Setting up the viewshed geoprocessing service

Introduction

The CreateViewshed analysis tool of ArcGIS Online and Portal for ArcGIS requires a backend viewshed service to work. This document explains how to set up this service on your own in-house server using the viewshed script tool available in this package.

As illustrated in the following diagram, setting up the viewshed service involves the following steps:

1. Organize the elevation source rasters
2. Create an ocean surface elevation raster
3. Create mosaic datasets and boundary feature classes from the data source rasters
4. Add the mosaic dataset and the supporting datasets to a map document
5. Update the viewshed script tool to use the layers in the map document
6. Publish the viewshed service to ArcGIS for Server

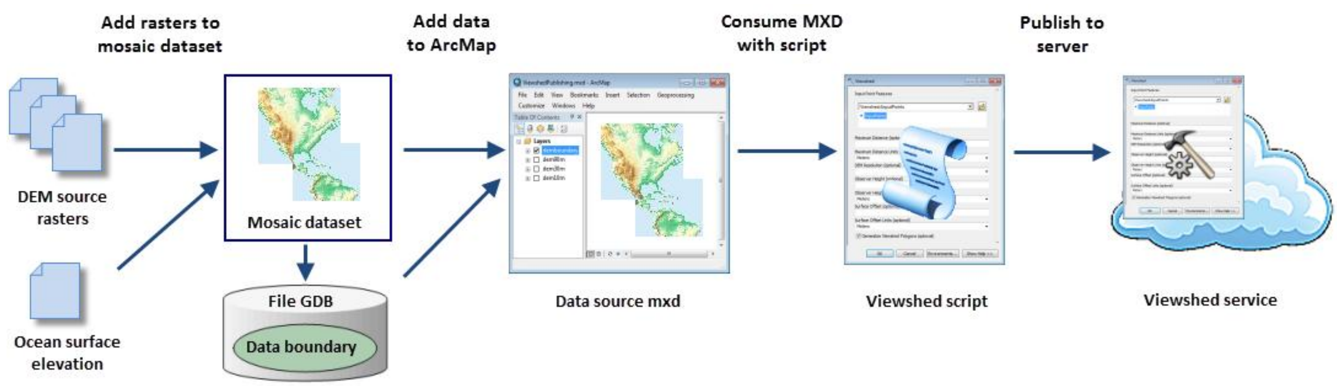

Fig 1. Workflow to create the viewshed service

Data requirement

The viewshed tool requires Digital Elevation Model (DEM) data and a few other supporting components. Following are details on the list of required datasets.

1. The **DEM source rasters**, which provides the elevation values for the viewshed calculation. If you don't already have elevation dataset you wish to use, various other elevation data products are available for this purpose, such as the National Elevation Dataset (NED) and Shuttle Radar Topography Mission (SRTM) data. Multiple resolutions can be available in a data product. For example, the NED data provides elevation data at 1 arc second (approximately 30 meters) and 1/3 arc second (approximately 10 meters).

If your organization has the [Data Appliance for ArcGIS]() from Esri, then the world elevation data from it—which includes SRTM and NED data at various resolutions—can be used as the data source for the viewshed tool.

2. An **ocean surface elevation dataset**. To incorporate ocean in the viewshed calculation, an ocean surface raster which has a constant value of 0 is needed. This can be created using Spatial Analyst tools.
3. A **mosaic dataset** for each DEM resolution. The individual elevation raster datasets for each resolution need to be added to a mosaic dataset. This mosaic dataset will be used as the input raster to the viewshed tool.
4. A **data boundary** feature class which describes the coverage of each DEM resolution. The data boundary features support the viewshed service in the following scenarios:
   - When the user specifies 'Finest' for the DEM Resolution parameter, the tool will query the data boundaries to find the best resolution available and use it to calculate the viewshed.
   - When the user selects a resolution other than 'Finest' for the DEM Resolution parameter, the tool will query the data boundary features to determine whether that particular resolution is available for the input area before calculating the viewshed. If the resolution is not available, the tool will return an error and will not execute.
   - During the calculation, the tool gets the metadata information from the data boundary features and returns it as attribute fields—such as Product Name, Source and Source URL—in the output viewshed.
5. A **data source map document** which contains all the necessary DEM layers and the data boundary layers in its Table of Contents (TOC). The viewshed tool uses the layers in this MXD document as the data source. This is also the work map document where you test the viewshed script before publishing it to an ArcGIS server machine. During the publishing process, the layers contained in this map document will be packaged and uploaded to the server.

Preparing the mosaic datasets and the map document

Folder structure and data organization
You will need to create the folder structure that stores all of the components required by the viewshed tool in one file system folder called Elevation.

The following image illustrates the required structure of the Elevation folder. It contains two sub folders, Data and Tools.

- The Data folder contains two sub folders: Layers and MD. The MD folder stores all the mosaic datasets (in Elevation.gdb) and the data boundary feature class (in Boundary.gdb). The Layers folder stores a layer that is used as the output viewshed symbology.
- The Tools folder contains the viewshed script tool and the utility toolbox that will be used in later steps.

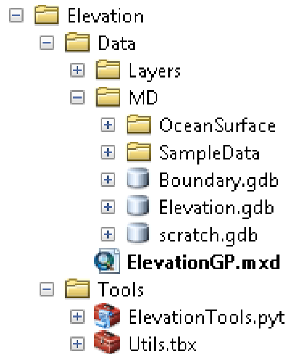

Fig 2. The contents of the Elevation folder

Organize the elevation source rasters

The source raster datasets for the viewshed tool should be organized by resolutions. For each resolution, the datasets should have the same cell size and spatial reference. Each resolution should have a separate workspace to store its raster datasets. The individual raster datasets will be added to mosaic datasets, which are then consumed by the viewshed tool. Before publishing the viewshed tool as a service, all of the individual raster datasets and the mosaic datasets should be moved to the server machine to be used as the elevation data source for the viewshed service.

Create the ocean surface elevation raster

The ocean surface elevation dataset is created as a single raster which will be added to the elevation mosaic datasets in later steps.

Steps:

1. Start ArcMap 10.3 or later.
2. Enable the ArcToolbox window.
3. Open the Create Constant Raster tool in the Spatial Analyst Tools » Raster Creation toolset.
   Note: You will need to have the Spatial Analyst licence enabled.
4. Specify the parameters and environment settings for the tool as follows:

Output raster	Save it as a Tif file (for example, oceanzero.tif) to the Elevation\Data\MD\OceanSurface folder.
Constant value	0
Output data type	INTEGER
Output cell size	0.05 *(Note: This value can be flexible, as long as this cell size is larger than any of the source raster cell sizes. Also, avoid creating a raster with a large number of rows and columns which could slow down the tool execution.)*
Output extent	Input an extent in decimal degrees. For example, for a global study area, you may specify the following values: left: -180, right: 180, top: 90, bottom: -90.
Output coordinate system	4326 *(Note: This is the EPSG code for the WGS84 Geographic coordinate system.)*

5. Click OK to run the tool.

Create the mosaic datasets

For each data resolution in your DEM source data, a mosaic dataset is created from the individual rasters.

Steps:

1. In ArcToolbox, open the Create Mosaic Dataset tool under Data Management Tools » Raster » Mosaic Dataset, and specify the following parameters:

Output Location	Save it to .\Elevation\Data\MD\Elevation.gdb
Mosaic Dataset Name	Provide a descriptive name, such as 'dem10m'.
Coordinate System	102100 *(Note: This is the EPSG code for the WGS 1984 Web Mercator Auxiliary Sphere coordinate system.)*

2. Leave the remaining parameters as default, then click OK to run the tool.
3. If you have more than one elevation resolution, repeat steps 1 – 2 for each resolution to create a new mosaic dataset for each of the resolutions.

Next, add the individual rasters to the mosaic dataset.

Steps:

1. In ArcToolbox, open the Add Rasters to Mosaic Dataset tool under Data Management Tools » Raster » Mosaic Dataset, and specify the following parameters:

Mosaic Dataset	Select one of the mosaic datasets that you created above.
Raster Type	Accept the default setting (Raster Dataset).
Input Data	Select the Workspace option. Then, browse to and add the workspace that contains all the individual rasters. Finally, browse to and add the OceanSurface folder (located under Elevation\Data\MD).

2. Leave the remaining parameters as default, then click OK to run the tool.
3. In the resultant mosaic dataset layer in the ArcMap TOC, right-click the Footprint layer, then select Open Attribute Table. Click on Table Options and select Add Field. Specify 'Best' for the Name and select Float for the Type, then click OK. Next, use the Field Calculator to calculate the value to [LowPS] * 10.
4. In the Catalog window, navigate to the mosaic dataset that you created above. Right-click it and select Properties to open the Mosaic Dataset Properties dialog.
5. Click on the Defaults tab. In Image Properties, locate the Allowed Mosaic Method setting, then click on ... to open the Configure Allow List dialog. Set the Default Method to By Attribute. Set the Order Field to Best. Click OK to close the dialog.
6. Still on the Defaults tab, in the Image Properties section, set the following properties according to the values in the table, then click OK to close the Mosaic Dataset Properties dialog.

Property name	**Value**
Maximum Size of Requests Rows Columns	 24000 24000
Default Compression Method (under Allowed Compression Methods)	LZ77
Default Resampling Method	Bilinear Interpolation

Maximum Number of Rasters per Mosaic	50
Always Clip the Raster to its Footprint	No
Footprints May Contain NoData	Yes
Always Clip the mosaic dataset to its Boundary	Yes

7. Click on the General tab. Under Raster Information, set Source Type to Elevation.
8. If you have more than one mosaic dataset, repeat steps 1 to 7 for each one to add rasters to them.

Create the data boundary feature class

The coverage of each data resolution is described by a data boundary feature, which follows the outline of the footprints of the mosaic dataset. The data boundary features are created by dissolving the footprints of the mosaic datasets. A utility geoprocessing tool is provided to facilitate this process.

Steps:

1. In ArcMap, load the mosaic dataset to the Table of Contents.
2. Open the geoprocessing tool Dissolve Footprint under Elevation\Tools\Utils.tbx.
3. Specify the following parameters for the tool:

Input Mosaic Dataset Footprint	Select the footprint layer in the mosaic dataset. For example, dem90m\Footprint.
Output Feature Class	Save it to the scratch gdb under Elevation\Data\MD using a descriptive name, such as boundary90m.
Data Resolution	Enter the resolution represented by the particular mosaic dataset. For example, 90.
Polygon Type	1
Product Name, Source, and Source URL	Specify some descriptive text for them. See the following screen capture for an example.

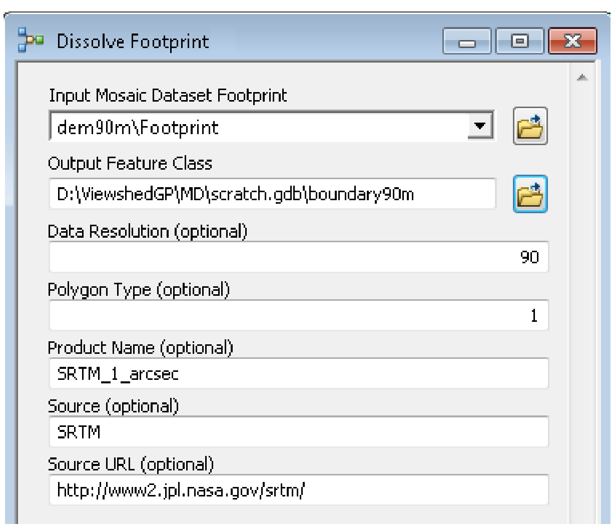

Fig 3. Example for Dissolve Footprint

4. If there is more than one mosaic dataset, repeat steps 1 to 3 for each of them and create a boundary feature class for each of them.

5. In ArcToolbox, open the Merge tool under Data Management Tools » General and specify all of the individual boundary feature classes created above to merge them into one. Set the Output Dataset location to Elevation\Data\MD\Boundary.gdb and name it 'databoundary' or some other descriptive name.

   The output boundary feature class should have the following fields:

Field name	Field type	Field length	Description
res	Short	n/a	Resolution in meters
polytype	Short	n/a	Polygon type (0, 1, or 2)
prd	String	50	Product name
src	String	50	Source name
srcurl	String	100	Source URL

   The following is an example of the data boundary feature class attribute table:

   databoundary

OBJECTID *	Shape *	dissolveid	res	polytype	prd	src	srcurl	Shape_Length	Shape_Area
1	Polygon	1	10	1	NED_1r3_arcsec	USGS	http://ned.usgs.gov/	516010.5978	16333349472.42
2	Polygon	1	90	1	SRTM	USGS, NASA, CGIAR	http://www.cgiar-csi.org/	738507.0566	32635048330.46

   Fig 4. A sample attribute table of the data boundary feature class

Create the map document

For performance considerations, all the mosaic datasets and boundary feature class are to be added to ArcMap and saved as a map document (.mxd). The viewshed tool will consume the layers in this map document instead of the datasets directly from disk because layers are faster for geoprocessing services.

Steps:

1. Open ArcMap as a new blank document.
2. Click the Add Data button, navigate to the Elevation\Data\MD\Elevation.gdb database, select the mosaic dataset for an elevation resolution, and then click Add to add it to the ArcMap TOC.
3. Repeat step 2 for all the other mosaic datasets that you created and add them to the TOC.
4. Click the Add Data button, navigate to the Elevation\Data\MD\Boundary.gdb database, select the 'databoundary' feature class, then click Add to add it to the TOC.
5. Rename the feature layer as 'databoundary_containment'.
6. Right-click the layer 'databoundary_containment' and select Properties to open the Layer Properties dialog.
7. On the Definition Query property page, click the Query Builder button to build the following query: polytype = 0 OR polytype = 1, then click OK to close the Layer Properties dialog.
8. Repeat steps 4 – 7 to add the data boundary feature class into the TOC again, rename the layer to 'databoundary_credit' and build the following definition query on the layer: polytype = 2 .
9. In ArcMap, click File » Map Document Properties, and check 'Store relative pathnames to data sources'.
10. Click the Save button and save the map document as ElevationGP.mxd under the Elevation\Data folder.

    After this step, the ArcMap TOC should look similar to the following screen capture:

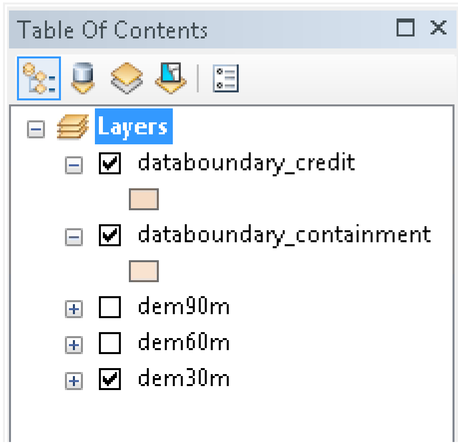

Fig 5. An example of the ArcMap Table of Contents window

Update the viewshed tool

Once the data is ready, you can update the viewshed tool script to point to the data. The implementation of the viewshed tool is found in the python toolbox ElevationTools.pyt. The portions of code that need to be updated are in the `__init__` functions for the Viewshed class and the Toolbox class in ElevationTools.pyt.

1. **Input observer schema feature class**
   Update the variable `self.observerSchema` to point to your own point feature class, or you can accept the default one. (This data is used as the schema for the first tool parameter on the viewshed script tool.)

```
#---------------------------------------------
#Input observer point schema
#---------------------------------------------
self.observerSchema = r"..\Data\MD\Boundary.gdb\obs_schema"
```

2. **Output viewshed symbology**
   To use a custom symbology for the output viewshed polygon layer, update the variable `self.outputSymbology` to point to your own layer file. You can also accept the default one.

```
#---------------------------------------------
#Output symbology
#---------------------------------------------
self.outputSymbology = r"..\Data\Layers\outputsymbology.lyr"
```

3. **DEM resolutions and the default resolution**
   Update the dictionary `self.dictDEMSources`. This dictionary provides the descriptions (the keys) for all the DEM resolutions. The keys will show up in the dropdown of the DEM resolution parameter on the tool dialog. Replace the key-value pairs in this dictionary with your particular DEM descriptions and resolutions. The DEM resolutions should be specified as integer values in the DEM XY units.

   Update the variables `self.defaultDEMResolution` and `self.defaultDEMMetadata`. The `self.defaultDEMResolution` variable defines the default resolution to use when the user omits the DEM resolution parameter. The `self.defaultDEMMetadata` variable defines the metadata for the default DEM resolution. The first string in the list represents the product name, the second string represents the source, and the third string represents the source URL.

```
#------------------------------------------
#DEM resolutions
#------------------------------------------
self.dictDEMSources = {"30m":"30", "60m":"60", "90m":"90"}
self.defaultDEMResolution = '90'
self.defaultDEMMetadata = ["SRTM", "USGS, NASA, CGIAR", "http://www.cgiar-csi.org/"]
```

4. **Data source layers**
   Update the dictionary `self.dictMosaicLayers`. This dictionary designates the DEM source layer for each resolution. Replace the key-value pairs in this dictionary with your DEM resolutions and the corresponding layer names. The DEM resolutions should be specified as integer values in meters.

```
#------------------------------------------
#Data source layers
#------------------------------------------
self.dictMosaicLayers = {'30':"dem30m", '60':"dem60m", '90':"dem90m"}
```

5. **Default and maximum radiuses**
   The variable `self.dictDefaultRadius` defines a default viewing distance for each resolution when the user omits the maximum distance parameter (the 2nd parameter on the tool). The variable `self.dictMaxRadius` defines a maximum viewing distance for each resolution when the input DEM resolution parameter is not 'Finest', and the `self.dictMaxRadiusFinest` variable defines a maximum viewing distance for each resolution when the input DEM resolution parameter is 'Finest'. Update these variables with your DEM resolutions and desired distance values.

```
#------------------------------------------
#default and maximum radiuses
#------------------------------------------
self.dictDefaultRadius = {'30':5000, '60':15000, '90':15000}
self.dictMaxRadius = {'30':15000, '60':30000, '90':50000}
self.dictMaxRadiusFinest = {'30':5000, '60':15000, '90':50000}
```

6. **Declare the data layers for the publisher**
   Finally, a code block needs to be added to the `__init__` function in the Toolbox class to declare the data layers. Each layer name is wrapped by an `arcpy.Describe` statement. These statements will never be executed, but they are mandatory for the publisher to pick up the layers during publishing. All the DEM mosaic dataset layers and the data boundary layers must be declared in this way. By default, there are three DEM data layers in the `arpcy.Describe` statements, remove the redundant ones if you have less than three DEM layers, or add new ones if you have more than three. Update the layer names in this code block with your own mosaic dataset layer names.

```
#-------------------------------------------
#Declare data layers for publisher
#-------------------------------------------
if False:
    arcpy.Describe("dem30m")
    arcpy.Describe("dem60m")
    arcpy.Describe("dem90m")
    arcpy.Describe("databoundary_containment")
    arcpy.Describe("databoundary_credit")
```

Publishing the viewshed tool as a geoprocessing service

Move the elevation data to the server machine and register it on ArcGIS server

The server machine that hosts the viewshed service needs a copy of the elevation data locally. This includes all the data under the 'Elevation\Data' folder and all the source raster datasets referenced by the mosaic datasets. (Avoid using an UNC path as the data path for a geoprocessing service because UNC path slows down the service.) The data needs to be registered in the server data store before you publish the service, so that it won't be copied by the publisher.

Steps:

1. Create a folder 'Elevation' on the hard drive of the server machine.
2. Copy the Elevation\Data folder (including all the data under it) from your local machine to the 'Elevation' folder that you created above on the server machine.
3. Copy all the source raster datasets referenced by the mosaic datasets to the server machine, if they are not on the server machine already.
4. After a mosaic dataset and all its source raster datasets are moved to the server machine, the path of the source raster datasets on the server machine is likely to be different from your local machine where you created the mosaic dataset. At this point, the mosaic dataset still stores the old path from your local machine, which needs to be repaired to point to the new path on the server. Perform the following steps for each mosaic dataset to repair its path:
    i. Share the 'Elevation' folder where the mosaic datasets were stored on the server machine. Grant yourself write access to the folder, so that you can modify its dataset properties.
    ii. On your local machine, in the ArcMap catalog window add a folder connection to the 'Elevation' folder on the server.
    iii. In the catalog window, expand the folder connection and navigate to a mosaic dataset, right-click it and select Modify >> Repair. This will open the Repair Mosaic Dataset dialog.
    iv. Adjust the Folder Paths Depth value, so that the full path to the source raster datasets is shown in the Old Path column (which shows the old path on your local machine). In the New Path column, enter the new path on the server. See the following screen capture for example (In this example, the source raster datasets are assumed to be saved in the folder 'c:\data\sampledata' on the server).

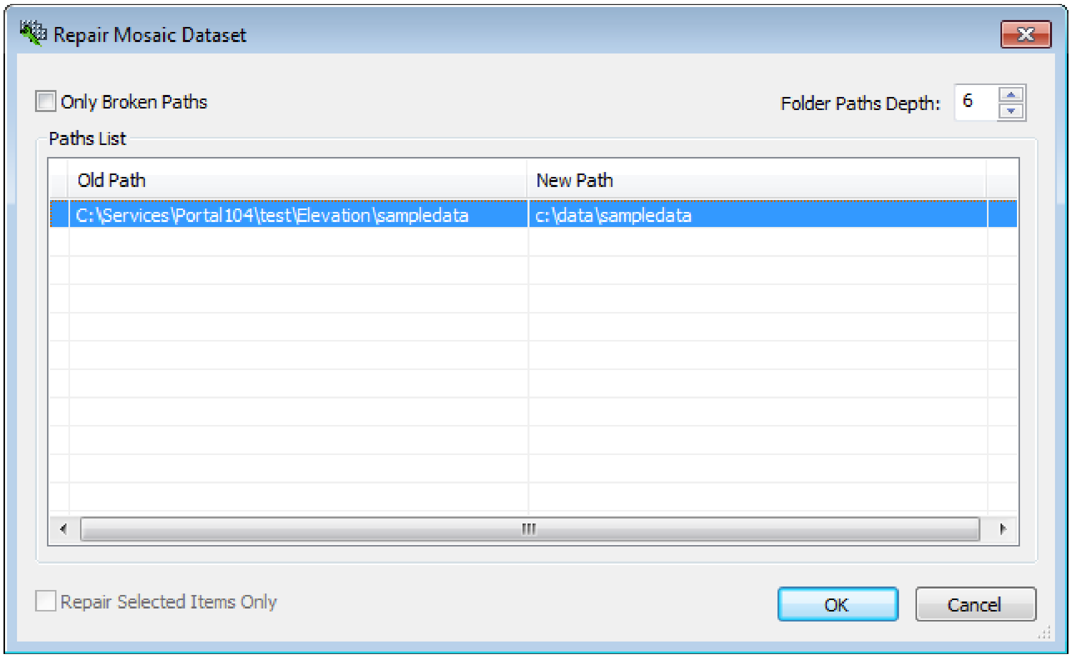

Fig 6. The Repair Mosaic Dataset dialog

5. In the ArcMap Catalog window, establish a publisher connection to the GIS server.
6. Register the 'Elevation\Data' folder in the ArcGIS server data store.

For more help on how to register a folder on ArcGIS server, go to [Registering your data with ArcGIS Server using ArcGIS for Desktop]().

Publish the viewshed service

Once the data has been registered, the service needs to be published.

Steps:

1. Open the data source map document ElevationGP.mxd, and enable the Spatial Analyst extension if it has not been enabled already.
2. Locate the viewshed tool in ElevationTools.pyt under the 'Elevation\Tools' folder, open it and run it in ArcMap.
3. Open the geoprocessing result window (under Geoprocessing menu » Result), if it is not already open.
4. In the Results window, find the history of the viewshed tool run. Right-click the history entry and click Share As » Geoprocessing Service.

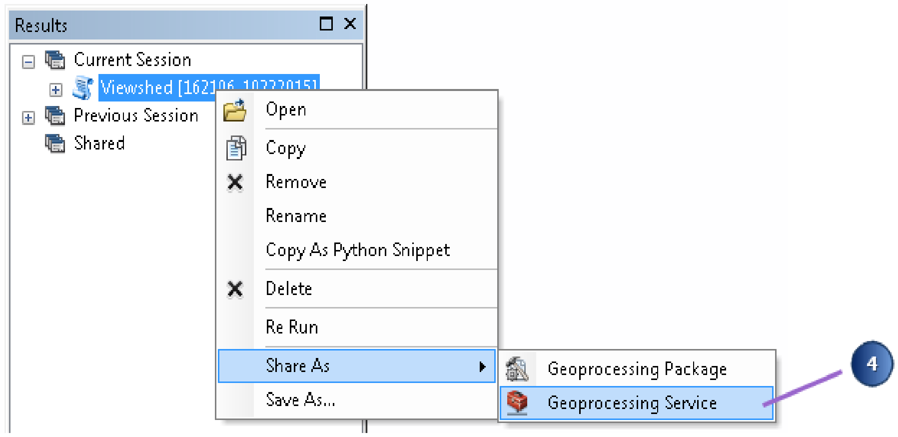

Fig 7. Share the tool history as a Geoprocessing Service

5. Follow the publishing wizard to publish the service to your ArcGIS server, specify "Elevation" as the service name. Make sure to set the following properties in the service editor:
   - Execution Mode: Asynchronous
   - Message Level: Warning

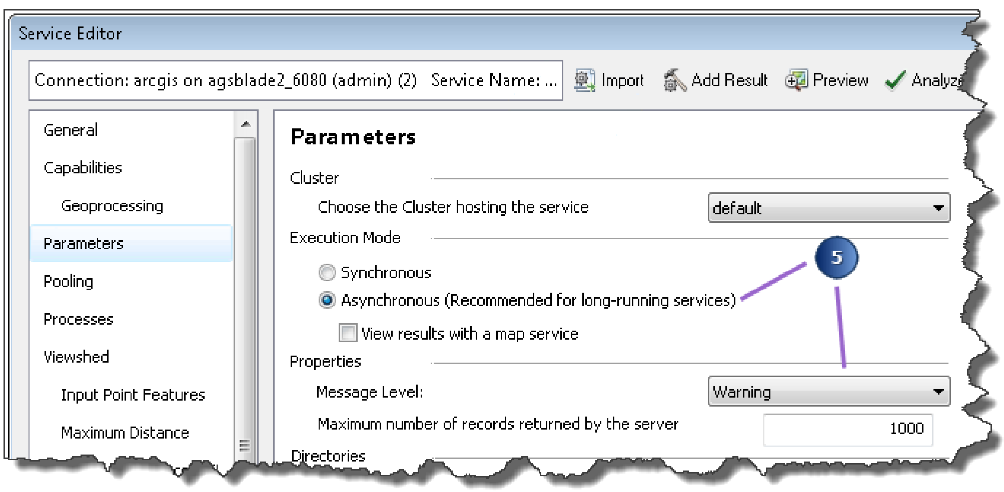

Fig 8. The parameters property page on the Service Editor

For more help on publishing a geoprocessing service, go to the ArcGIS desktop help page [A quick tour of publishing a geoprocessing service](#).