Overview and usage notes re: ArcGIS Online Workflow Scripts & Sample Data as applied to Elevation

4 July 2017

This version compatible with
ArcMap version 10.1 through 10.5.1
ArcGIS Pro 2.0

Contents

Intended audience

The scripts and data described in this package are intended for users of ArcGIS with experience in use of the Mosaic Dataset. Familiarity with ModelBuilder and Python programming are helpful, but not required. Where appropriate, links will be provided to introductory materials in the ArcGIS Help system and Resource Center.

Purpose

The scripts and documentation in this package provide an example of "best practices" for creating multi-resolution elevation mosaic datasets (and image services based on those mosaic datasets) as well as an automated method for their creation and configuration.

The scripts (and sample data, downloaded in a separate *.zip file) are designed to allow an ArcGIS user to review a working example, then modify it for application to their own data.

The primary documentation provided with the sample package is contained in this document, which is focused on the contents, structure, and use of the sample scripts and data, but does not include discussion regarding "Why are the mosaic datasets organized this way? What are the alternatives and tradeoffs of other designs?" etc. For background discussion on mosaic dataset design and configuration, and workflows for elevation data as well as other types of data, please refer to the **Image Management Guidebook** within the ArcGIS Help system. Hyperlinks to appropriate external documentation will be included as appropriate.

Contents of sample download from ArcGIS Online

a. Source for Download

Please refer to the "**ArcGIS Imagery Workflows**" Group on ArcGIS Online to find two items for download:

- **ElevationScripts.zip** (containing this document along with the Python scripts and associated files), and
- **ElevationSampleDataDownload.ZIP** (the elevation data files listed in section **g** below)

b. Directories

The two zip files from ArcGIS Online should be extracted to c:\Image_Mgmt_Workflows, creating the subdirectories shown below. Details regarding the contents of each directory are included in the discussion further below.

c:\Image_Mgmt_Workflows\elevation\batchfiles\
c:\Image_Mgmt_Workflows\elevation\data\
c:\Image_Mgmt_Workflows\elevation\Doc\
c:\Image_Mgmt_Workflows\elevation\logs\
c:\Image_Mgmt_Workflows\elevation\MD\

c:\Image_Mgmt_Workflows\elevation\Parameter\
c:\Image_Mgmt_Workflows\elevation\scripts\

c. Initilization

Before running any of the sample batch files they need to be initialized with the correct path. To facilitate this**,** the 'Initialize_Script_Paths.bat' needs to be executed. This batch file will set the correct path and the correct ArcGIS version available on the system. If you are using ArcGIS Pro, run the script 'Initialize_Script_Paths_ArcGISPro.bat'

Reset Batch File: After running the 'Intialize_Script_Paths.bat'**,** a **'**reset**'** batch file ***is created*** ('Reset_Script_Paths.bat' or 'Reset_Script_Paths_ArcGISPro.bat' as appropriate) that can be used to reset the sample batch files to ***their*** original state. It is imperative that this script be run if the project folder is being moved to a different location.

d. Python scripts (under \scripts\ directory)

The core functions in this sample are contained in Python scripts which encapsulate all of the required functions to set up an elevation mosaic dataset. Note that the internal workings of the scripts are not intended for modification; when applying these scripts to your own data, all modifications should be achievable by focusing only on the configuration files in \Parameter\Config.

The primary script used for building mosaic datasets is "**MDCS.py**". The name is an acronym for "Mosaic Dataset Configuration Script". The \scripts\ directory includes many other files and subdirectories that will be described as appropriate. For further detail on MDCS, refer to ArcGIS online to find a download with detailed documentation at this link.

e. Batch files for command line execution

Batch files are provided in the \batchfiles\ directory to call MDCS. These batch files are described below; this document will discuss ModelBuilder for the purpose of instruction, but users seeking to create an automated production environment may also work in the command line batch mode.

f. Geodatabases (under \MD\ directory)

Execution of the batch files in this package will populate existing geodatabases with multiple Mosaic Datasets, described in detail below. See the Sample#.gdb's which will be created in the \MD\ directory.

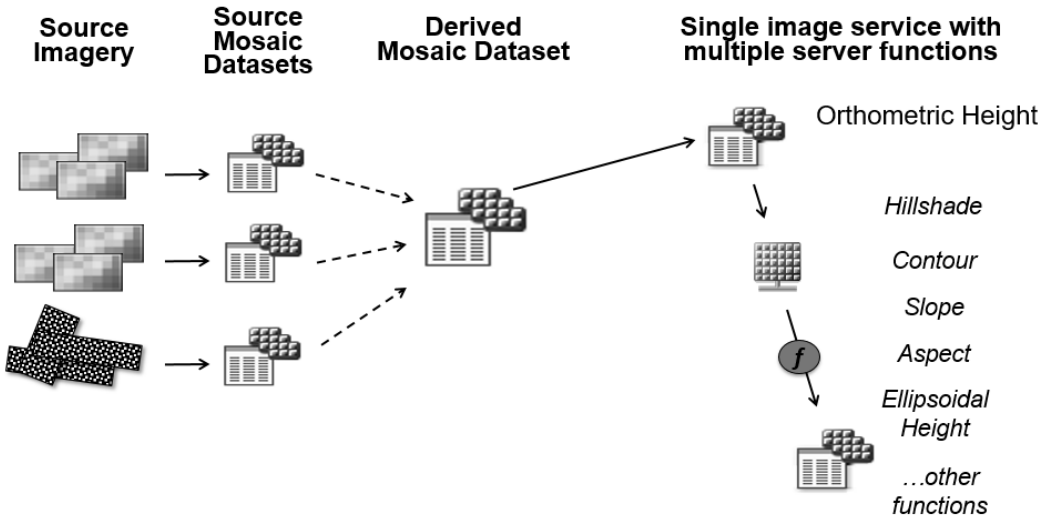
g. Sample elevation data (under \Data\ directory)

In the separate *ElevationSampleDataDownload*.ZIP package, you will find numerous image files that will be used by the script and sample models to build the example elevation geodatabase and associated output products. These should be extracted to the same root folder, creating the data folders listed here, under c:\Image_Mgmt_Workflows\elevation\data\. A description of the contents is included in the appendix. Note: to limit data volume, all source data is in the region around Portland, Oregon, in the northwestern USA.

General design discussion

a. Source – Derived Mosaic Dataset design

One objective of the sample scripts provided here, to accompany the **Image Management Guidebook,** is to encourage the following general design for management of large collections of imagery. This design is described in detail in the Guidebook, with a very brief overview presented below.



The recommended system design involves three fundamental steps:

- Each logical collection of source data is organized into its own Source Mosaic Dataset which can be validated, managed, and used as distinct datasets;
- All Source Mosaics are consolidated into a Derived Mosaic Dataset to provide a single location for users to find all elevation data;
- This centralized collection of all elevation data is shared as a dynamic image service, and any ancillary products (e.g. Slope, Hillshade, and others) are generated on-the-fly by applying functions (compiled into Raster Function Templates or *RFT.xml* files) which are attached to the Mosaic Dataset as Processing Templates.

Batch files

The batch files in \elevation\batchfiles\ArcGISPro are very straightforward: These files must be run in the proper sequence (Source, then Derived) as follows:

```
Generate_Source_MD_sample1_ArcGISPro.bat
Generate_Derived_MD_sample1_ArcGISPro.bat
```

to generate a simplified version of the ArcGIS Online "World Elevation" geodatabase, named "\MD\Sample1.gdb". This sample database will be described below, and note there are corresponding scripts for Sample0 and Sample2.

If using ArcMap, the instructions are the same, but use the batch files in \elevation\batchfiles\.

Inside each batch file, the commands are also very straightforward, e.g. (from Generate_Source_MD_sample1.bat – but note that verbose paths have been hidden for readability):

python.exe MDCS.py -i: S_SRTM.xml

This calls the script **MDCS.py**, and all configuration parameters for the mosaic dataset "S_SRTM" are defined in the configuration file \Parameter\Config\sample#**S_SRTM.xml**. The following sections will provide further detail on the contents and editing of the configuration files.

a. SETUP/CONFIGURATION

Download the two zip files – *ElevationScripts.zip* containing this documentation, scripts, and supporting files, and the elevation sample data in *ElevationSampleDataDownload.zip*. As noted above, if the zip package is extracted into a directory named "c:\Image_Mgmt_Workflows" these tools will run without editing.

- These tools are built for ArcGIS Pro version 2, or ArcMap 10.3 or later, running the STANDARD or ADVANCED license level.
- These tools require the Python environment (included and installed with ArcGIS).

b. RUN Sample0

Run the batch file *Generate_Source_MD_sample0_ArcGISPro.bat* for Sample0 to generate a single Source mosaic dataset.

c. EVALUATE RESULTS – Sample0

Sample0 will create "S_USGS_NED13arcsec", with the "S_" prefix used as a convention to identify "Source" mosaic datasets. This mosaic dataset may be loaded into ArcGIS for review, but note it consists of only one tile. The purpose of the Sample0 model was simply to introduce the structure of building one mosaic dataset, using a configuration file as input to MDCS. In the later models, this structure is repeated for every mosaic dataset.

d. RUN Sample1

Run the batch files for Sample1 in the sequence noted above – first "Generate_Source_MD_sample1_ArcGISPro.bat" for Source, then "Generate_Derived_MD_sample1_ArcGISPro.bat" for Derived.
These batch files will build a simplified version of the ArcGIS Online "World Elevation" geodatabase, loading the following input data:

- GMTED2010 @ 250 meter resolution
- SRTM_CGIAR_CSI @ 90 meters
- USGS_NED 1 arcsec @ 30 meters
- USGS_NED 1/3 arcsec @ 10 meters
- USGS_NED 1/9 arcsec @ 3 meters

Processing time for Sample1 is approximately 15 minutes. The resulting mosaic datasets are created in the geodatabase named "\MD\Sample1.gdb"; note this geodatabase must already exist, but must not have any content inside, prior to running the model.

Also note that the results of running any script are captured in XML formatted *log files* written to the \logs\ directory. The log file lists the name of the mosaic dataset that was created, and also includes a time and date within the file name.

e. EVALUATE RESULTS – Sample1

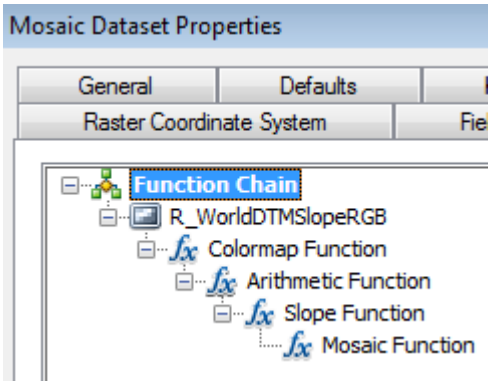
Six Source Mosaic Datasets will be created (named "S_XXXX" where XXX lists the dataset name), then all records from the S_MDs will be combined into a multi-resolution Derived Mosaic Dataset, "D_WorldDTM."

Within this Derived MD, multiple functions will be attached as Processing Templates using *.rft.xml files (RFT = Raster Function Template). When selected as Processing Functions (either viewing the Derived MD in ArcGIS Desktop, or an image service based on this Derived MD) to generate different visualizations and analytical results:

- Aspect (aspect from 0 to 360 degrees, 16 bits/pixel)
- AspectRGB (aspect represented in color, 24 bits/pixel)
- ElevationTintedHillshade (color hillshade, 24 bits/pixel)
- GrayscaleHillshade (grayscale hillshade, 8 bits/pixel)
- Slope (slope from 0 to 90 degrees, 8 bits/pixel)
- SlopeRGB (slope represented in color, 24 bits/pixel)

The hillshades and the slope/aspect RGB mosaic datasets are used for visualization, whereas the DTM with no function, or Slope, Aspect, and Ellipsoidal Height provide quantitative data values, so the usage of the Derived MD using these functions can be very different.

The Raster Function Template (*.rft.xml) files in \Parameter\RasterFunctionTemplates\ define the parameters for the functions applied to the Derived MD. The Configuration file for the Derived MD references all *.rft.xml files that are required. The screenshot below shows the functions applied to create SlopeRGB, but note there are details that may not be apparent – for example, the default output type for the Slope function is 32 bit float, and it must be explicitly changed to unsigned 8 before applying the Colormap function. Refer to the ArcGIS Help system HERE for information on mosaic dataset functions, and THIS LINK describes saving functions in a *.rft.xml file for later application.



f. RUN SAMPLE 2

Finally, run the batch files for Sample2, again in the Source/Derived sequence. The resulting mosaic datasets are created in the geodatabase "MD\Sample2.gdb". This will build a more complicated version of the World Elevation geodatabase, adding these additional input data sources:

- Portland Lidar (raster datasets derived from lidar) @ 0.8 meter resolution
- USGS "CLICK" Lidar (point clouds in LAS format), sampled @ 2 meter resolution

- EGM2008 (a worldwide geoid) to enable creation of an alternative version of the worldwide DTM referenced to ellipsoidal height (vs. the original DTM which is orthometric height).
- ETOPO (bathymetric data for the ocean floor)

g. EVALUATE RESULTS – Sample2

The four additional data sources listed above result in six new Source MDs, since both Lidar datasets yield two S_MDs: the bare earth DTM (Portland Lidar and USGS Click Lidar), and also two "first return" DSMs.

As in Sample1, all datasets representing bare earth will be combined into D_WorldDTM. In addition, two additional Derived Mosaic Datasets will be created: one representing the DSM from Lidar (D_WorldDSM) and a combined topographic and bathymetric surface (D_WorldTopoBathy) which shows both bare earth and the ocean floor (based on the ETOPO data).

The same raster functions are applied as in Sample1, with one more added:

- EllipsoidalHeight (worldwide ground elevation referenced to the WGS84 ellipsoid by a function which adds the EGM2008 geoid values to the orthometric heights)

An important detail added in the Sample2 script is the inclusion of Lidar data. Whereas other elevation datasets are loaded using Raster Type = Raster Dataset, the Lidar datasets must use a more unique raster type, defined in *.art.XML files in the \Parameter\Rastertype\ directory. See ArcGIS Help HERE for guidance on how to create *.art.XML files to modify a raster type. These specific *.art.XML files rescale the input data from units of feet to meters (for both the Portland Lidar and USGS Click Lidar collections), and also define parameters of the raster surfaces (output pixel size, interpolation method and region fill size, etc.) created from the point clouds in LAS format (USGS Click Lidar only).

Appendix 1: Sample Elevation Data

Data Identifier	Approx. Pixel size (m)	Source	Description
Portland LiDAR	0.8	www.oregonmetro.gov	sample of Portland, Oregon metro area derived from Lidar
USGS Click	2	www.usgs.gov	sample from USGS "CLICK" Lidar holdings in LAS format
NED 1/9 Arc Second	3.1	www.usgs.gov	sample of USGS 1/9 arcsecond product, originally derived from Lidar
NED 1/3 Arc Second	10	www.usgs.gov	USGS 1/3 arcsecond product
NED 1 Arc Second	31	www.usgs.gov	USGS 1 arcsecond product
SRTM	93	www.cgiar-csi.org, www.usgs.gov, www.nasa.gov	subset from the Shuttle Radar Topography Mission
GMTED2010	232	www.usgs.gov	subset from the USGS GMTED
ETOPO	928	www.usgs.gov	subset from the USGS ETOPO bathymetric data
EGM2008 geoid	4638	earth-info.nga.mil	worldwide geoid
World Background Zero	111,300	www.esri.com	worldwide low resolution raster with value 0 everywhere, used to fill "NoData" areas

Appendix 2: Known issues/limitations

a. Exercise caution with regard to running scripts more than once. Depending on which commands are executed, these scripts may add duplicate records into any existing mosaic datasets. For simplicity, when applying these scripts to your custom data, the recommended procedure is to begin with an empty geodatabase and build the mosaic datasets from scratch.

b. Raster Type selections applied in the (create) Source Mosaic Dataset script are limited to these two options ONLY:
    a. Raster Type = Raster Dataset with no changes to any default settings, or
    b. Raster Type set by reading *.art.xml file.

    Raster Type properties are not read into the script, so if any properties are changed from the defaults, the user must save and apply a *.art file to set the properties.