Overview

Geospatial data that you obtain for use in your projects may be provided without georeference information or with nominal georeference that may not be accurate enough for your objectives. The Georeference process in TNTmips has been designed with an intuitive and flexible interface to let you efficiently carry out various georeferencing tasks, including:

- georeference spatial objects that have no prior georeference
- improve or replace previous georeference information
- automatically generate many georeference control points for an image using a reference image
- use reference objects in any coordinate reference system
- set up simple georeference for images and implied georeference for geometric objects
- snap control points to elements in a geometric reference object
- snap control points to intersections of a virtual map grid
- import GPS points as control points.

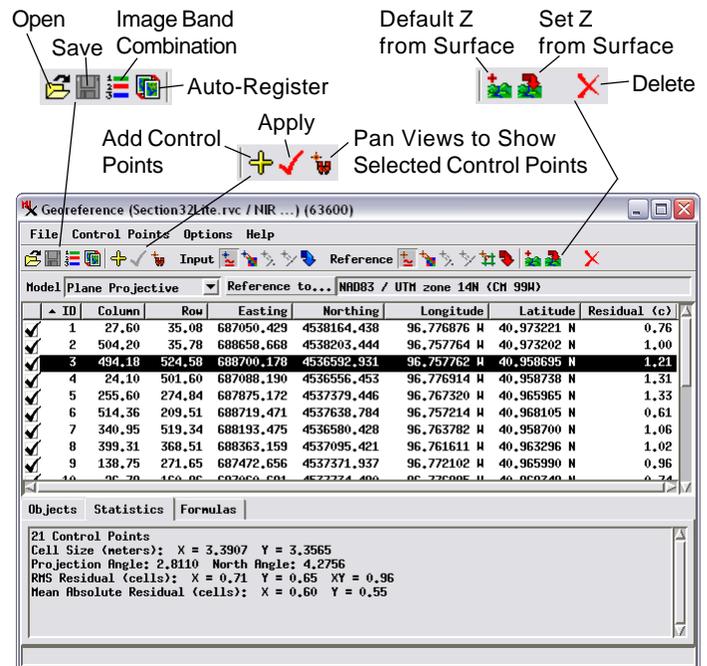## Input Data and Georeference Types

You can use the Georeference process to georeference any type of spatial object (raster, vector, CAD, TIN, shape) including external files in any format that can be directly used in the TNT products (TIFF, JP2, shapefile, ...). You can simultaneously georeference multiple bands of multispectral images and view any single band or combination of the image bands while georeferencing (see the Technical Guide entitled *Georeference: Multiband and Multiresolution Images*, which also describes how you can easily transfer georeference between band sets of multiresolution images).

The input data layer is automatically displayed in the Georeference Input View (see illustration to the right). This view includes all of the familiar controls and tools provided with standard view windows in the TNTmips Display process. The Georeference process also provides icon buttons for a number of specialized tools (described below) for creating georeference control points.

You can also set up georeference information that does not require multiple control points: Simple Georeference for raster images and Implied Georeference for geometric objects. As described in the TechGuide entitled *Georeference: Simple and Implied*, procedures for creating these georeference types are integrated into the normal workflow of selecting an input object and defining georeference parameters.

Reference Data

You can use any type of spatial object as a visual reference layer to provide the reference (map) coordinates for your control points. When you use an image as a reference, you can use a single grayscale raster, an RGB display of separate image bands, or a color composite raster. This image can be in a TNT Project File (standard raster object or TNT tileset raster), in a external file in any format supported for direct use (GeoTIFF, GeoJP2, MrSID, ...), or in a standard web tileset structure (Google Maps, Google Earth, or Bing Maps) on your local network or on the web. Thus you can use any MicroImages' sample web tileset, such as the global 10-meter

Open — Save — Image Band Combination — Auto-Register — Add Control Points — Apply — Pan Views to Show Selected Control Points — Default Z from Surface — Set Z from Surface — Delete

The Input View (below left) automatically displays the input spatial object(s). You can use the Options menu on the Georeference window to open a separate Reference View to display one or more reference objects. By default these views are geolocked by scale and position once sufficient control points are defined. When you hover the mouse cursor over a control point, a DataTip shows residual values for the point. Control points are shown in a separate layer in each view, either of which can be toggled on/off as needed.
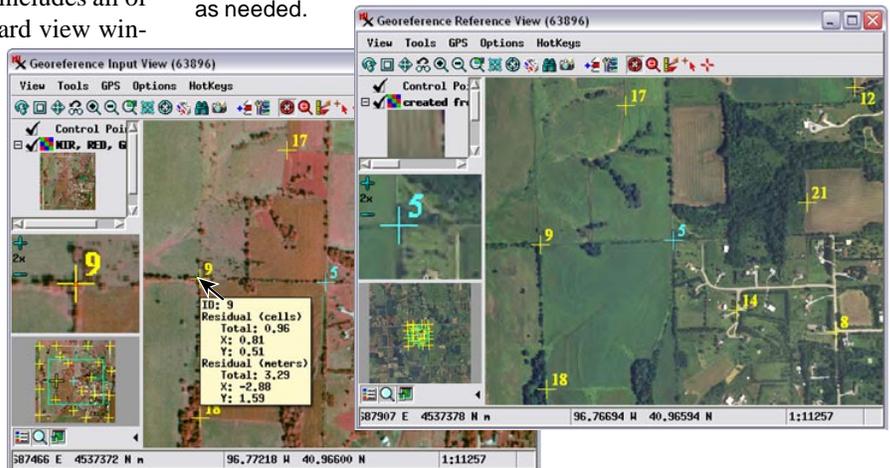

Landsat tileset or one of the USA state orthoimage tilesets, or your own image tileset, to provide a reference image for georeferencing.

A Reference View to display one or more reference layers can be opened using the Options menu on the Georeference window. A Crosshair tool is provided in each view to allow you to manually designate corresponding control point locations in the input and reference views (see illustrations on the reverse). Turning on the crosshair tool in one of the views automatically turns it on in the other. You can drag the crosshair intersection with the mouse to reposition it and drag a crosshair line to rotate the crosshairs.

If the input is at least minimally georeferenced, a reference layer can be added directly to the Input View. This option is particularly useful when you are using a geometric object as a reference for an input image. The reference geometric object can be overlaid directly on the

Crosshair tool (yellow lines) in the Input View (left) and Reference View (right) being used to set the input and reference coordinates for a new control point. The Input View crosshair has been rotated to align with the intersecting roads in the image.

input so you can visually relate line intersections, points, and other features in the geometric object with corresponding features in the input. You can also display input and reference images together in the Input View. Special raster overlay modes are available to display the input and reference image with transparency and in different colors so you can see both images at the same time and identify corresponding feature in each. You can also display both images in their normal colors and use the layer controls to show/hide the overlaid image to compare features. The raster/raster overlay modes can be selected from the Options menu on the Input View.

When the reference object is displayed in the Input View a Tiepoint tool is provided to let you graphically create control points. This is an elastic line tool with a "+" symbol marking the input object position and an arrowhead marking the reference position. Click

and drag to place the tiepoint line beginning with the "input" end of the line.
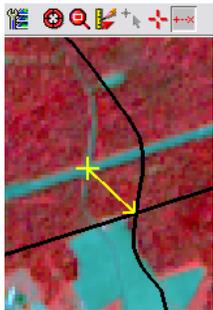
Input View with a geometric object with roads (black lines) being used as a reference object for an input image (shown with color-infrared display). The Tiepoint tool (in yellow in this illustration) is used to graphically place control points when input and reference objects are overlaid in the Input View.

Auto-Register Image to a Reference Image
When you are georeferencing an image and have a reference image of similar or higher resolution available, you can use the Auto-Register operation in the Georeference process to automatically generate hundreds to thousands of control points within a specified residual limit. This operation is described in the TechGuide entitled *Georeference: Auto-Register to Reference Image*.

Setting Initial Georeference Parameters
When you select an object or set of objects to georeference, the process first checks each input object for an existing georeference subobject. If each input object has a single georeference subobject and all are equivalent, these georeference parameters are automatically loaded. If different georeference parameters are detected, a dialog window prompts you to either select the georeference to edit or to skip the existing georeference in order to create a completely new georeference subobject.

If you are starting with no georeference, a sequence of dialog windows appears so you can set up necessary georeference parameters.

The Coordinate Reference System window appears first, enabling you to designate the coordinate reference system (CRS, consisting of datum and coordinate system) to use to georeference the object. This is the standard dialog window used throughout the TNT products for this purpose (see the Technical Guide entitled *Coordinate Reference System Window*).

Once you have set the CRS, the *Select georeference model* window appears (see illustration below). A number of mathematical models are provided to relate the distribution of control points in object coordinates to their distribution in map coordinates in the CRS you have selected. The dialog window provides a brief explanation of each model to aid you in selecting a model appropriate for your input object (see the TechGuide entitled
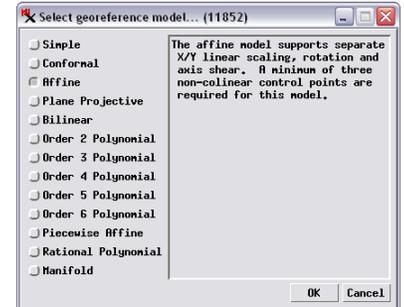
Georeference: Choosing a Model). Simpler models requiring fewer control points are listed at the top of the list. Once you have more control points than the minimum for the selected model, the geoference process computes a global best fit between object and map coordinates and computes residuals for each control point.

You can change the spatial reference system (CRS) at any time as you work by pressing the *Reference to* pushbutton on the Georeference window. You can specify whether to convert existing points to the new CRS or to keep the current values (in the rare case when the old CRS was incorrectly specified and the existing points are actually in the new CRS). You can also change the residual model at any time by making a selection from the Model menu.

Editing and Adding Control Points
The Georeference process has two overall modes for working with control points. When you have loaded a partially-georeferenced object, the default mode allows you to edit the existing control points. To edit points graphically, select an entry in the control point list and turn on the available graphic tool (Crosshair if you are working with a Reference View, or Tiepoint tool if you have overlaid input and reference). You can also edit the input or reference coordinates for the selected point directly in the control point list (see the TechGuide entitled *Georeference: Control Point List*).

To add new control points, press the Add Control Points icon button (a toggle) in the Georeference window's toolbar (this mode is activated automatically when you load an ungeoreferenced input object). You can then use the Crosshair or Tiepoint tool to place new control points. The georeference process provides several modes that are available to assist you in placing points. The Input and Reference toolbars provide icon buttons indicating the current "helper" mode. Using the default mode of Estimate from Model, when you use one of the graphic tools to set either the input or reference coordinates, the other pair of coordinates are automatically estimated using the current model and shown in the control point list; you can accept these or use the tool to set your own. Other helper modes are provided to snap control points to reference elements or to a virtual reference map grid, as described in the TechGuide entitled *Georeference: Snap Control Points to Elements or Reference Grid*.