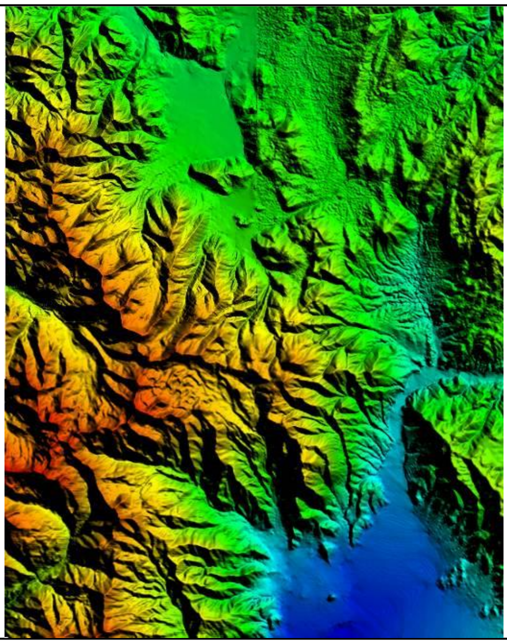
GMS

v. 10.0

GMS 10.0 Tutorial

Rasters

Using rasters for interpolation and visualization in GMS



Objectives

Learn how GMS uses rasters to support all kinds of digital elevation models and how rasters can be used for interpolation in GMS.

Prerequisite Tutorials

- Geostatistics – 2D

Required Components

- None

Time

- 15-30 minutes

1 Introduction

Rasters are regularly spaced, gridded data. An image is therefore a raster, but, in GMS, the term “raster” is typically used to refer to an image that has elevation data. A Digital Elevation Model, or DEM, is a raster and is used to represent the surface of a terrain. A raster doesn't have to be a DEM and the values at each pixel don't have to represent elevations. They can represent anything—concentrations, flow rates, etc.

DEM data is useful when building a groundwater model because it can be used to determine the ground surface elevation and the elevation of features on the surface such as drains and streams. DEMs can also be used to represent the geologic layers beneath the surface, or they can be used like scatter points to represent any 2D dataset such as concentration of a contaminant in X and Y.

Raster data is usually quite dense and can consume a considerable amount of disk space and memory. Although a raster could be represented using the 2D object types in GMS (TIN, 2D Grid, 2D Mesh, 2D Scatter Points), due to the large amount of data, rasters are rendered as images. This requires less memory and allows for fast rendering. The disadvantage with this approach is that the raster is only visible in plan view and is not a true 3D surface.

In this tutorial, it will be necessary to import some DEM files around the area of Park City, Utah, and use the DEMs in various ways.

1.1 Outline

Here are the steps of the tutorial:

1. Import some DEMs.
2. Change the display options.
3. Interpolate to scatter points.

4. Interpolate to MODFLOW layers.

5. Interpolate to feature objects.

6. Convert the DEM to scatter points.

7. Create a raster from scatter points.

2 Getting Started

Do the following to get started:

1. If necessary, launch GMS.

2. If GMS is already running, select the *File* | **New** command to ensure that the program settings are restored to their default state.

3 Open the Starting Project

Start by opening a project that has some existing data.

1. Select the **Open** button.

2. Change the directory to view *Tutorials\GIS\Rasters.*

3. Select the file "start.gpr."

4. Select **Open**.

This project contains a TIN and a coverage but they are both turned off so nothing appears in the Graphics Window. The project also has the projection set to UTM.

4 Importing LiDAR Data

Now it is possible to open a DEM containing LiDAR data. LiDAR data is typically very dense.

1. Select the **Open** button.

2. In the *Open* dialog, change the *Files of type* to "Raster/DEM Files."

3. Change the directory to view *Tutorials\GIS\Rasters.*

4. Select the file "LiDAR1.asc."

5. Click **Open**.

When the file opens, the user should see the data displayed as in Figure 1 below.

Note that in the *Open* dialog, the *Files of type* was set to "Raster/DEM Files." The extensions included in this list are the most common extensions for DEM files, but there are many others. If the user encounters a DEM file whose extension is not listed, the user can change the *Files of type* to "All Files (*.*)" and attempt to open it.

In GMS, a "raster" and an image are basically the same thing, but the raster icon in the Project Explorer is different from the image icon to indicate that the raster includes elevation data.

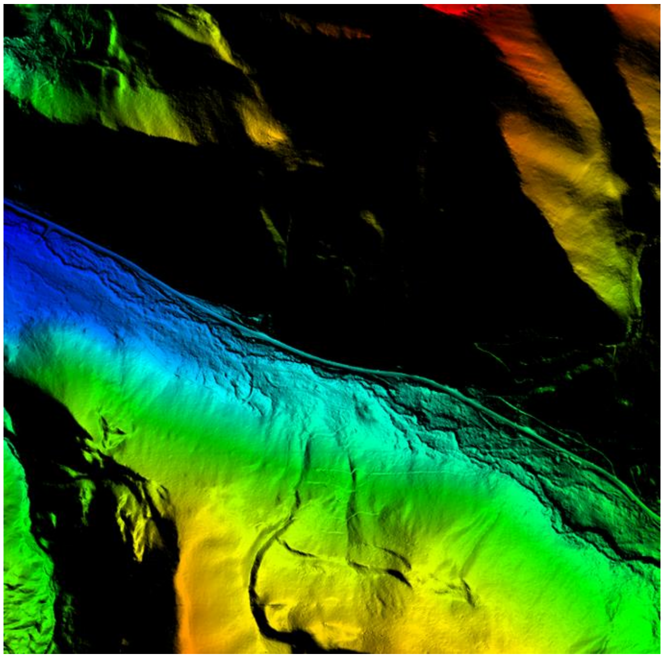


Figure 1 LiDAR data in GMS

5 Importing via Drag and Drop

Now it is time to bring in some more DEMs. It's often easier to just drag and drop the files into GMS.

1. Outside of GMS in a Windows Explorer window, open the *Tutorials\GIS\Rasters* folder.
2. Select the following files and drag them and drop them into the GMS Graphics Window (pay close attention to the file extensions as they aren't all the same):
   - Brighton.tif
   - HeberCity.tif
   - PkCityE.flt

- PkCityW.bil

The display should look like Figure 2 below.

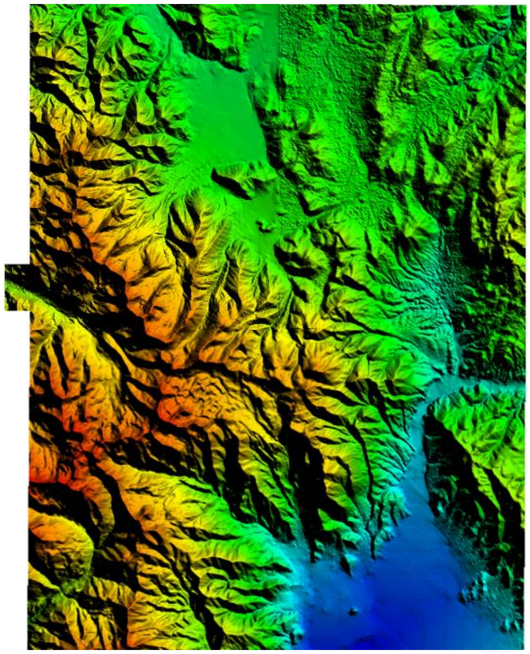


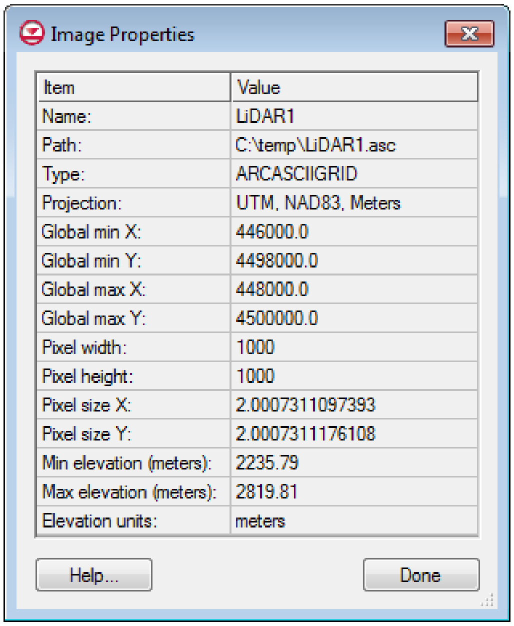
Figure 2 Multiple DEMs loaded into GMS

The DEMs were created in a geographic projection, meaning latitude and longitude, but GMS projects them on the fly to the UTM projection that GMS is already using so that they are displayed in the right place.

6 Viewing the Raster Properties

1. In the Project Explorer, right-click on the “LiDAR1.asc” item and select the **Properties** command.

This brings up the *Image Properties* dialog as shown in Figure 3.



Item	Value
Name:	LiDAR1
Path:	C:\temp\LiDAR1.asc
Type:	ARCASCIIGRID
Projection:	UTM, NAD83, Meters
Global min X:	446000.0
Global min Y:	4498000.0
Global max X:	448000.0
Global max Y:	4500000.0
Pixel width:	1000
Pixel height:	1000
Pixel size X:	2.0007311097393
Pixel size Y:	2.0007311176108
Min elevation (meters):	2235.79
Max elevation (meters):	2819.81
Elevation units:	meters

Figure 3 Image properties

Notice that the path to the file on disk is shown along with the image type, projection information, extents in X and Y, pixel resolution and size, and elevation data. Also notice that the raster type is ARCASCIIGRID and the pixel size is about 2 meters.

2. Click **Done** to exit the *Image Properties* dialog.

3. Now examine the properties of the other rasters.

Notice that the results are four different DEM types (ARCASCIIGRID, BIL, FLOATGRID and GEOTIFF) with three different pixel sizes (2m, 10m, and 30m) loaded into GMS.

7 Raster Display Options

The way rasters are rendered can be adjusted.

1. Select the **Frame Image** button to see all the raster data.

2. Select the **Display Options** button.

3. In the *Display Options* dialog, from the list on the left, make sure the *GIS* item is selected.

4. In the *Rasters* section, turn off *Enable hill shading*, and click **OK**.

Hill shading creates shadows which make the image appear 3D, despite the fact that it is really 2D. The user may want to repeatedly turn this option on and off to see how it works. The shadows associated with hill shading have nothing to do with the lighting model and light direction that is available with other 3D surface type objects in GMS. Thus, changing the lighting model will not change the hill shading.

5. Select the **Display Options** button.
6. In the *Display Options* dialog, from the list on the left, select the *GIS* item.
7. Under the *Rasters* section, change the *Shader* to “HSV Shader,” and click **OK**.

The user should try the other shaders to see how they look also. These options are currently the only display options available for rasters in GMS.

8. Go back to the *Display Options* dialog and select the *GIS* item in the list on the left.
9. Turn on *Enable hill shading*.
10. Set the *Shader* back to **Atlas Shader**.
11. Click **OK**.

8 2D vs. 3D

With hill shading on, the rasters appear to be 3D. However, it is just an illusion. A true 3D surface would require more memory and GMS has not implemented true 3D surfaces for rasters at this time.

1. Switch to the **Oblique View** tool.

Notice that nothing is displayed. Rasters, like images, are only rendered in 2D in the background while in plan view.

2. Switch back to the **Plan View** tool.

9 Downloading Elevation Data

Now it is necessary to download elevation data for the area using the Online Maps feature. The user must have an internet connection for this next section to work correctly. A separate tutorial explains more about the Online Maps feature.

1. Select the **Add Online Maps** button. The *Get Online Maps* dialog will appear.
2. In the dialog, select the thumbnail entitled “United States Elevation Data (NED) (10m Resolution).” The user may need to scroll to the right to see this item.
3. Select **OK**.

After a few moments, a new item will appear in the Project Explorer indicating that an online map is being downloaded. This map is different from the other available maps in that it contains elevation data. It is possible to right-click on this map and export it to a local file that can be used like the other rasters demonstrated in this tutorial. In the interest of time, it is now necessary to remove this item from project

4. Select the "United States Elevation Data (NED) (10m Resolution)" item from the Project Explorer, and then select the **Delete** command.

10 Convert Raster to Scatter Points

A raster can be converted to a 2D Grid and to 2D Scatter Points. First, the tutorial will take a look at conversion to 2D Scatter Points.

1. In the *Project Explorer*, right-click on the "PkCityW.bil" item and select *Convert To* **| 2D Scatter.**

2. In the *Raster → Scatter* dialog, change the *Num rows / columns to skip* to "1." Notice the number of scatter points that will be created decreases.

If the DEM data is very dense, it is often a good idea to reduce the number of scatter points in this way because scatter points use much more memory than DEM data.

3. Click **OK**.

A new scatter point set is created.

4. Switch to oblique view.

The user should now see what appears to be a 3D surface. If the user zooms in close, however, he or she will see it is really just a lot of individual points.

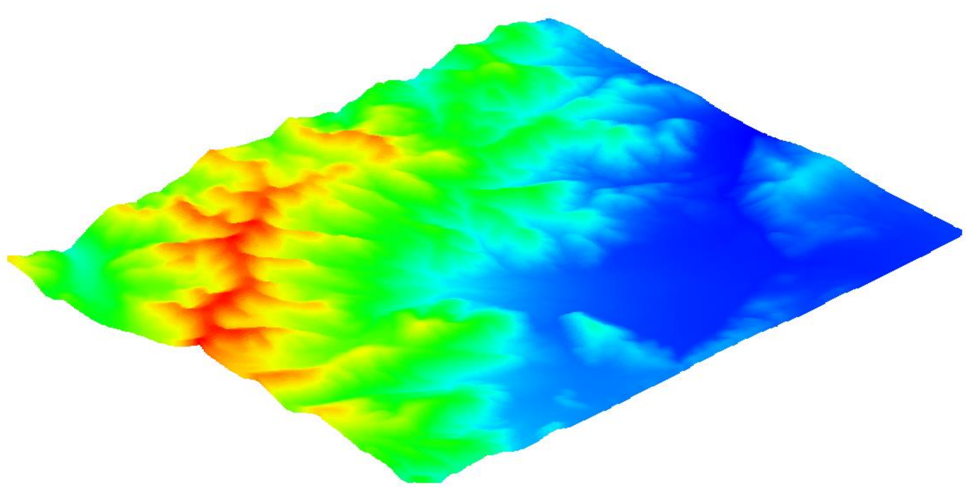


Figure 4 Scatter points in oblique view

11 Convert Scatter Points to Rasters

It is also possible to go the other way and convert scatter points to one or more rasters.

1. Switch back to plan view.

2. In the Project Explorer, right-click on the "PkCityW.bil" 2D scatter set and select the *Interpolate To* **| New Raster** command.

This opens the *Scatter → Raster* dialog. Here, the user can pick the interpolation scheme, the cell size of the raster, and how to define the boundary of the raster.

3. Click the **Interpolation Options** button.

This opens the *2D Interpolation Options* dialog—the same dialog that is always used to specify 2D interpolation options. All the interpolation methods can be used when interpolating to rasters, including whether the user wants to interpolate all time steps or just the current one. The data is not transient, so this option does not apply, but if it was and the user selected the *Use all time steps* option, the user would get a raster for each time step.

4. Click **Cancel** to return to the *Scatter → Raster* dialog.

If more than one dataset is associated with the scatter set, then the *Create rasters for* combo box can be used to specify all datasets or just the active dataset. If choosing all datasets, a separate raster will be created for each dataset.

The raster that these scatter points were created from had a cell size around 30 meters. The next steps will create a raster that is less dense by specifying a bigger cell size.

5. Change the *Cell size* to "100."

6. Make sure the *Scatter set extents* option is selected in the Raster extents section of the dialog.

It is possible to limit the extents of the new raster(s) by using polygons defined in a coverage. The raster will always be created as a rectangle, but if a polygon is used to define the extents, it is possible to optionally mask (inactivate) the areas of the raster outside the polygon. For this tutorial, just use the extents of the scatter points.

7. Click **OK**.

8. In the *Save As* dialog, accept the default name.

9. Click **Save**.

A new raster file is created on disk and automatically loaded into GMS. Let's compare it to the original raster it is derived from.

10. Turn off the "PkCityW.bil" 2D Scatter Data item.

11. Turn on and off the new raster (“default_idw_grad”).

Notice that the new raster is a lot less sharp than the original “PkCityW.bil” raster because when the user first converted the “PkCityW.bil” raster to scatter points, the user skipped every other row, and then the user chose a larger cell size when interpolating the scatter points back to a raster.

12 Interpolate to a TIN

The elevations of the raster can be interpolated to several other GMS data types. The next step is to interpolate to a TIN.

1. In the Project Explorer, select the “TIN Data” folder.
2. Select all the rasters in the Project Explorer.
3. Right-click on any of the selected rasters and select the *New Raster Catalog* command.

GMS uses a raster catalog to group the rasters together. Then GMS interpolates from the raster catalog to the TIN in order to create one dataset on the TIN using all the rasters in the catalog. If instead GMS interpolated using multiple selected rasters, the end result would be multiple datsets on the TIN, which is usually not wanted.

4. Right-click on the Raster Catalog and select the *Interpolate To* | **TIN** command.
5. Accept the default name and click **OK**.

The user should now see that the contours on the TIN match the elevations of the raster. Note that the TIN crossed over the boundaries of two rasters and that GMS used all the selected rasters to interpolate to the TIN.

13 Interpolate to Feature Objects

It is also possible to interpolate from rasters to the Z values of feature objects.

1. In the Project Explorer, right-click in the empty space and select the **Uncheck All** command to hide everything.
2. Turn on the “Map Data” folder.
3. Switch to *Front View* tool.

Notice that the feature objects in the coverage are all at an elevation of zero.

4. Select all the rasters in the Project Explorer.

5. Right-click on any of the selected rasters and select the *Interpolate To* **| Active Coverage** command.

The user should now see that the elevations of the feature objects in the coverage have been changed.

In this case the raster catalog wasn't used, although it could have been and the results would have been the same. Since coverages cannot have multiple datasets like TINs can, there is no need for using the raster catalog.

14 Interpolate to MODFLOW Layers

The "MODFLOW – Interpolating Layer Data" tutorial illustrates how to interpolate from scatter points to MODFLOW top and bottom layer elevation arrays. The user can also interpolate to MODFLOW elevation arrays using raster data.

1. Select the **New** button and choose **No** when asked to save the current project.
2. Select the **Open** button.
3. Go to *Tutorials\GIS\Rasters*.
4. Select "points.gpr," and select **Open.**

This project is similar to the one from the "MODFLOW – Interpolating Layer Data" tutorial, but instead of scatter points, it uses rasters. Notice that the MODFLOW model layers are completely flat.

1. Expand the "GIS Layers" folder to see the rasters.
2. Select all the rasters in the Project Explorer.
3. Right-click on any of the selected rasters and select the *Interpolate To* **| MODFLOW Layers** command.

This opens the *Interpolate to MODFLOW Layers* dialog. The mapping in the lower part of the dialog should already be set up. GMS automatically mapped the appropriate raster to the appropriate MODFLOW layer array based on the names of the rasters. For more information on this dialog, refer to the "MODFLOW – Interpolating Layer Data" tutorial.

4. Click **OK**.
5. Select the **Frame Image** tool to reposition the image.

Now see that the layer elevations are no longer flat.

The raster catalog could have been used in this case and the results would have been the same.

15 Conclusion

This concludes the tutorial. Here are some of the key concepts in this tutorial:

- Rasters are images with elevation data.
- Rasters, like images, are 2D and only drawn in the background when in plan view, but they can appear 3D if hill shading is enabled.
- Rasters can be downloaded using the Online Maps feature.
- Rasters can be converted to 2D scatter sets and 2D grids.
- 2D scatter points can be converted into rasters.
- Rasters can be interpolated to many other GMS object types.