Working with scenes in ArcGIS Pro - visualising the 3rd dimension

Scenario

Maps are typically displayed in 2 dimensions on a screen or sheet of paper, with elevation (the 3rd dimension) displayed as contours or sometimes hill-shading. A regular map user with interpret contour data with very little effort, whilst an occasional map user would likely misidentify contours and their meaning. GIS has the capability of turning elevation data into realistic 3 dimensional images, where the foreground can obscure the background. Such imagery is usually visually dramatic and immediately intuitive. In ArcGIS Desktop, there were three separate pieces of software. ArcScene was used for three-dimensional visualisation at a local level; ArcGlobe for 3-dimensional visualisation at continental or global scale; and ArcMap for 2-dimensional visualisation. In ArcGISPro, these three separate packages have been integrated within a single package.

In this exercise, we will use scenes to visualise the landscape around the Vale of Pewsey in Wiltshire, England. For environmental managers, the concept of landscape (the visual features of an area of land and their aesthetic appeal) is important in assessing the visual impact of developments. Many local authorities have developed landscape character maps, for example, showing the visual character of different parts of the landscape.

Data used in exercise

We will use several Ordnance Survey (OS) open data sets for this exercise. The supplied data are:

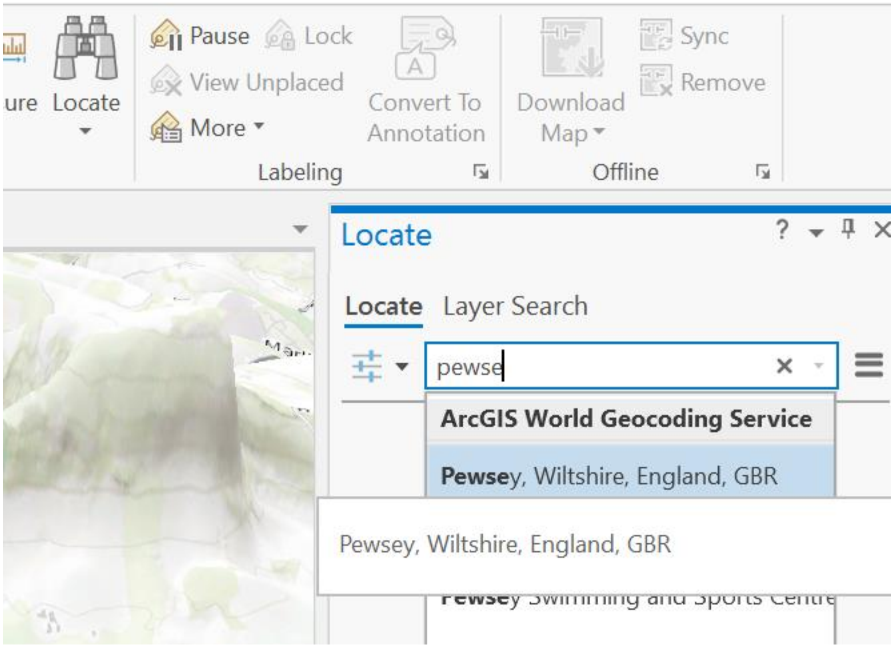
- **SU16DEM** – OS Terrain DTM 50 gridded elevation data (open data) in geotiff format
- **Buildingswilts** – OS VectorMap District open data with building outlines in shape file format
- **Roadswilts** – OS VectorMap District open data with roads in shape file format
- **Woodlandwilts** – OS VectorMap District open data with woodland areas in shape file format

Each map layer is in British National Grid coordinates. You can download data like this yourself, either via the Digimap service for British universities (https://digimap.edina.ac.uk/) or via the OS web site (https://osdatahub.os.uk/downloads/open).

1.1 Setting up a scene

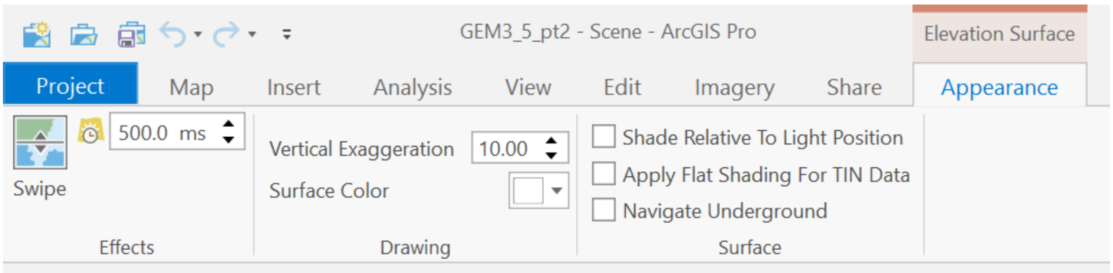
When you start up ArcGIS Pro, as a template, select a *local scene* (given that we will be generating 3-dimensional perspective views of a local area). It is probably also wise early on to activate the 3D Analyst and Spatial Analyst extension licences. To do this, head for the *project* menu, then *licencing*, then press *configure your licencing options* and make sure that these two are activated.

Next, we need to head for our study site – the small town of Pewsey in Wiltshire, England. Click on the *map* menu, then choose *locate*, and type in 'Pewsey'. ESRI's world geocoding service will then locate the place named Pewsey from a cloud-held database of placenames and their coordinates:



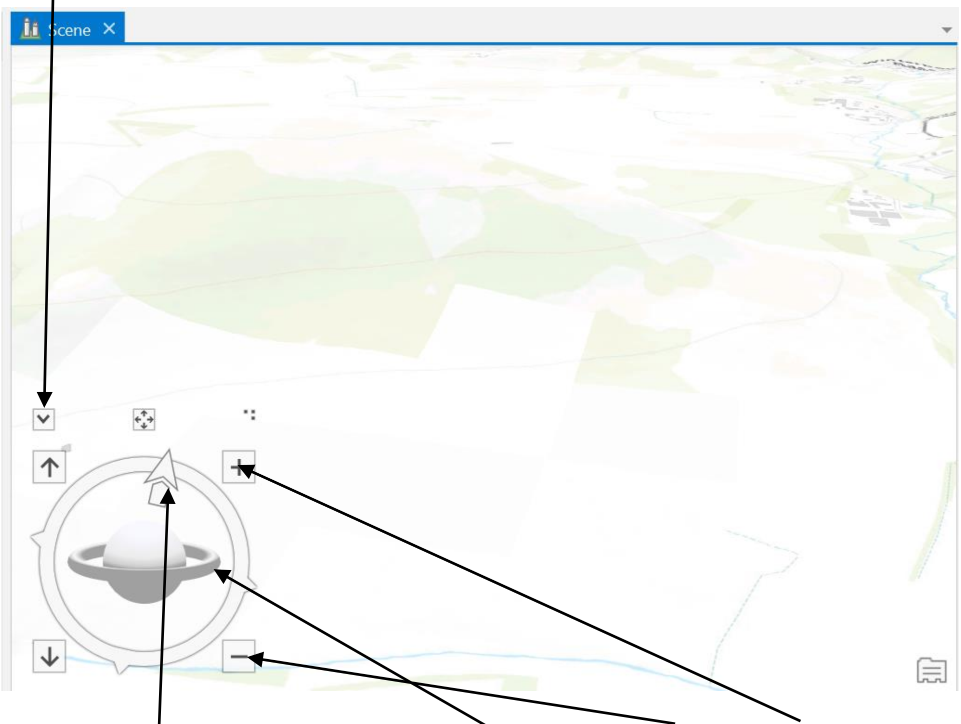
You should see several layers appearing automatically. Under 'elevation surfaces', ESRI will access a web-hosted elevation layer for the study site and use this to visualise the surface of the landscape. You should also see standard base-map layers appear, which will be draped over the landscape.

With a scene, it is a good idea to set a vertical exaggeration factor early on. This factor artificially increases vertical differences in height, which often necessary because vertical topographic differences in elevation are typically very small, relative to horizontal distances in a landscape. To do this, select the *ground* layer in the left-hand panel – you should see a context-sensitive *appearance* menu at the top of the screen. Click on this and set the *vertical exaggeration* to be **10**:



Optionally, you may also wish to select *shade relative to light position* too, which will add hillshading to your visualisation.

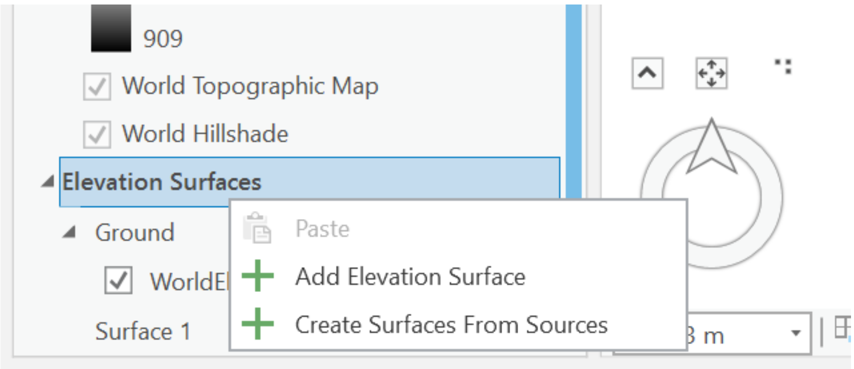
Now we have this set up, we can start to navigate around. You can use this button to see full navigation controls:



You can use your middle mouse button to zoom in or out, or these controls. This control sets the viewing angle and this one sets the 'tilt'. Play around and see if you can navigate around your landscape using the controls. You can also pan using the left mouse button too.

Hopefully, with a little experimentation, you should be able to see something like this:

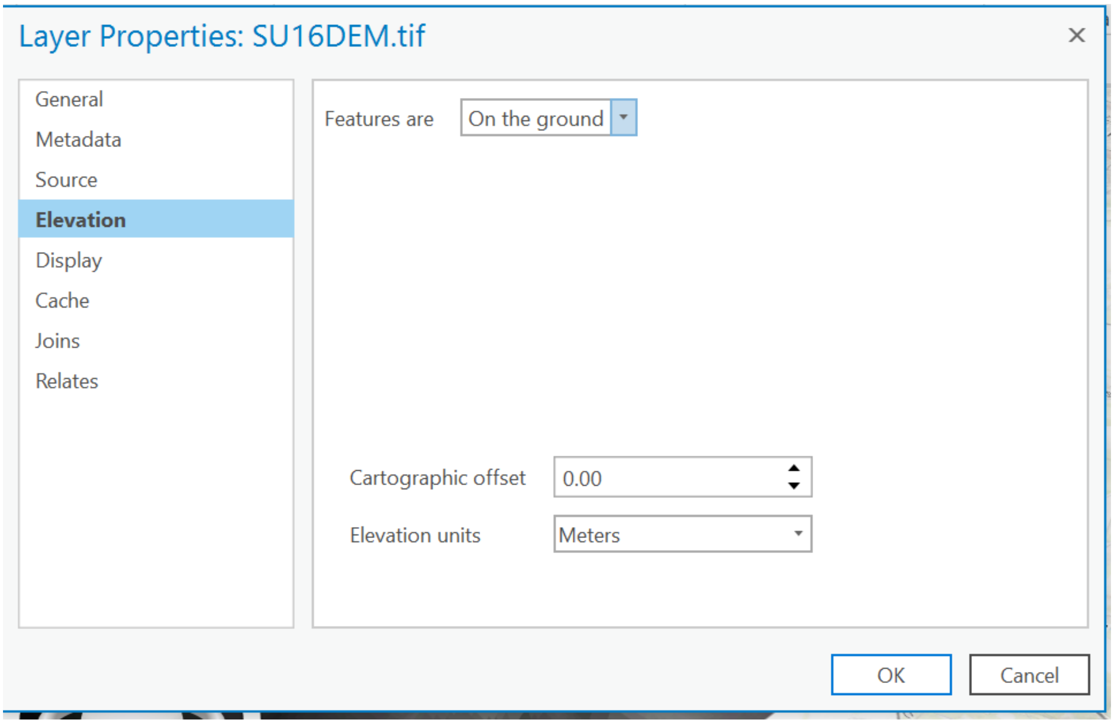
If you wish, we can also add in our own elevation data set to ESRI's cloud-held one. If you right-click on *elevation surfaces,* you can choose *create surfaces from sources* to add in your own custom elevation surface here. Let us try and load up our elevation surface here - **SU16DEM**. Note that you will need to set the file type to be *rasters (all local types)* to see this file since it is a geotiff:



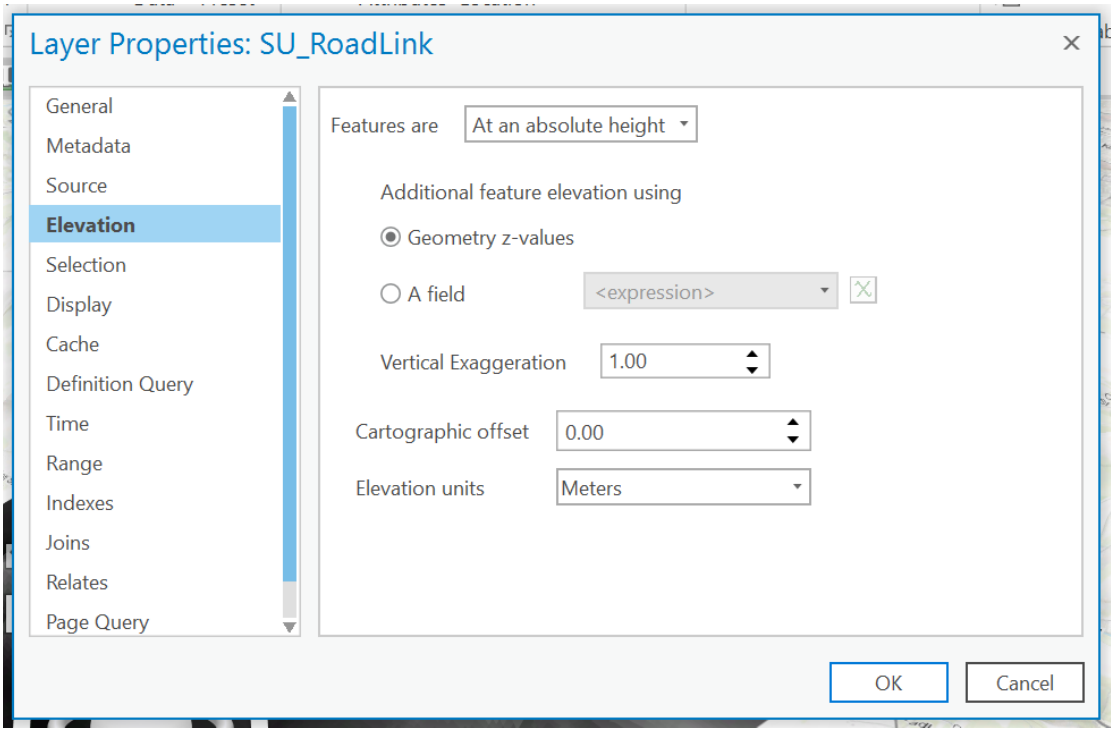
Where our custom elevation file is higher up the drawing order (i.e. nearer the top of the panel), it will be used in preference to ESRI's one in rendering the scene. You may want to set the vertical exaggeration for this layer to be 10, as you did with the ESRI elevation layer earlier via the *appearance* menu.

You can also drag and drop **SU16DEM** from the catalog pane on the right into the main display window. It should now appear as a 2D raster layer and appear 'draped' over the landscape. Whilst adding this particular layer of elevation may not add that much to our visualisation, clearly this could help us understand other map layers where terrain is of importance, such as a raster layer depicting solar radiation or even ambient noise levels. Note that if you right-click on our raster layer and choose *properties*, you can control how it behaves via its *elevation* properties. For example, adding a *cartographic offset* will raise the entire layer above the ground. Under 'features are', it is also possible to raise features above the ground, though in most cases *on the ground* is the appropriate setting.

You may wish to experiment with the symbology for the layer, perhaps making it semi-transparent, or perhaps turning off its visibility whilst we explore other layers.



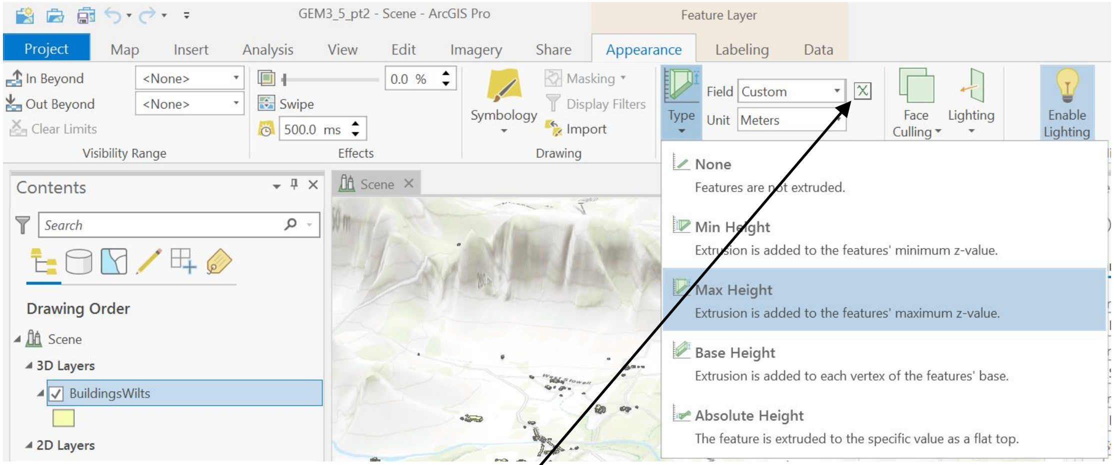
Now try adding in the layer **buildingwilts** to the display in the same way, dragging and dropping it from the catalog panel. This should be displayed as a 3D layer. Again, via its *properties* (accessible by a right-click on the layer in the left-hand panel), we can control how it behaves within the scene:



You can set a *vertical exaggeration* for this layer too, setting this to be **10** to match the exaggeration that we set for the underlying elevation layers. Other than this, we do not need to change any other settings, but will explain them here. Again, there is a *cartographic offset* option, which causes the layer as a whole to be raised up above the elevation surface if positive or sunk beneath it if negative. The *additional feature elevation using* setting indicates where elevation values for the layer come from. With a 3D layer, each vertex defining the shape of a line or polygon has not only X and Y coordinates but a Z (height) coordinate too. The setting *geometry z-values* means that heights will be taken from this coordinate information – the Z values. Alternatively, we could instead use elevation information stored in an attribute field of our choosing via this screen. Finally, the setting *features are….at an absolute height* tells us that the Z coordinates measure elevation from sea level (or more formally, what would be known as a vertical datum, a reference or base elevation level). There are other, less frequently used options in here, such as the height values being expressed relative to an elevation surface (e.g. if we knew the height of lampposts above the ground surface, but not their absolute elevation in metres above sea level).

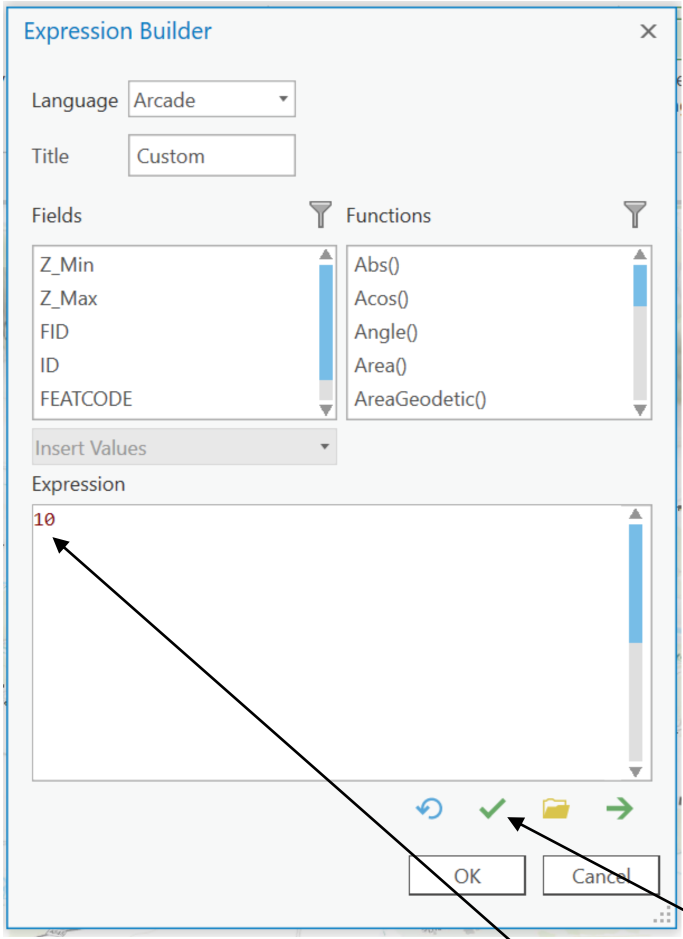
With 3D layers, further very useful visualisation functionality is accessible via the *appearance* menu at the top of your screen. Again, this is context-dependent and you will only see the menu if you have a 3D layer (such as **buildingswilts**) selected in the left-hand panel.

One really useful function on the *appearance* menu is the ability to extrude objects, in other words, make them ‘stand out’ from the underlying elevation surface:



If you click on *type*, you can set how our buildings will be extruded. I have chosen *max height*, which means for example that if a square building's shape is defined by four vertices, the extrusion of the building will occur relative to the tallest of these four corners. Other options are to use the *min height* (lowest-lying corner) or the 'base height' option, where the top of the building will follow the heights of each of its corners.

Under *field*, if we had an attribute field for the layer with building heights, we could use this to extrude each building by the height recorded in this field. As we do not, we will instead need to set a constant value, which we can do via the 'function' button:

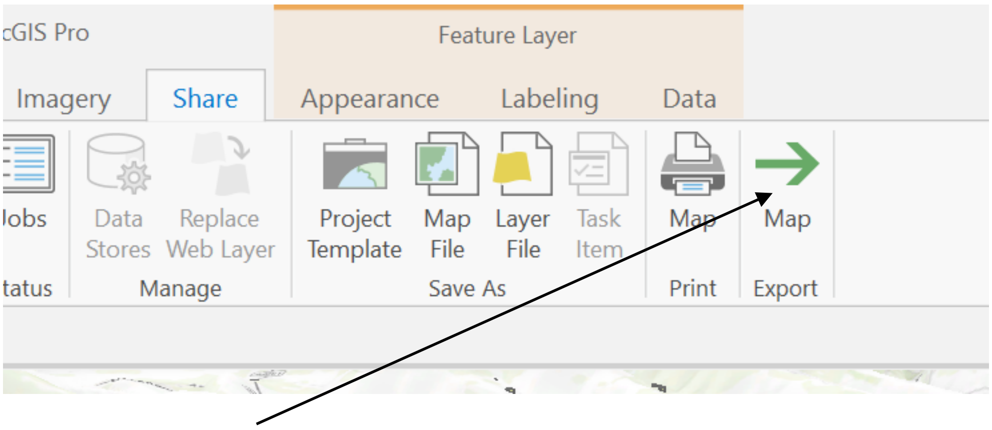


This button enables us to type in an expression. For example, we could extrude each of our buildings by a height of 10 metres. This button enables us to check that our expression syntax is correct before executing it.

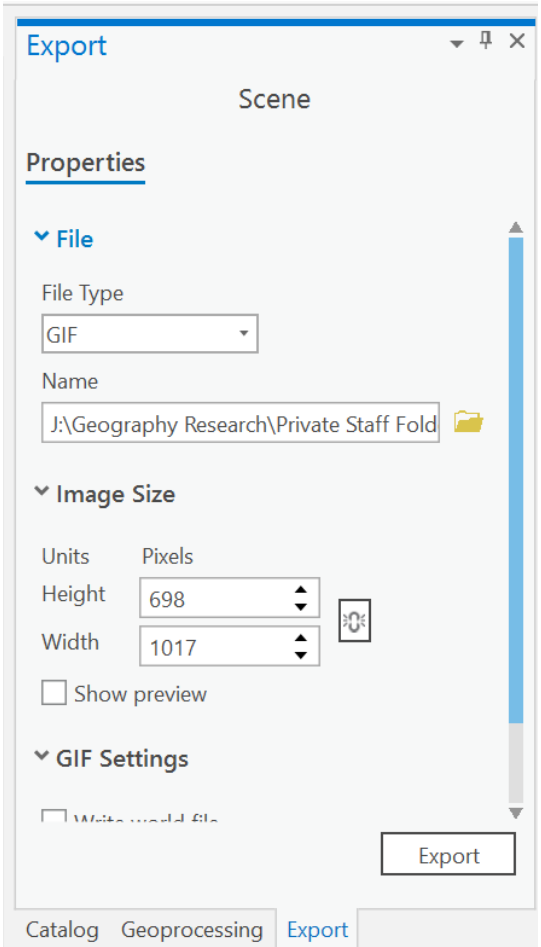
All being well, you should now see something like this, with the buildings extruded:

1.2 Adding a scene to a coursework report

There are also various options for sharing scenes you have created with others. For now, we will focus on exporting your scene for subsequent use in a report. To do this, first click on the *Share* menu:



Next, click on *map.* Finally, you should be able to choose a file type, such as a gif or jpeg and file name.

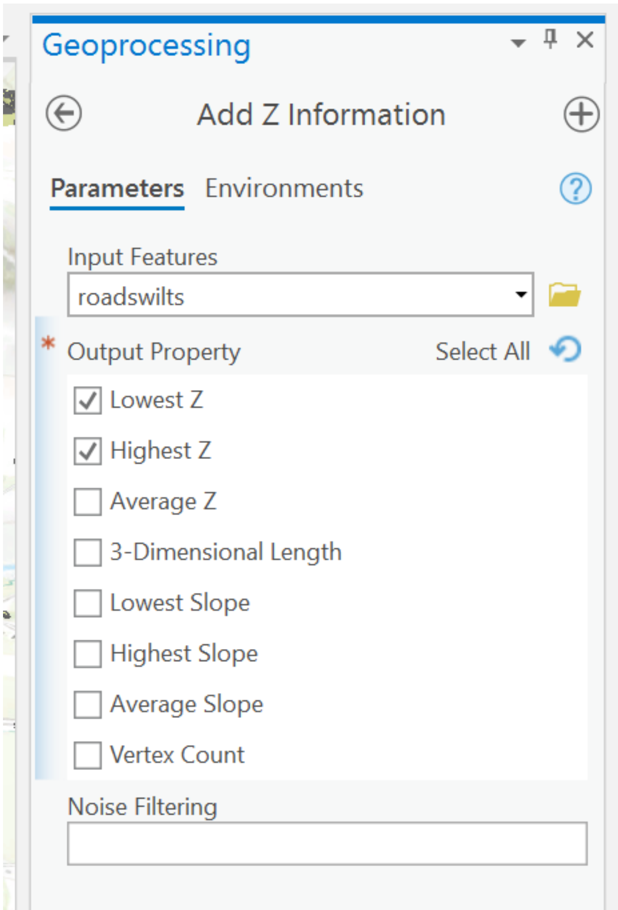


This can subsequently be imported from within Word by going to the *insert* menu in Word, choosing *picture* and then *from file*.

1.3 Trouble-shooting 3D map layers

Try loading up one of the other layers provided for this exercise, such as **roadswilts**. You may well find that it does not seem to feature anywhere on your display, and you may encounter similar issues when downloading and working with your own Ordnance Survey data or shape files from elsewhere. How can we fix such a problem?

One way of diagnosing this problem is to check the underlying Z coordinates, held in the geometry for the road shapes alongside their X and Y coordinates. To do this, head for the *analysis* menu and choose *tools* to pull up the geoprocessing panel. Next, search for 'add Z' to find the *add Z information* tool. This tool will add attributes to the shape file, based on the underlying Z coordinates. For example, we can take our layer and generate new attribute fields that contain the lowest and highest elevation (Z) values for the points making up each road line feature in **roadswilts**:

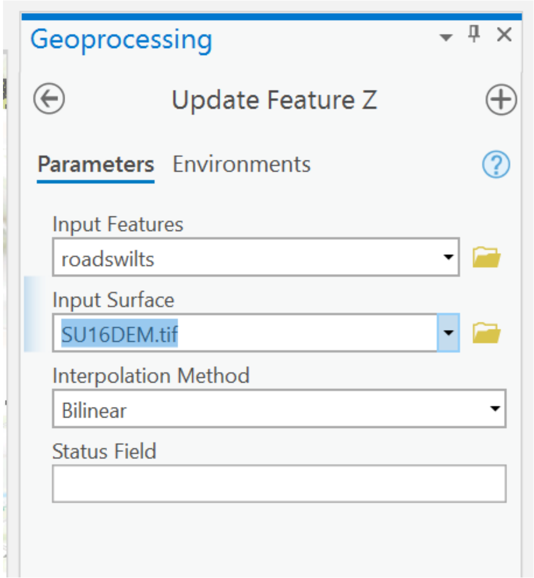


Try running the tool, then take a look at its attributes by opening up the attribute table (right-click on the layer after running the tool then choose *attribute table*). What do you see?

You should see a lot of zeros – something has gone wrong with the Z information for this layer.

Technical tip: many tools will not run if a layer's attribute table is open and you are using that layer as an input to a tool. Always close down a layer's table first before using it as an input to a tool!

To fix this, we need to run another tool on the layer. Go back to the geoprocessing panel again and this time, try searching for 'update Z' to find the *update feature Z* tool. This tool will update the Z values for a 3D map layer to reflect the elevation values in a second elevation surface layer of your choosing:



If you run this tool for **roadswilts** with the **su16dem** layer, it will take the elevation values from the OS elevation layer and add them to the Z coordinates for roadswilts. Note that optionally, before running the tool, you could open up the attribute table for the layer and use the *add* button at the top of the table to add a new number field (e.g. of type Long) called say **ZStatus**. If you set that field as the *status field*, then it would indicate whether or not a line feature in the layer had successfully been given new Z values (1=Yes; 0=No) – though of course, make sure you close down and save the attribute table before running the tool if you do this!

If you wanted to double-check whether the tool had worked as you expected, you could run *add Z information* again, but this time calculating say *average Z values*. Are they still zero or have they been updated?

You should find that this fixes up the problem with the roads layer, so that it displays correctly – do not forget to set its vertical exaggeration to be 10 though, to match everything else.

You may wish to experiment with trouble-shooting and then adding other layers to your visualisation, such as the **woodlandwilts** layer in much the same way.

There is a lot more that can be done with scenes, but this should give you a ‘quick start’ overview of some of the key functionality.