Global Land Survey Digital Elevation Model (GLSDEM) Technical Guide

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Objective

Topographic information is now a much required variable in many remote sensing and GIS projects. Public and private agencies are often engaged in using Landsat data to carry out regional analyses, and any form of elevation information in a format similar to the Landsat data products could potentially be useful for improved understanding of land surface changes. The objective of this technical guide is for users to understand the detailed steps involved in processing the GLSDEM product to a form that may be used efficiently in direct conjunction with any of the Landsat or GLS datasets.

Methodology

<u>GLSDEM product in Degree tiles</u>

Georeferencing

The GLSDEM dataset (minus the GTOPO30) acquired from the USGS are in Band Interleaved by Line (BIL) binary format and each file extent covers 1 deg latitude x 1 deg longitude. These binary format files were georeferenced to their corresponding geolocations using the header files provided with each tile. Each file would then have a corresponding latitude/longitude location designated by the lower left corner coordinates in the filenames. The following section serves as a guide to each of the processes involved in converting the GLSDEM degree tiles obtained from the USGS to a Landsat WRS-2 tiling system, as illustrated in figure 1.

GTOPO 30 processing

GTOPO30 data were obtained for Eurasia and Greenland since the DTED Level 1 and 2 data are not publicly available. The native GTOPO30 tiles come in 30 arc-second (0.00833 deg) spatial resolution. To begin with, a mosaic of all GTOPO30 tiles over 60 N was created. The GTOPO30 tiles use a value of -9999 for oceans. Since the rest of the GLSDEM inputs (NED, CDED and SRTM) use a value of 0, all sea/ocean areas in the GTOPO30 tiles were set to 0 in order to make the GLSDEM a consistent product.

Since the output resolution of the GLSDEM deg tiles is 3 arc-second, the GTOPO30 tiles were resampled down from 30 to 3-arc seconds. This was done using a cubic convolution algorithm. The resulting 3-arc second GTOPO mosaic was subset into Geographic 1deg latitude x 1deg longitude tiles for Eurasia and Greenland above 60 deg N. These 3-arc second GTOPO 1deg x 1deg tiles, along with the 1deg x 1deg NED, CDED and SRTM constitute the public version of the GLSDEM product in Geographic degree tiles.

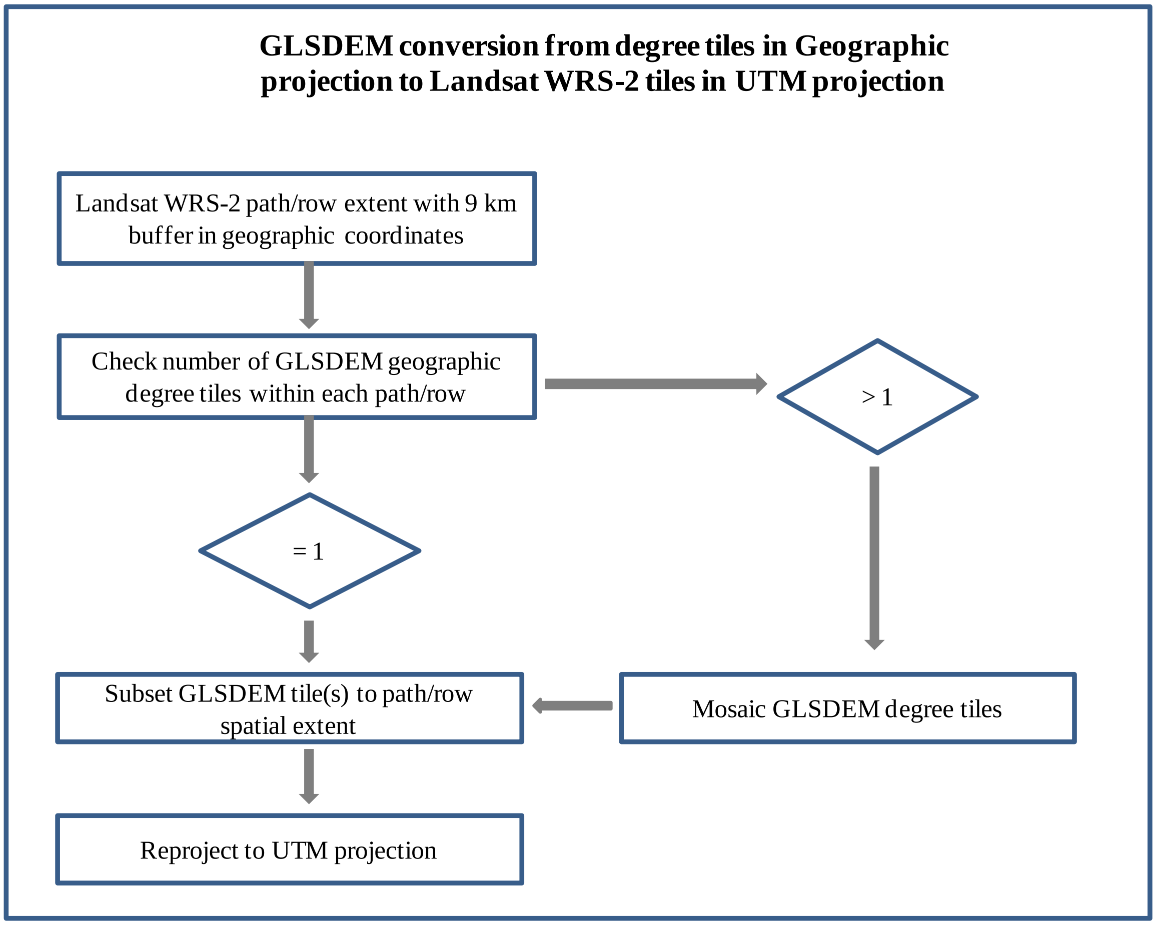

Figure 1. Process flow to convert GLSDEM 1 degree tiles in Geographic projection to Landsat WRS- 2 tiles in UTM projection

GLSDEM product in Landsat WRS-2 tiles

Data processing

The geographical extents of each Landsat WRS-2 tile were obtained using the excel file provided on http://landsathandbook.gsfc.nasa.gov/handbook/handbook_htmls/chapter5/chapter5.html

The GLS2000 dataset was used as the baseline for deciding the total number of DEM tiles to be produced in the WRS-2 format. The UTM zones assigned to the GLS2000 tiles were used for the GLSDEM UTM output tiles. In addition to the WRS-2 extent, a 9km buffer around the Landsat path/row extent was introduced to account for possible displacements in orbital drift of the actual scene extents.

In most cases, the spatial extent of a single WRS-2 path row would comprise of many 3 arc second (~90m) GLSDEM degree tiles. Therefore a mosaicking operation was to be performed for cases where more than one GLSDEM degree tiles covered the extent of a WRS-2 tile. For each GLS2000 path/row, the number of GLSDEM degree tiles required to be mosaicked were queried using the map coordinates information in the excel file above. The GLSDEM degree tiles were then mosaicked to form a single file that would cover the entire corresponding path/row.

The mosaicked DEMs were subset and masked to fit the geographical extent of the buffered path/row tiles for each of the GLS2000 path/rows. These DEM subsets were then reprojected from geographic to UTM projection. The output GLSDEM elevation values are in units of meter and the tiles are in GeoTIFF image format compressed using gzip, UTM projection, WGS 84 horizontal datum, and EGM96 geoid.

Finally, browse and preview (thumbnail) jpegs for each of the GLSDEM WRS-2 tiles were created to enable the user to quickly view the general elevation patterns and spatial extent of the data within each tile. This form of data distribution is consistent with all other datasets provided by the GLCF.

<u>Specific issues confronted while processing global datasets:</u>

Typically, the conversion flow from a source dataset to a destination dataset can be carried out systematically with few or no special cases. However in the case of reprojecting a global dataset in geographic projection, problems arise while processing files around the 180E/W line. Since the geographic projection has set limits of 0-180 with the central meridian set to zero, the two “ends” of the projection system around the Pacific tend to be split in half. This representation, although suitable for map displays, presents problems while processing datasets that may comprise of both the East and West ends of the 180 degree line.

The following steps were used to process the GLSDEM WRS-2 tiles that lie around the International Date Line. While the steps employed here are specific to the case of global GLSDEM processing, the concepts/ procedures could be applied to other relevant scenarios as well.

1) The central meridian was changed from 0 deg longitude (Greenwich) to a suitable meridian such that the area of interest no longer lies at the junction of 180E/W. Specifically, we set the central meridian to 90 deg E longitude (India/China). Effectively, this new “central” meridian is the new 0 deg longitude (India/ China) from which all measurements east and west of it are made. Therefore, parts of Alaska, Russia and some South Pacific islands which lie at the 180E/W junction when the Greenwich meridian is used as the central meridian, now have values of 90E longitude i.e., 90 E of the new central meridian in India/ China.
2) All conversion operations listed in Figure 1 were carried out in a manner similar to tiles with the original Geographic projection; by offsetting the map coordinates of concerned WRS-2 path/rows by the magnitude and direction of change in the new central meridian. In the above example, to determine the number of GLSDEM tiles that lie within a path/row in Russia/ Alaska border, we subtracted a value of 90 deg longitude from the original WRS-2 map longitudes to reflect

changes due to the positioning of a new central meridian. Once the subsets of the GLSDEM in the new geographic projection (with the new central meridian) were created, we reprojected these subsets from the new geographic projection to UTM projection.

Feedback

Please email us at glcf@umiacs.umd.edu with questions and comments regarding the derived GLSDEM product.