

Building 3D Landscapes



for **TNTsim3D™**
with
TNTmips®

Before Getting Started

The exercises in this booklet introduce you to the Landscape Builder process in TNTmips. Using the Landscape Builder you can process your geospatial data into Landscape files for use in TNTsim3D for Windows, the real-time 3D simulation software provided with TNTmips. The Landscape Builder automates the creation of Landscape Files containing the specially-formatted Terrain and Texture raster objects used by TNTsim3D.

Prerequisite Skills This booklet assumes that you have completed the exercises in *Getting Started: Displaying Geospatial Data* and *Getting Started: Navigating*. Those exercises introduce essential skills and basic techniques that are not covered again here. Please consult those booklets and the TNTmips reference manual 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 CD, you can download the data from MicroImages' web site. In particular, this booklet uses sample files in the LANDSCP data collection.

More Documentation This booklet is intended only as an introduction to building landscapes for TNTsim3D. For information on operating TNTsim3D, consult the tutorial booklet *Using TNTsim3D*.

TNTmips and TNTlite® TNTmips comes in two versions: the professional version and the free TNTlite version. This booklet refers to both versions as "TNTmips." If you did not purchase the professional version (which requires a software license key), TNTmips operates in TNTlite mode, which limits object size and enables data sharing only with other copies of TNTlite.

The largest landscape you can build using TNTlite is 512 by 512 texture cells. TNTsim3D can efficiently handle much larger landscape sizes that cover larger areas and/or provide higher spatial detail. The first several exercises in this booklet use sample data that meet TNTlite object size restrictions. But in order to fully illustrate the features available in the Landscape Builder, the remaining exercises use larger sample objects that cannot be used in TNTlite.

Randall B. Smith, Ph.D., 17 July 2002

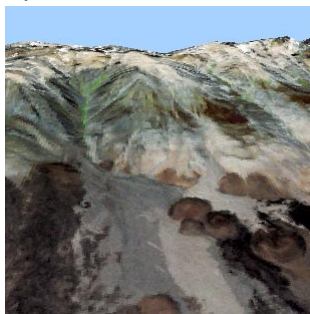
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It may be difficult to identify the important points in some illustrations without a color copy of this booklet. You can print or read this booklet in color from MicroImages' Web site. The Web site is also your source for the newest Getting Started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

<http://www.microimages.com>

Welcome to Building Landscapes

TNTsim3D shows a 3D perspective view of your geodata and allows you to move through the scene and view any portion of it from any vantage point. Real-time 3D rendering of this sort places considerable demands on your computer resources. In order for TNTsim3D to provide both smooth movement and realistic rendering of the scene, the geospatial data in a Landscape File must be specially formatted prior to use in the simulator. The Landscape Builder allows you to easily assemble the data for your 3D scene and creates a Landscape File with the required characteristics.



In the Landscape Builder you first select a single raster of any type to provide the *terrain*. This raster can depict variations in ground surface elevation or of any other spatially varying numerical quantity (such as soil pH, crop yield, or water table level). You then add one or more objects to create a visual image to be saved as a texture raster. The texture can be as simple as an image of the terrain itself, or a composite of a number of overlaid geodata layers. All objects are automatically registered (and reprojected if necessary) and shown in the View window, and all standard tools for enhancing the visual display are provided. When you save a Landscape File, you have the option of reopening the file to create additional textures. You can also open existing files to add new textures.

The terrain and texture rasters in a Landscape File must have matching geographic extents and meet special raster size requirements. The Landscape Builder provides the specialized tools to let you set the extents, orientation, and relative size of the texture and terrain rasters. It also creates a special tiling and pyramid structure for each texture raster.






STEPS

- launch TNTmips
- from the Support menu choose TNTsim3D Landscape Builder

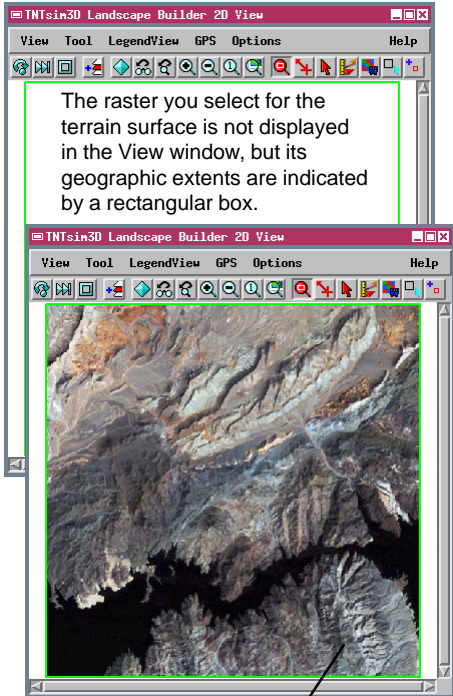
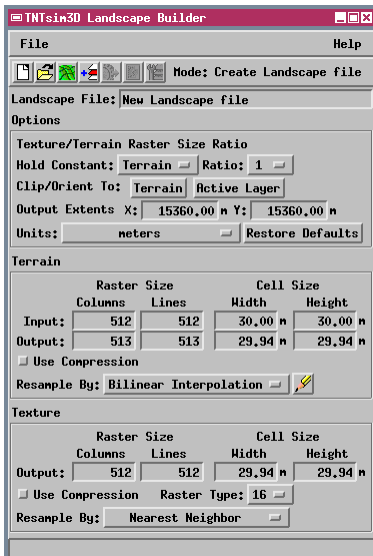
The exercises on pages 4-6 show you how to create new Landscape files and how to add new textures to existing files. Page 7 illustrates how to use multiple layers to create a texture image. Different ways to control the extents and orientation of the landscape are discussed on pages 8-10. Pages 11-12 explain some special constraints on the sizes of output landscape rasters, adjusting the relative sizes of terrain and texture rasters, and strategies for reducing file sizes. An example of using a terrain raster that does not represent earth surface elevations is provided on page 14.

Make Your First Landscape

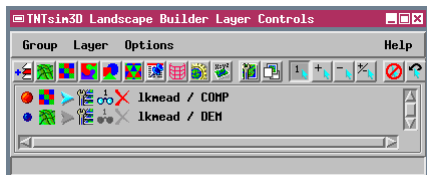
STEPS

- press the New icon button on the Landscape Builder window 
- use the standard Select Object window to navigate to the LKMEAD Project File in the LANDSCP directory, and select raster DEM 
- click the Add Layer icon button and select Quick-Add from the dropdown menu 
- select raster COMP from the LKMEAD Project File 
- press the Run icon button and use the New File dialog window to name a new *.sim file 
- use the two subsequent popup dialog windows to name the Terrain object and Texture object

Let's begin by making a new landscape file with a single color composite raster to provide the texture image. The composite was created from a combination of three Landsat Thematic Mapper bands to produce a "natural" color image of part of Lake Mead and surrounding areas in Nevada (USA). The DEM and the composite raster already match in geographic extents and in orientation, so no further adjustments are required after the terrain and texture layers are loaded.



Any texture layers you add are shown automatically in the View window.



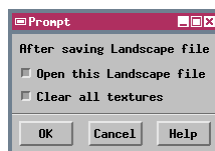
This exercise continues on the next page.

Choices When Saving a Landscape File

A Landscape File can include any number of texture layers that you can independently select for use in different views in TNTsim3D. However, textures must be created and saved one at a time in the Landscape Builder process.

When you save a Landscape File, you might want to go on to add additional textures to the same file or begin creating a new file. In either case you may or may not want to use your previous texture layers in making the next texture. The Landscape Builder makes the transition to the next task smoother by prompting you during the file save dialog for the actions to be taken after the current Landscape File has been saved. You can choose whether or not to re-open the current file and whether or not to clear all current texture layers.

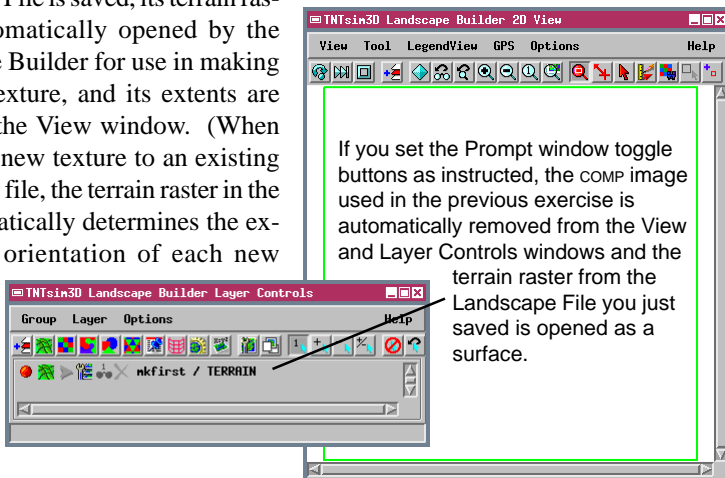
In this example we want to go on to add another texture layer to the same Landscape File, but the color composite we used earlier is not needed for the new texture. So when you save the initial file, set the toggles on the Prompt window to open the file but clear all textures (all layers in the View window that were used to make the texture image). After the Landscape File is saved, its terrain raster is automatically opened by the Landscape Builder for use in making the next texture, and its extents are shown in the View window. (When you add a new texture to an existing Landscape file, the terrain raster in the file automatically determines the extents and orientation of each new texture raster).



The Prompt window opens each time you create a new Landscape File or add a texture to an existing file. It opens at the end of the file save dialog sequence, allowing you to configure the Landscape Builder for your next task.


- ☑ in the Prompt window, turn on both the toggle labeled Open this Landscape file and the toggle labeled Clear all textures

You can view the new simulated landscape in TNTsim3D or view its rasters in the TNTmips Spatial Data Display process.



Add a Texture to a Landscape File

STEPS

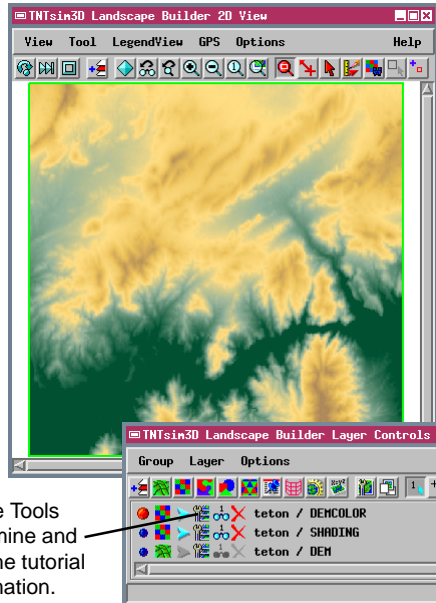
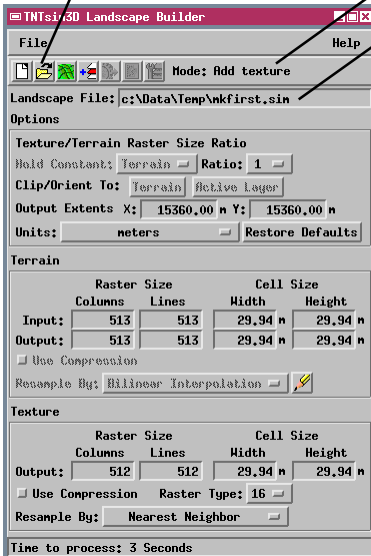
- ☑ click the Add Layer icon button  and select Quick-Add from the dropdown menu
- ☑ select raster comp from the LKMEAD Project File
- ☑ press the Run icon button and use the Name Object dialog to name the new texture
- ☑ in the Prompt window, turn OFF the toggle button for Open this Landscape file but turn ON the button for Clear all textures

The elevation raster you use to provide the terrain for a Landscape file can also be used to make useful texture images, even if you have no other imagery or spatial data for the area. In this exercise the DEM for the Lake Mead area is displayed with a color palette to create a second texture layer in your first Landscape File.

You can easily add a series of textures to a newly created Landscape File in one session, as in this set of exercises. You can also go back to a previously created Landscape File to add new textures. To do so, use the Open icon button on the Landscape Builder window to select the desired file.

Use the Open icon button to open a pre-existing Landscape File to add a new texture.

When you have opened a Landscape file using the Open icon button or after saving (by means of the Prompt window), the Landscape Builder is in Add Texture mode and the name of the selected file is shown in the Landscape File field.



You can use the Edit Colors option from the Tools menu in the Layer Controls window to examine and modify a raster layer's color palette. See the tutorial booklet *Getting Good Color* for more information.




Texture from Multiple Layers

When you save a Landscape File and choose not to reopen it (as at the end of the preceding exercise), the elevation raster you previously selected to control the terrain remains loaded. To clear it and select a new elevation raster, press the New icon button.

The Landscape Builder incorporates the same multi-layer display capabilities found in the TNTmips Spatial Data Display process. You can build up complex texture images by overlaying different layers of any object type and by using special effects such as transparency for vector polygon fills or raster layers.

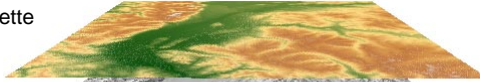
In this exercise, two raster layers are used to create the texture image. The first layer is a shading raster computed from the DEM using the TNTmips Slope, Aspect, and Shading process (accessed from the Process / Raster / Elevation menu). The second layer is simply a copy of the DEM with a custom color pal-

STEPS

- press the New icon button and select raster DEM from the TETON Project File 
- press the Add Layer icon button and choose Quick-Add from the menu 
- select rasters SHADING and DEMCOLOR (in that order) from the TETON Project File
- press the Run icon button and name the new Landscape File and the terrain and texture objects 
- in the Prompt window, turn OFF both toggle buttons (do not open file but retain current texture layers)

Color Shaded Relief Texture Created From:

DEM with color palette with partially transparent colors

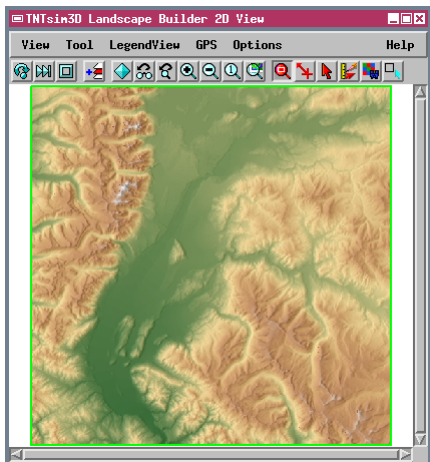


Shading raster



ette that has a transparency value of 30% set for each color. When the two layers are overlaid, the transparency allows the elevation-coded colors to blend visually with the underlying shading to producing a color shaded relief texture. When viewed in TNTsim3D, the color and shading cues in the texture reinforce the 3D rendering of the terrain to provide a very effective perspective view of the surface.

Keep the current settings and continue to the next exercise.

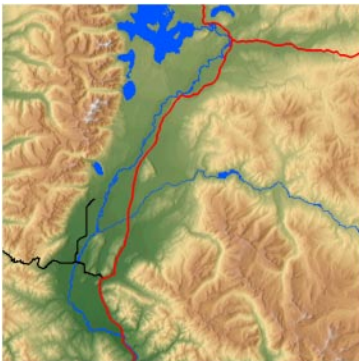


Clip / Orient to Terrain

NOTE: after the last exercise the SHADING and DEMCOLOR rasters should remain as texture layers

STEPS

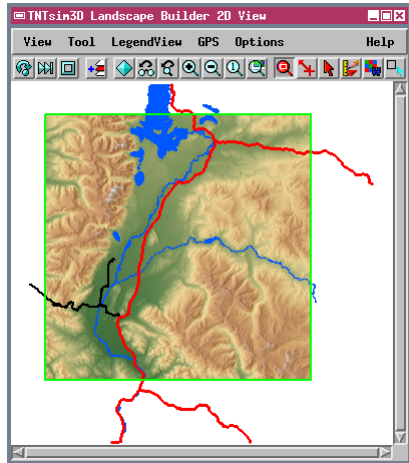
- ☑ press the Add Layer icon button and choose Quick-Add from the menu
- ☑ select vector objects HYDRO and HIGHWAYS (in that order) from the TETON Project File
- ☑ note that the colored extents box still outlines the extents of the selected terrain raster
- ☑ press the Run icon button and name a new Landscape file and the terrain and texture objects
- ☑ in the Prompt window turn OFF the toggle button for Open this Landscape file but turn ON the button for Clear all textures



Output texture raster clipped to the terrain extents.

The input objects you select to build a landscape do not have to have matching extents, orientations, and map projections. Different projections are reconciled automatically by the process, and the Landscape Builder provides several ways for you to set the orientation and extents for the final landscape.

The two vector layers added in this exercise extend beyond the geographic boundaries of the terrain raster and the texture layers derived from it. Since the vector lines and polygons lying outside the terrain extents have no geographic context, there is no reason to include them in the texture image. So we would like to have these elements clipped at the boundary of the terrain raster. In fact, by default the Landscape Builder clips all texture layers to the extents of the selected terrain raster (shown by the colored extents box in the View window) and also orients all layers to the terrain raster's orientation.






Most of the data layers used in this exercise are georeferenced to the same coordinate system (Universal Transverse Mercator), but the highways layer uses Latitude-Longitude coordinates. These differing systems are reconciled automatically as the layers are added.

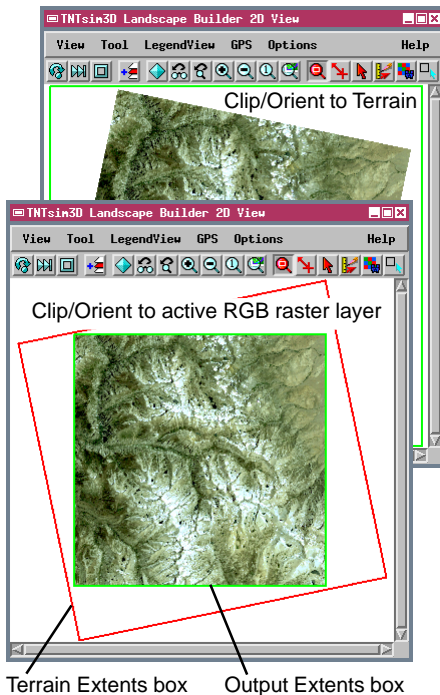
Clip / Orient to Active Layer

You can also clip and orient the landscape to any object you add as a texture layer. First make sure that the desired layer is the active layer in the view (the Layer Select button to the left of its entry in the Layer Controls window should be red; if not, left-click on it). Then press the Active Layer push button to the right of the Clip/Orient To: label on the Landscape Builder window's Options panel.

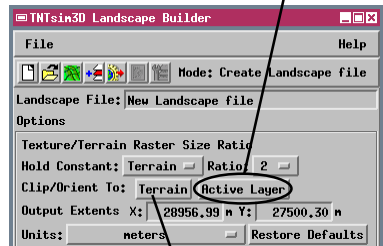
In this exercise we clip and orient the landscape to an RGB raster layer used for the texture. Since this raster layer was the last one added, it is the active layer by default. The rasters in this layer are georeferenced, but their lines and columns are not parallel to grid lines in the referenced coordinate system (Universal Transverse Mercator Zone 11). Lines and columns in the larger terrain raster *are* oriented to this coordinate system.

STEPS

- press the New icon button and select raster DEM from the KINGS Project File 
- press the Add Layer icon button and choose Raster and then Quick-Add RGB from the dropdown menu 
- select rasters BAND3, BAND2, and BAND1 (in that order) from the KINGS Project File
- note that the RGB raster layer is now the active layer in the Layer Controls window
- on the Options panel of the Landscape Builder window, press the Active Layer push button
- press the Run icon button and name a new Landscape file and its objects 
- keep the Prompt window settings from the previous exercise






Select button for Active Layer



You can use the Clip/Orient To: Terrain button to resume using the terrain layer to clip and orient the landscape.

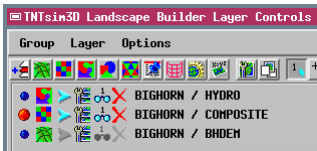
Set Output Extents Manually





STEPS

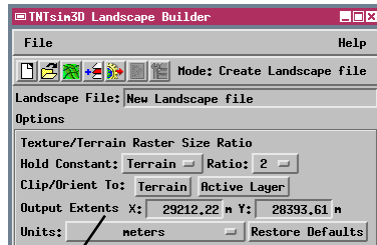
- press the New icon button and select raster **BHDEM** from the **BIGHORN Project File**

- press the Add Layer icon button and choose Quick-Add from the menu
 
- select raster object **COMPOSITE** and vector object **HYDRO** (in that order) from the **BIGHORN Project File**
- in the Layer Controls window, click the blue **Select** icon button for the **COMPOSITE** layer (it should turn red)
 

You may encounter instances where none of the automatic clip/orient options give you the extents you want for the landscape. You can then use the Output Extents tool to manually resize the Output Extents box, clipping all of the layers exactly where you want.

In this example the selected terrain raster does not cover the full extents of the **COMPOSITE** raster. If we use only the option to clip/orient to the active layer using the composite layer, there would be no valid terrain elevations for the lower left corner of the landscape. (In that event, the Landscape Builder would fill the no-data terrain cells with the minimum value from the terrain). Instead, we can reduce the size of the output extents box on the left and bottom so that there will be valid terrain values for the entire landscape.

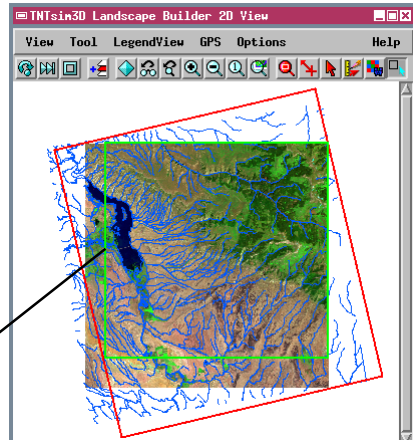


- press the Active Layer push button in the Landscape Builder window
 
- click the Output Extents icon button in the View window toolbar
 
- with the mouse, left-click and drag the left and bottom sides of the Output Extents box inward until the lower left corner is inside the Terrain Extents box
 
- keep these settings and continue to the next page
 



The current numeric output extents are shown on the Options panel. The Units menu allows you to select appropriate length units for the extents fields.

Resize the Output Extents box so that it lies entirely inside the Terrain Extents box.




Landscape Raster Size Constraints

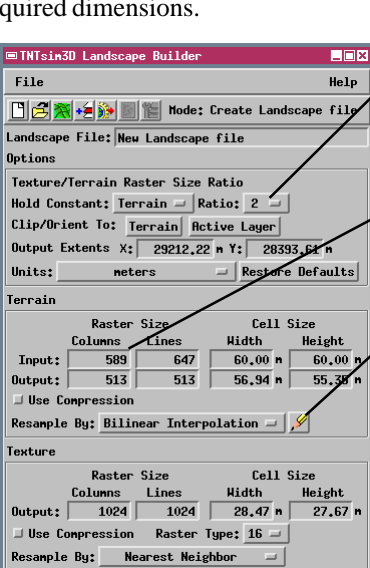
If you were watching the Landscape Builder window closely as you performed the steps on the previous page, you may have noticed that the setting on the Ratio menu changed from 1 to 2 when you changed the clip/orient setting. This menu sets the size ratio between the texture and terrain rasters. (Size refers to the output raster dimensions in numbers of lines and columns.) In general, a realistic landscape simulation needs less spatial detail in the terrain raster than in the texture overlay. You can set the texture/terrain raster size ratio to be 1, 2, or a power of 2 (up to 64).

The texture raster created by the Landscape Builder uses a special tiling scheme, with each tile containing 256 lines and 256 columns of cells. The number of tiles in each raster dimension is constrained to be 1, 2, or a power of 2. As a result, the number of raster cells in each dimension can be 256, 512, 1024, 2048, and so on. The Landscape Builder automatically adjusts the output terrain and texture cell sizes (and the ratio menu) to produce rasters with the required dimensions.

STEPS

- note the current setting on the Ratio menu (Options panel of the Landscape Builder window) and the raster and cell sizes for the output Terrain and Texture rasters
- press the Run  icon button and name a new Landscape file and its objects
- keep the Prompt window settings from the previous exercise

The dimensions of the output terrain raster are computed automatically by dividing each texture raster dimension by the selected size ratio and adding one cell. For example, with output texture dimensions of 2048 by 4096 and a ratio of 4, the terrain raster would have dimensions of 513 by 1025 cells.



You can set a Texture/Terrain Raster Size Ratio using the Ratio menu.

You can manually edit the dimensions or cell size of either output landscape raster, but any values you enter are adjusted automatically to maintain the selected size ratio and to meet the raster dimension constraints required by TNTsim3D.

As noted in the previous exercises, the View window shows two extents boxes: one for the current output extents, and one for the terrain extents. (When you select a new terrain raster, the two boxes coincide.) The output extents box uses the graphic tool color and line width set in the TNTmips General System Preferences window (Support / Setup / Preferences). You can set the color and line width for the terrain extents box by pressing the Specify Terrain Extents Style icon button.

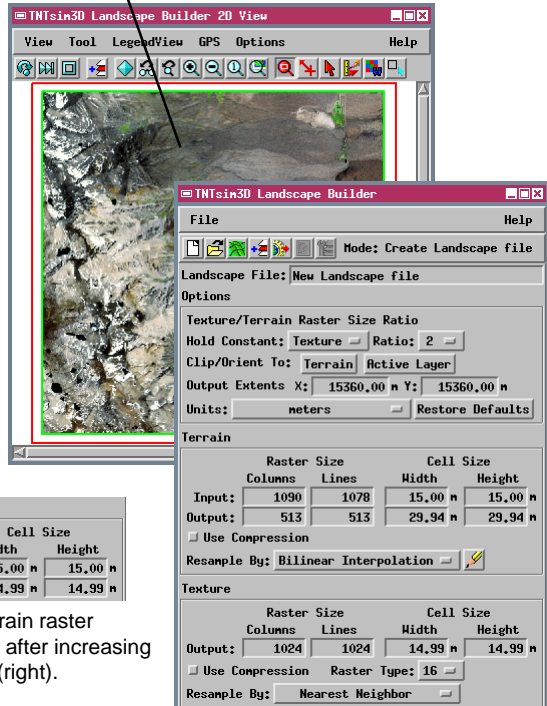
Using Texture/Terrain Size Ratios

STEPS

- ☑ press the New icon button and select raster RMDEM from the REDMTN Project File
- ☑ press the Add Layer icon button and choose Raster / Add RGBI Rasters from the menu from the REDMTN Project File, select BAND3 for Red, BAND2 for Green, BAND1 for Blue, and BAND8F for Intensity
- ☑ the Raster Layer Controls window should open automatically; on the Options panel, choose HBS on the Color Blending Mode menu, then click [OK]
- ☑ for the Clip/Orient To: option, press Active Layer
- ☑ select Texture from the Hold Constant menu on the Landscape Builder window's Options panel
- ☑ select 2 from the Ratio menu and note the new output size for the Terrain raster
- ☑ keep these settings and continue to the next page

When you change the Ratio menu setting, the Landscape Builder automatically updates the output dimensions and cell size of either the terrain or texture raster; the dimensions and cell size of the other are left unchanged. You can choose which raster is left unchanged by using the Hold Constant menu on the Options panel. In this example the input DEM and the rasters used for the RGBI raster display have approximately the same cell size (15 meters). By holding the Texture raster constant and increasing the size ratio from 1 to 2, we can decrease the size and spatial detail of the output Terrain raster while preserving the detail level of the texture image.

This RGBI display uses a high-resolution panchromatic band as Intensity and three lower-resolution color bands (previously resampled to match the Intensity raster) to provide a highly detailed "natural" color image.



Initial size settings for the Terrain raster (above), and revised settings after increasing the Texture/Terrain size ratio (right).


Raster Type and Compression

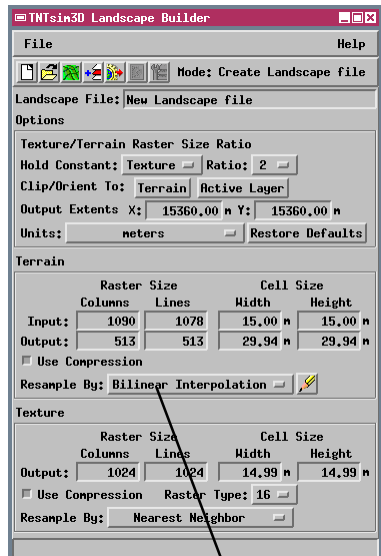
If you create Landscape Files covering large areas with a number of detailed textures, you will find that file sizes can quickly grow large. TNTsim3D has no problem handling large files (over 500 MB), but smaller files are more easily distributed. Aside from the dimensions of the texture and terrain rasters, two other settings in the Landscape Builder affect the size of the Landscape File: the raster type of the texture and compression of the texture and terrain rasters.

The Raster Type menu on the Texture panel lets you select the bit-depth of the texture raster. The choices are 24-bit (highest stored size), 16-bit, and 8-bit (least stored size). The 24-bit and 16-bit options produce a color composite texture raster with separate red, green, and blue values for each cell. When you select 8-bit, a color palette is created to assign color information to each raster value. The default setting is 16-bit, which provides a very wide range of possible colors with smaller stored size than a 24-bit texture. If you select the 8-bit option for color image textures you may see significant artifacts due to color reduction. But the 8-bit option can be useful if the texture is a grayscale image, as it provides an adequate range of gray levels with minimal storage requirements.

You can also achieve smaller file sizes by applying compression to the terrain and texture rasters. When the Use Compression button is turned on, a standard lossless compression is applied to the raster before it is stored in the Landscape File. Compression is most effective for texture rasters with large areas of uniform color, but you will see some benefit for nearly all rasters. Decompression in TNTsim3D is very fast, so using compressed rasters has minimal impact on its performance.

STEPS

- turn on the Use Compression toggle on both the Terrain and Texture panels of the Landscape Builder window
- press the Run icon button and name a new Landscape file and its objects 
- keep the Prompt window settings from the previous exercise



You can choose one of three standard resampling methods to use in creating the output Terrain raster. Only Nearest Neighbor resampling is available for the Texture raster. For information about these methods see the tutorial booklet *Rectifying Images*.

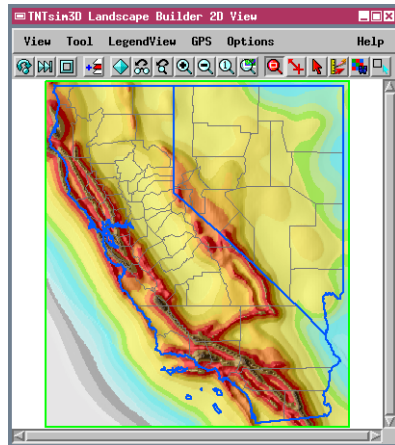
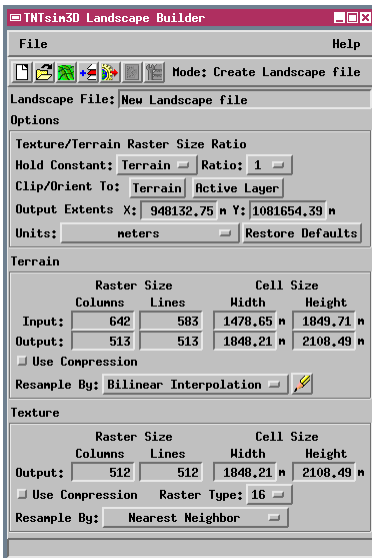
Be Creative with Terrain Rasters

STEPS

- press the New icon button and select raster CNPGA from the PGA Project File
- press the Add Layer icon button and choose Quick-Add from the menu
- from the PGA Project File, select (in order) raster objects SHADING and CNPGA and vector objects COUNTIES and STATES
- press the Run icon button and name a new Landscape File and its objects
- keep the Prompt window settings from the previous exercise

You aren't limited to land surface elevation rasters when selecting the terrain component for a landscape. The terrain raster you select can represent any smoothly-varying spatial quantity. The landscape you build in this exercise shows predicted earthquake shaking risk for the area of California and Nevada (USA). Specifically, it shows the peak ground acceleration that has a 10% probability of being exceeded during the next 50 years. The same raster is also used (with color palette) as part of the texture overlay. The highest values (shown in dark brown) are more than 180% of g (9.8 m/sec/sec, the normal downward acceleration of gravity).

If the cell values in your input terrain raster are small compared to the cell size (as in this example), you can increase the cell value scale for the raster using the Edit Object Information option in Project File Maintenance. For this exercise I set the cell value scale for the PGA raster to 500. As a result, significant relief appears automatically in TNTsim3D without adjusting its Vertical Exaggeration setting.



WARNING: Once you have created a landscape file, do not modify the terrain or texture raster using any other TNTmips process. Doing so will remove the special tiling and pyramid structure needed for proper operation of TNTsim3D.

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Advanced Software for Geospatial Analysis

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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 MicroImages' web site, or you can order TNTlite on CD-ROM.

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