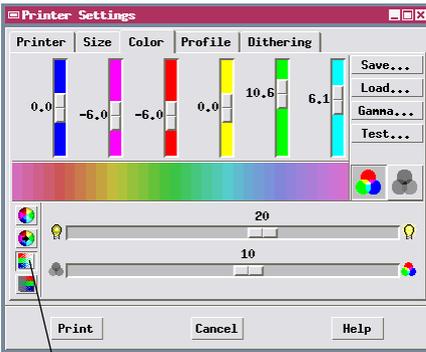
The Gamma Contrast window opens with default values for gamma of 1.00 for each color component.

You can also change the allowed minimum and maximum input and output values to adjust the brightness and contrast of the print.



Printing Test Strips

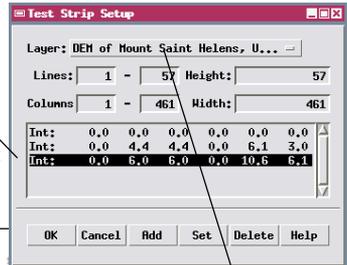
The settings on the Color panel affect the printing process and not the screen display, so you must print the layout to assess the results. It may take some trial and error to discover the best settings for your printer, and printing the entire layout for each change in settings would be time-consuming. To avoid this problem, you can print a set of test strips of a raster layer that use a sample area to show the results of a number of different color balance or gamma contrast settings.



STEPS

- reopen DEM_Layout and select Print from the Display menu
- click the Color tab on the PrinterSettings window
- set the horizontal Brightness slider to 20 and the Saturation slider to 10
- click [Test...]
- in the Test Strip Setup window, click [Add]
- with the Brightness icon button turned on, set the color sliders to the following values from left to right:
0.0, -4.4, -4.4, 0.0, 6.1, 3.0
- click Add again
- repeat the last two steps with the following slider settings:
0.0, -6.0, -6.0, 0.0, 10.6, 6.1
- click [OK] on the Test Strip Setup window to print the test strips

You can adjust settings for any or all of the color balance parameters before adding a listing in the Test Strip Setup window. The listing shows the settings for whichever parameter is currently selected by a color balance icon button.



Each test strip is preceded by a listing of all settings:

Color Balance
Gamma Contrast:

RGB
CMY

Hue:	0.0	0.0	0.0	0.0	0.0	0.0	Red:	1.00	1.255	1.255	Cyan:	1.00	1.255	1.255
Shift:	0.0	0.0	0.0	0.0	0.0	0.0	Green:	1.00	1.255	1.255	Magenta:	1.00	1.255	1.255
Int:	0.0	0.0	0.0	0.0	0.0	0.0	Blue:	1.00	1.255	1.255	Yellow:	1.00	1.255	1.255
Sat:	0.0	0.0	0.0	0.0	0.0	0.0	Contrast:	50	Brightness:	115				
Intensity: +20 Saturation: +10 Dither Pattern: Stuck!														

Hue:	0.0	0.0	0.0	0.0	0.0	0.0	Red:	1.00	1.255	1.255	Cyan:	1.00	1.255	1.255
Shift:	0.0	0.0	0.0	0.0	0.0	0.0	Green:	1.00	1.255	1.255	Magenta:	1.00	1.255	1.255
Int:	0.0	-4.4	-4.4	0.0	6.1	3.0	Blue:	1.00	1.255	1.255	Yellow:	1.00	1.255	1.255
Sat:	0.0	0.0	0.0	0.0	0.0	0.0	Contrast:	50	Brightness:	115				
Intensity: +20 Saturation: +10 Dither Pattern: Stuck!														

Hue:	0.0	0.0	0.0	0.0	0.0	0.0	Red:	1.00	1.255	1.255	Cyan:	1.00	1.255	1.255
Shift:	0.0	0.0	0.0	0.0	0.0	0.0	Green:	1.00	1.255	1.255	Magenta:	1.00	1.255	1.255
Int:	0.0	0.0	0.0	0.0	0.0	0.0	Blue:	1.00	1.255	1.255	Yellow:	1.00	1.255	1.255
Sat:	0.0	0.0	0.0	0.0	0.0	0.0	Contrast:	50	Brightness:	115				
Intensity: +20 Saturation: +10 Dither Pattern: Stuck!														

Hue:	0.0	0.0	0.0	0.0	0.0	0.0	Red:	1.00	1.255	1.255	Cyan:	1.00	1.255	1.255
Shift:	0.0	0.0	0.0	0.0	0.0	0.0	Green:	1.00	1.255	1.255	Magenta:	1.00	1.255	1.255
Int:	0.0	-6.0	-6.0	0.0	10.6	6.1	Blue:	1.00	1.255	1.255	Yellow:	1.00	1.255	1.255
Sat:	0.0	0.0	0.0	0.0	0.0	0.0	Contrast:	50	Brightness:	115				
Intensity: +20 Saturation: +10														

If there is more than one raster layer in your layout, use the Layer option button to choose which layer to test.

Advanced Software for Geospatial Analysis

GOOD COLOR

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

TNTmips Basic TNTmips Basic is a low-cost version of TNTmips for small projects.

TNTmips Free TNTmips Free is a free version of TNTmips for students and professionals with small projects. You can download TNTmips Free from MicroImages' web site.

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 or DVD at low cost. TNTatlas CDs/DVDs can be used on any popular computing platform.

Index

additive primary colors.....	3,4	dithering.....	28,30
brightness, display.....	6-15	gamma contrast.....	36
brightness, print.....	34-36	gamut.....	31-33
CMY color model.....	3,28	HBS color model.....	21
color balance.....	7,11,35	HIS color model.....	21,26,34
color conversion process.....	27	hue.....	21,35
color display mode.....	4,5	intensity.....	21,26,27,30,34
color palette (color map).....	17-22,24	Printer Settings Window.....	29-37
color profile.....	31-33	proof to screen.....	32-33
color spread.....	21,22,24	rendering intent.....	32-33
composite color raster.....	16,17	RGB color model.....	3,21
contrast enhancement.....	6-13,27	RGB raster display.....	5-15,27
auto-normalized.....	10,11	RGBI raster display.....	26
equalized.....	13	saturation.....	21,30,34
exponential.....	8	subtractive primary colors.....	3
hyperbolic tangent.....	14	test strips, printing.....	37
local area.....	12	transparency	
linear.....	7	color palette.....	24
logarithmic.....	15	raster.....	23
user drawn.....	15	vector polygon fills.....	25



MicroImages, Inc.

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

www.microimages.com