A DESCRIPTION OF STEPS TAKEN TO GENERATE CONTOUR MAPS FROM BARE EARTH LIDAR AND DEMS

The following is a description of the steps that were taken to generate contour maps from available bare earth LiDAR and DEM data for selected mound sites in Mississippi. For sites where high-resolution (i.e., 1/9 arc-second) bare earth LiDAR coverage is available, additional on-the-ground topographic mapping with a total station usually is not needed. For sites with medium-resolution (i.e., 1/3 arc-second) coverage derived from DEMs, the data are intended to supplement total station mapping by providing topographic coverage of the surrounding site area.

Obtaining the LiDAR and DEM Data

Bare earth LiDAR and DEM data were obtained from four separate datasets. These datasets vary with respect to resolution (i.e., data point interval), map projection (i.e., UTM, state plane, longitude-latitude), horizontal and vertical measurement units (i.e., degrees, feet, or meters for X, Y values, and feet or meters for Z values), and distributed file types (i.e., ArcGrid raster format and as xyz data in ASCII file formats).

1. USGS National Map (formerly the National Elevation Dataset), accessible using the National Map Viewer at http://nationalmap.gov/elevation.html. Coverage is available at 1 arc-second and 1/3 arc-second resolutions for all of Mississippi, and coverage at 1/9 arc-second resolution is available for some areas. Site maps generated from 1/3 arc-second data (roughly 10-meter point spacing) include Bates 2, Bayou Pierre, Emerald, Foster, Henderson, Gordon, Lessley, Mangum, Mount Locust, and Smith Creek. These data are provided in user-specified blocks as raster datasets (DEMs in Arc/Info Binary Grid [*.adf] format) in geographic projection (NAD83, longitude and latitude, decimal degrees) with elevation in meters (NAVD88, measurement precision to 6 decimal places).

2. Mississippi Geospatial Clearinghouse (MGC), accessible at http://www.gis.ms.gov, provides access to USACE (U.S. Army Corps of Engineers) datasets for the Mississippi River Delta. Coverage is available at 1/9 arc-second resolution. According to USACE (n.d.), "the project area requires LiDAR to be collected on average of 1.0 meter point spacing or better and vertical accuracy of 15.0 centimeters RMSE or better to support 2' contour generation when combined with breaklines. Site maps generated from the USACE dataset include Aden, Dornbusch, Hardee, Haynes Bluff, and Jeff Davis. These data are provided as raster datasets (DEMs in Arc/Info Binary Grid [*.adf] format) in approximately one-mile-square mosaic blocks and are projected in Mississippi State Plane West (NAD83, feet) with elevation in feet (vertical datum not specified, measurement precision to 12 decimal places).

3. Mississippi Geospatial Clearinghouse (MGC) also provides access to Hinds County 1/9 arc-second LiDAR coverage for the Pocahontas site. Data are provided as edited point clouds (i.e., xyz data) in ASCII format as a text (*.txt) file. Coverage is in approximately one-mile-square mosaic blocks, projected in Mississippi State Plane West (NAD83, feet) with elevation in feet (NAVD88, .65-ft resolution).

4. The Louisiana Statewide GIS (Atlas), accessible at http://atlas.lsu.edu/. Atlas provides access to statewide Louisiana LiDAR coverage at 1/9 arc-second resolution, and the coverage area includes portions of Mississippi along the Mississippi River. According to Cunningham et al. (n.d.), "the LIDAR systems being used in the Louisiana project are accurate to 15-30 cm RMSE, depending upon land cover, and will support contours of 1'-2' vertical map accuracy standards." Site maps generated from Louisiana LiDAR include Fatherland, Anna, Pumpkin Lake, Feltus, and Windsor. These data are provided in blocks representing a quarter of a 7.5-minute quadrangle, and are provided as raw point clouds and edited point clouds (i.e., xyz data) in ASCII format as a comma-delimited (*.csv) file. They also are provided as DEMS and contour map shapefiles. The X, Y coordinates are UTM Zone 15 North (NAD83, meters). The Z value, or elevation, is in feet (NAVD88, .01-ft resolution).

Extracting the XYZ Data

The USGS National Map and MGC (Mississippi River Delta) provide data as a raster dataset in ArcInfo Binary Grid format. The xyz data from these sources were extracted using Spatial Analyst in ArcGIS 10.0. The process is outlined in "How To: Convert a raster dataset to an XYZ table" (http://support.esri.com/en/knowledgebase/techarticles/detail/28730) and is described as follows:

1. Open ArcGIS and add the raster dataset.
2. Open the Sample tool from ArcToolbox > Spatial Analyst Tools > Extraction.
3. Select the raster dataset as the Input Raster.
4. Select the raster dataset again in the 'Input location raster or point features' drop-down list.
5. Make sure 'Resampling "technique" is set to NEAREST.
6. Specify an output table.
7. Click OK.
8. Open the new table in ArcMap.
9. Select Options > Export.
10. Set Export to "All records."
11. Click the browser button next to the Output Table field.
12. Set Save As Type to Text File and set an output location and filename.
13. Click Save.
14. Click OK on the Export Data menu.
15. The output text file is in the format: ID, z, x, y.

MGS provides Hinds County LiDAR data in ASCII format as an xyz test file (*.txt), and Atlas provides edited Louisiana LiDAR data in ASCII format as a comma-delimited file (*.csv). Both of these file types can be used without modification.

Transforming the XYZ Data

Because the LiDAR and DEM data from various sources are not uniformly projected, nor do they use the same system of measurement, they must be transformed to a common projection and measure. For the purpose of this project, all data were transformed to UTM Zone 15N (meters) with elevation in meters. XYZ files from all four datasets required some type of data transformation, and these transformations were performed as follows using Surfer 9.0.

Data from USGS National Map (lat-long, z in meters)

1. Open Surfer, click on File | Open, and select the text file (*.txt) that contains the xyz data. It should appear in a spreadsheet within surfer with values in five columns as follows: ID, z, x, y, z.
2. Right-click at the tops of the first two columns and select Delete. You now should have data in three columns: x (longitude), y (latitude), and z (elevation in meters).
3. Select Data | New Projected Coordinates at the top menu. Source Columns should be X=Column A and Y=Column B, and Target Columns should be X=Column D and Y=Column E. Set Source Coordinate to Geographic (lat-lon) / North American Datum 1983. Then set Target Coordinate to Projected Systems / UTM / WGS84 / UTM zone 15N. Then click OK. This will generate new UTM Zone 15 easting and northing values in columns D and E, respectively.
4. Click on File | Save and select "Comma" as the delimiter.

Data from MGC (state plane, xyz in feet)

1. Open Surfer, click on File | Open, and select the text file (*.txt) that contains the xyz data. It should appear in a spreadsheet within surfer with values in five columns as follows: ID, z, x, y, z.
2. Right-click at the tops of the first two columns and select Delete. You now should have data in three columns: x (feet), y (feet), and z (elevation in feet).
3. Select Data | New Projected Coordinates at the top menu. Source Columns should be X=Column A and Y=Column B, and Target Columns should be X=Column D and Y=Column E. Set Source Coordinate to Projected Systems / State Plane / 1983/ Mississippi West (Feet). Then set Target Coordinate to Projected Systems / UTM / WGS84 / UTM zone 15N. Then click OK. This will generate new UTM Zone 15 easting and northing values in columns D and E, respectively.
4. The final step is to transform elevations from feet to meters. To begin, scroll to the bottom of the spreadsheet and write down the last row number (you will need this later). Then, select Data | Transform at the top menu. In the Transform window, "Transform with" should be set to column variables. In the "Transform equation" box, type the following: F = C * .3048. Then, enter "1" for "First row" and the number you wrote down for "Last row." Finally, click OK. This will create the metric equivalent to the original elevations and write them to column F.

5. Click on File | Save and select "Comma" as the delimiter.

Data from Louisiana Statewide GIS (UTM Zone 15N meters, z in feet)

1. Open Surfer, click on File | Open, and select the comma-delimited file (*.csv) from the Edited Points folder that contains the xyz data. It should appear in a spreadsheet within surfer with values in three columns as follows: x, y, z.
2. Transform elevations from feet to meters. To begin, scroll to the bottom of the spreadsheet and write down the last row number (you will need this later). Then, select Data | Transform at the top menu. In the Transform window, "Transform with" should be set to column variables. In the "Transform equation" box, type the following: D = C * .3048. Then, enter "1" for "First row" and the number you wrote down for "Last row." Finally, click OK. This will create the metric equivalent to the original elevations and write them to column D.
3. Click on File | Save and select "Comma" as the delimiter.

Gridding the XYZ Data

In this step, the extracted, reprojected, and transformed LiDAR and DEM data are clipped and gridded to create a grid file (*.grd) that Surfer can use to generate a contour map or three-dimensional surface model of the site. (Note: For sites where LiDAR/DEM elevation data and data from on-the-ground total station mapping are combined to create a map, those data need to be combined before undertaking this step. This also applies to site maps using data from more than a single LiDAR/DEM dataset. These data can be combined in the Surfer spreadsheet by simply copying and pasting, and then saved with a new file name.) Then, proceed as follows:

1. Open Surfer and select File | New | Plot from the top menu. Then, select Grid | Data from the top menu and select the file that you want to grid (it should have either a *.txt or *.csv extension).
2. In the Grid Data dialog box, select the appropriate data columns for your X, Y, and Z values. Remember that your transformed and reprojected data file still contains the original x, y, and z values in addition to the new ones you want to use. If unsure, just click the "View Data" button to view the data file. The Gridding Method should be set to Kriging.
3. Under "Output Grid File," the default file name is the same as the input file name but with a *.grd extension. You probably do not need to change it.
4. Under "Grid Line Geometry," you can specify the xy boundaries for your grid file as well as the spacing of the new, gridded data points. Because your data file likely covers a much larger area than you need for an individual site map, determine the proper minimum and maximum easting and northing values and enter them in the appropriate boxes. As a rule, boundaries that are 500 meters from a site's center (i.e., creating a 1000x1000-meter map) should be more than adequate in most instances.
5. Finally, determine and enter the data point interval for the grid file. For files generated from 1/3 arc-second DEM data, set X and Y spacing to 2 meters. (This will automatically re-set the values in the "# of lines" box.) For files generated from 1/9 arc-second LiDAR data, also set X and Y spacing to 2 meters.

6. Once all the parameters have been specified, click OK. This step may take from several minutes, depending on the file size and the number of lines to be gridded.

Generating a Contour Map

In this step, the gridded data are used to create a contour map, and the map is exported as a ESRI shapefile that can be viewed and modified, if necessary, in ArcGIS. The gridded data also can be used to generate a three-dimensional surface model in Surfer. To create a contour map, proceed as follows:

1. Open Surfer and select File | New | Plot from the top menu. Then, select Map | New | Contour Map from the top menu and select the grid file (*.grd) that you want to use. Click OK.
2. A default contour map should appear, along with an Object Manager at the left edge of the screen. Double-click on Contours to bring up the "Contours Properties" dialog box. Click on the General tab, select Smooth Contours, and then select Medium for Amount.
3. Now, click on the Levels tab and click Level. Set Interval to .25 (as in .25 meter contour interval). Then click on Label and then Font. Set Font Size to 0 (this will turn off the contour interval labels). Click OK to close the Font Properties window and click OK again to close the Labels window. Now, click Apply in the Contour Properties window and then click OK to close the window.
4. At left, uncheck the boxes beside Right Axis, Left Axis, Top Axis, and Bottom Axis.
5. Select File | Save or Save As to save a copy of this plot file, as you might want to make changes to it later.
6. Select File | Export and select SHP ESRI Shapefile under "Save as type". Then, enter a file name and click on Save.

Please note that the shapefile generated by Surfer lacks a *.prj file but will properly project in ArcGIS if the default projection is UTM Zone 15N. You also can create the prj file in Notepad. Simply copy and paste the following (without any spaces) and save it with the shapefile's name. It will save with a *.txt extension, so change the file name to *.prj in Windows explorer. This file should be placed in the same folder that contains the other shapefile files (i.e, *.shp, *.shx, *.dbf).

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93.0],PARAMETER["Scale_Factor",0.9996],PARAMETER["Latitude_Of_Origin",0.0],
UNIT["Meter",1.0]]
```

References Cited

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