3D LANDSCAPES

Tutorial

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 PRODATA / LANDSCP data collections.

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

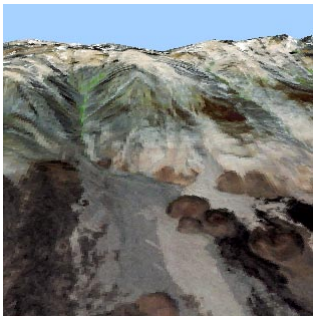
Randall B. Smith, Ph.D., 14 February 2002

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 the 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.

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 the texture raster.

STEPS

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

The exercises on pages 4-5 show you how to select input data for the terrain and texture components, and how to use mulitple layers to create a texture image. Different ways to control the extents and orientation of the landscape are discussed on pages 6-8. Pages 9 and 10 explain some special constraints on the sizes of output landscape rasters and the relative sizes of terrain and texture rasters. An example of using a terrain raster that does not represent earth surface elevations is provided on page 11.

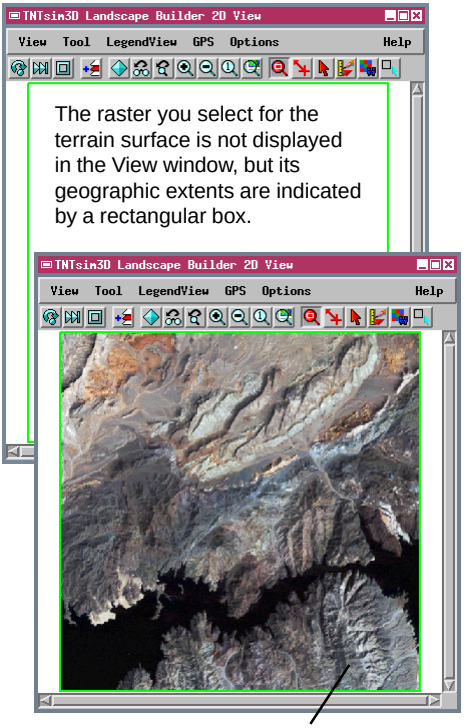
NOTE: This exercise can be completed in TNTlite.

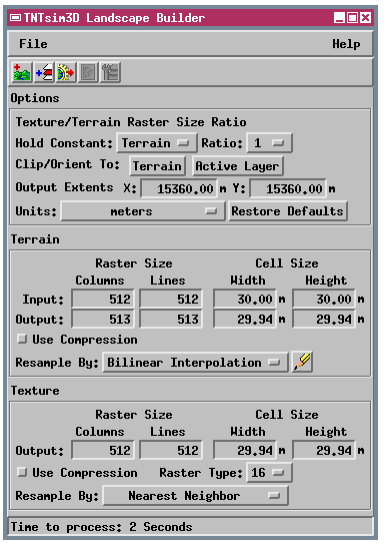
Make Your First Landscape

STEPS

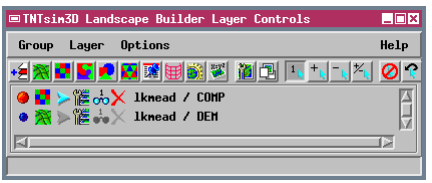
- ☑ press the Open Terrain icon button on the Landscape Builder window
- ☑ use the standard Select Object window to navigate to the LKMEAD Project File in the LANDSCP directory, and select raster DEM
- ☑ click the Add Layer icon button and select Quick-Add from the dropdown menu
- ☑ select raster COMP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

Let's begin by making a 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.





You can view the output landscape file in TNTsim3D, or view its rasters in the TNTmips Spatial Data Display process.



Texture from Multiple Layers

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.

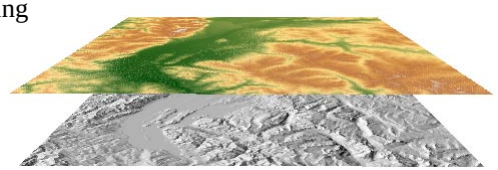
In the example used for this exercise, the simulation is created entirely from images derived from the elevation model (DEM) used for the terrain surface. Two raster layers are used to create the texture image. The first layer is a shading raster computed from the DEM using the TNTmips Slope, Aspect, and Shading process (accessed from the Process / Raster / Elevation menu). The second layer is simply a copy of the DEM with a custom color palette 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 terrain rendering to provide a very effective 3D perspective view of the terrain.

NOTE: pressing the Open Terrain icon button clears the Landscape Builder of any previously-selected data layers.

STEPS

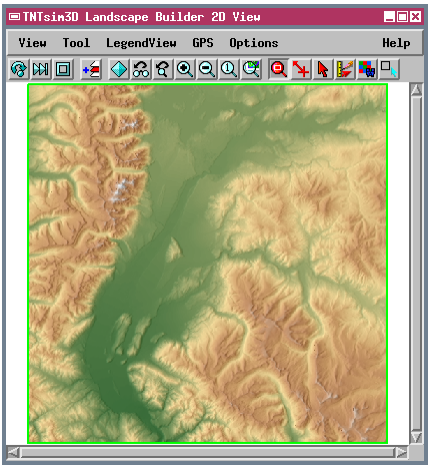
- ☑ press the Open Terrain icon button and select raster DEM from the TETON Project File
- ☑ press the Add Layer icon button and choose Quick-Add from the menu
- ☑ select rasters SHADING and DEMCOLOR (in that order) from the TETON Project File
- ☑ press the Run icon button and name a new *.sim file

Color Shaded Relief Texture Created From:

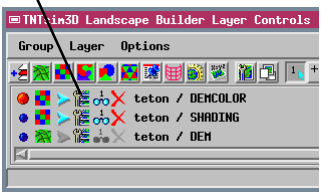


DEM with color palette with partially transparent colors

Shading raster



You can use the Edit Colors option from the Tools menu to examine and modify a raster layer's color palette.



Keep the current settings and continue to the next exercise.

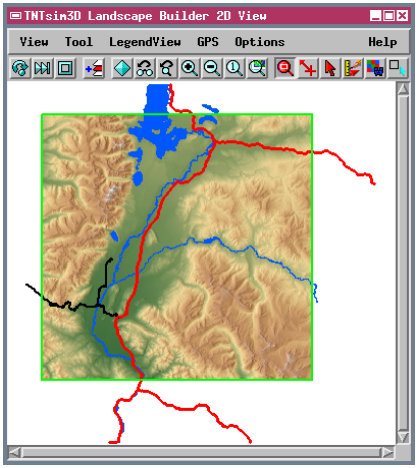
Clip / Orient to Terrain

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 *.sim file

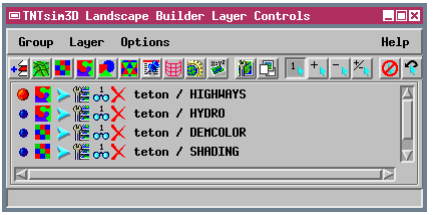
The input objects you select to build a landscape do not have to have matching extents, orientations, and map projections. Different projections are reconciled automatically by the process, and the Landscape Builder provides several ways for you to set the orientation and extents for the final landscape.

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.

Output texture raster automatically clipped to the terrain extents.

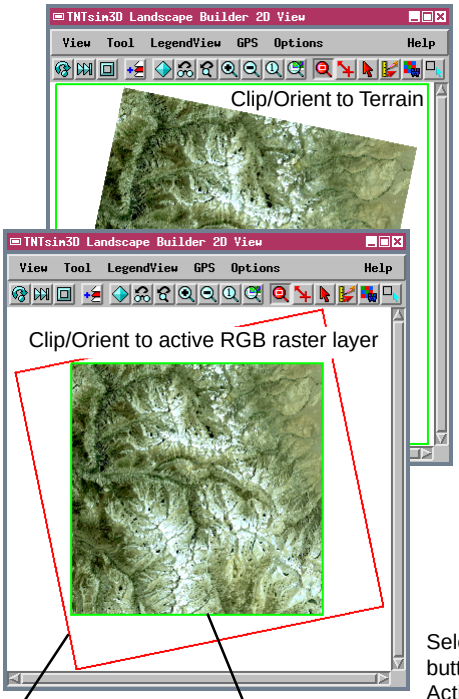


Clip / Orient to Active Layer

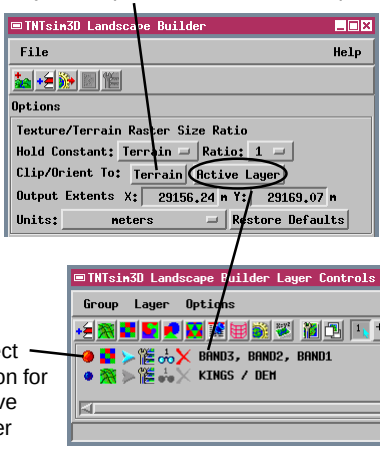
You can also clip and orient the landscape to any object you add as a texture layer. First make sure that the desired layer is the active layer in the view, then press the Active Layer push button to the right of the Clip/Orient To: entry on the Landscape Builder window's Options panel. In this exercise 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 automatically the active layer (indicated by the red color of the Layer Select button to the left of its entry in the Layer Controls window). 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 Open Terrain 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 *.sim file



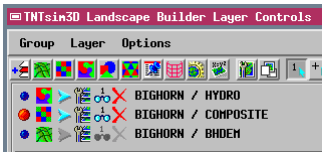
You can use the Clip/Orient To: Terrain button to resume using the terrain layer to clip and orient the landscape.



Set Output Extents Manually

STEPS

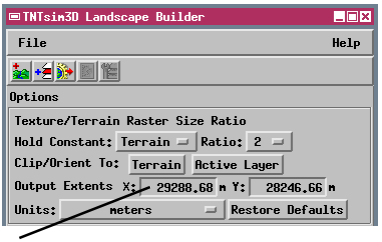
- ☑ press the Open Terrain icon button and select raster BHDEM from the BIGHORN Project File
- ☑ press the Add Layer icon button and choose Quick-Add from the menu
- ☑ select raster object COMPOSITE and vector object HYDRO (in that order) from the BIGHORN Project File
- ☑ in the Layer Controls window,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



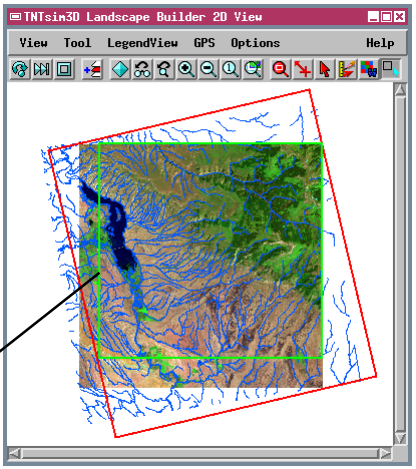
- ☑ press the Active Layer push button in the Landscape Builder window
- ☑ click the Output Extents icon button in the View window toolbar
- ☑ with the mouse, left-click and drag the left and bottom sides of the Output Extents box inward until the lower left corner is inside the Terrain Extents box
-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

In some cases none of the automatic clip/orient options may 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 used the automatic clip/orient to active layer option 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.



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

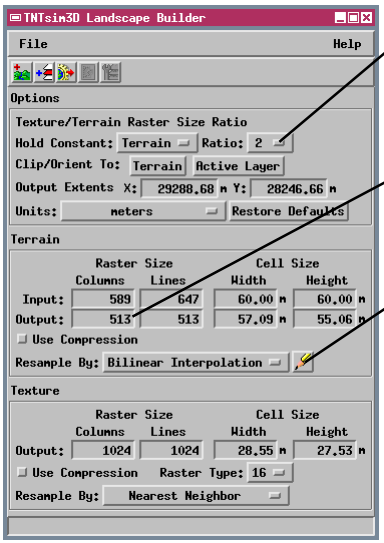
If you were watching the Landscape Builder window closely as you performed the steps on the previous page, you may have noticed that the setting on the Ratio menu changed from 1 to 2 when you changed the clip/orient setting. This menu sets the size ratio between the output texture and terrain rasters. The ratio pertains 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)
- ☑ note the raster and cell sizes for the output Terrain and Texture rasters
- ☑ press the Run  icon button and name a new *.sim file

The default 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 open 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.

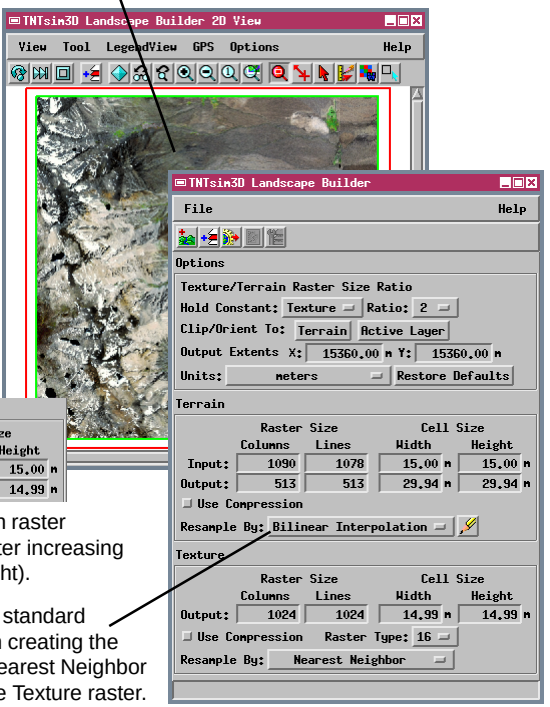
Using Texture/Terrain Size Ratios

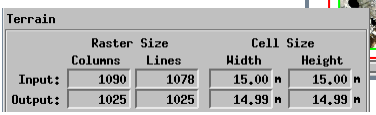
STEPS

- ☑ press the Open Terrain 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
- ☑ press the Run icon button and name a new *.sim file

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).

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.

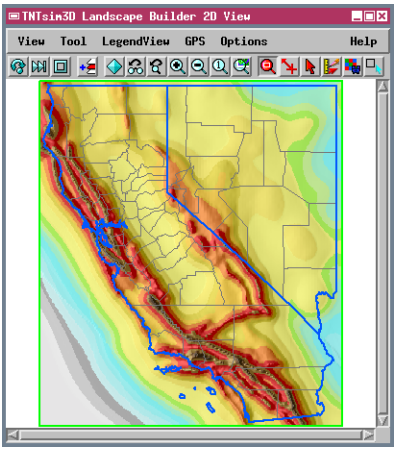
Be Creative with Terrain Rasters

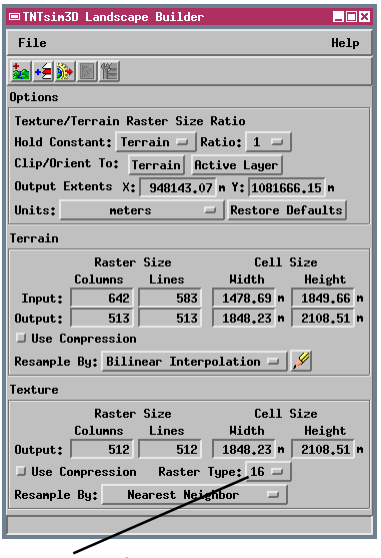
You aren't limited to land surface elevation rasters when selecting the terrain component for a landscape. The terrain raster you select can represent any smoothly-varying spatial quantity. The landscape you build in this exercise shows predicted earthquake shaking risk for the area of California and 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.

STEPS

- ☑ press the Open Terrain 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 *.sim file





You can set the output Texture raster to be a 24-bit composite, 16-bit composite, or 8-bit composite raster.

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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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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