LiDAR Workshop

Ex #4: Volumetric Change Analysis and Feature Extraction: coastal erosion and deposition volumes, buildings and tree extraction

Introduction:

The recent advent of airborne LiDAR system represents a technological breakthrough in surveying and mapping surface topography in a quick, cost-effective manner. Surface elevation measurements from airborne LiDAR are much more accurate, reliable and denser than those from the traditional photogrammetric technique or InSAR technique. The LiDAR system offers an extraordinary capability in gathering highly accurate and densely sampled topography data for coastal studies, which allows for an entirely new level of detailed analysis of micro-geomorphology of the beach and sand dunes in the coastal zone. The repeat LiDAR surveys at different times also render us the capability of conducting three-dimensional volumetric change analysis and thorough sediment budget estimation over a broad region.

The Cut/Fill tool in Spatial Analyst summarizes the areas and volumes of change between two surfaces. The Cut/Fill tool enables you to create a map based on two input surfaces — before and after — displaying the areas and volumes of surface materials that have been modified by the removal or addition of surface material. By taking two surface rasters of a given area from two different time periods, the Cut/Fill tool will produce a raster of regions where material was removed, added, or where the surface did not change. The attribute table of the raster contains the volume and area of each of the connected regions. The attribute table of the output raster presents the changes in the surface volumes following the Cut/Fill operation. Positive values for the volume difference indicate regions of the before raster surface that have been cut (material removed). Negative values indicate areas that have been filled (material added). Both the input raster surfaces must be coincident. That is, they must have a common origin, the same number of rows and columns of cells, and the same cell size. When the Cut/Fill operation is performed from the Tool, by default a specialized renderer is applied that highlights the locations of cut and of fill. The renderer draws areas that have been cut in blue, and areas that have been filled in red. Areas that have not changed are displayed in grey.

Alternatively, math operations, conditional function, slice function, reclass function in grid module in ArcGIS can be used to effectively extract and classify terrain features and change features. The cell-by-cell differencing method represents a low level of data processing. Object-oriented technique needs to be developed to explicitly identify and delineate individual erosion and deposition zones (patches) and destroyed buildings. Such technique will reap the potential of airborne LiDAR data for understanding of coastal morphological changes.

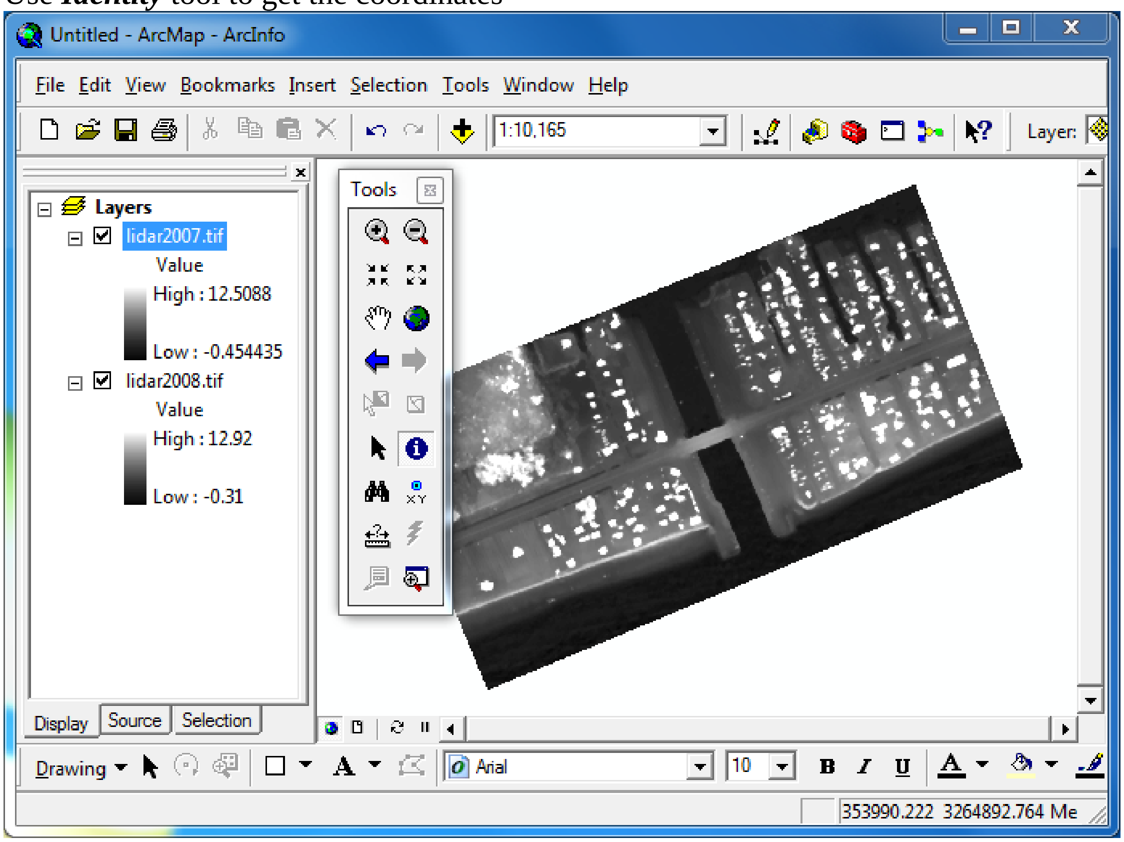
Data sets

In the directory Ex4\TX_LiDAR, there are two LiDAR data sets: lidar2007 and lidar2008. These data sets cover part of the ocean front coast of Bolivar Peninsula around Rollover, Texas. All data sets have been georeferenced in UTM (Zone 15N) coordinate system with reference to WGS84 ellipsoid. "lidar2007" is the airborne LiDAR digital surface model (DSM) acquired in 2007 before the Hurricane Ike, and "lidar2008" is the airborne LiDAR digital surface model (DSM) acquired in 2008 after the Hurricane Ike. The Bolivar Peninsula is located in the east side of the Galveston Bay, Texas, and the Hurricane Ike made landfall on the Bolivar Peninsular in September, 2008. The coast under investigation is near Rollover Pass, where development density is quite high. It contains the shoreline, beaches, foredunes, geotubes, highway 87, rows of houses and vegetation landward. Two successive LiDAR surveys before and after the Hurricane Ike can be employed to conduct coastal morphology and volumetric change analysis to evaluate the damage caused by the Hurricane Ike.

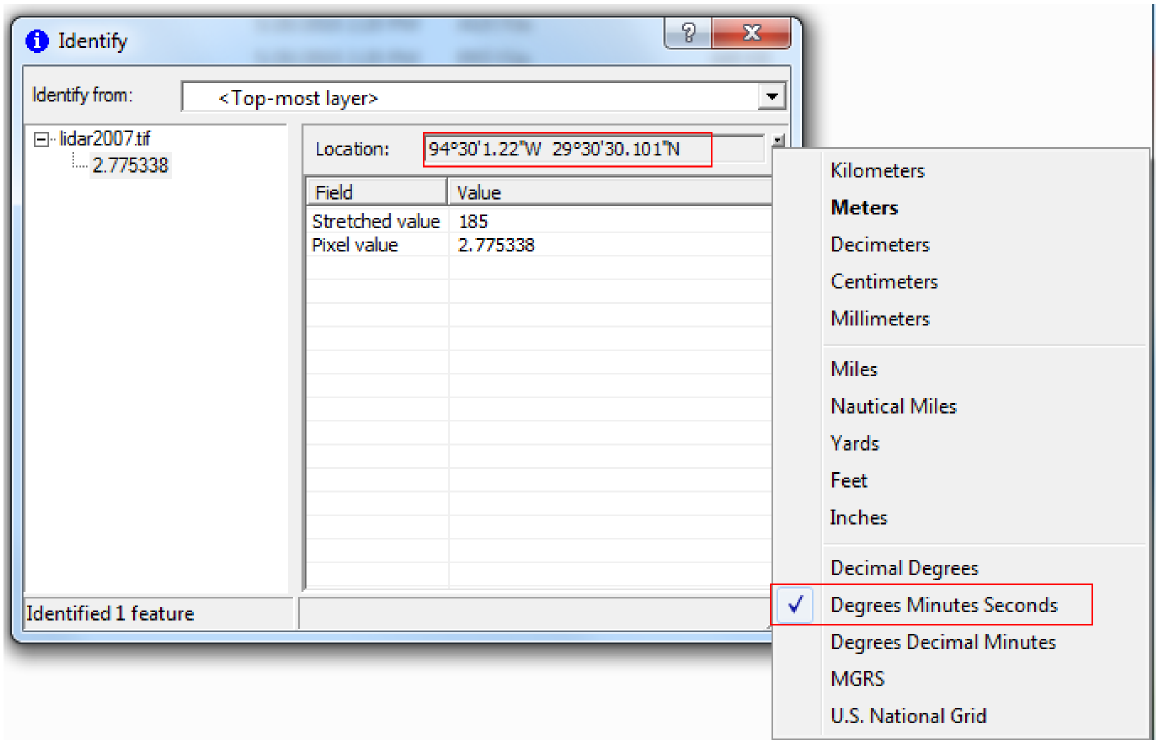
Exercise Instructions:

1. Locating the Study Area on Google Map

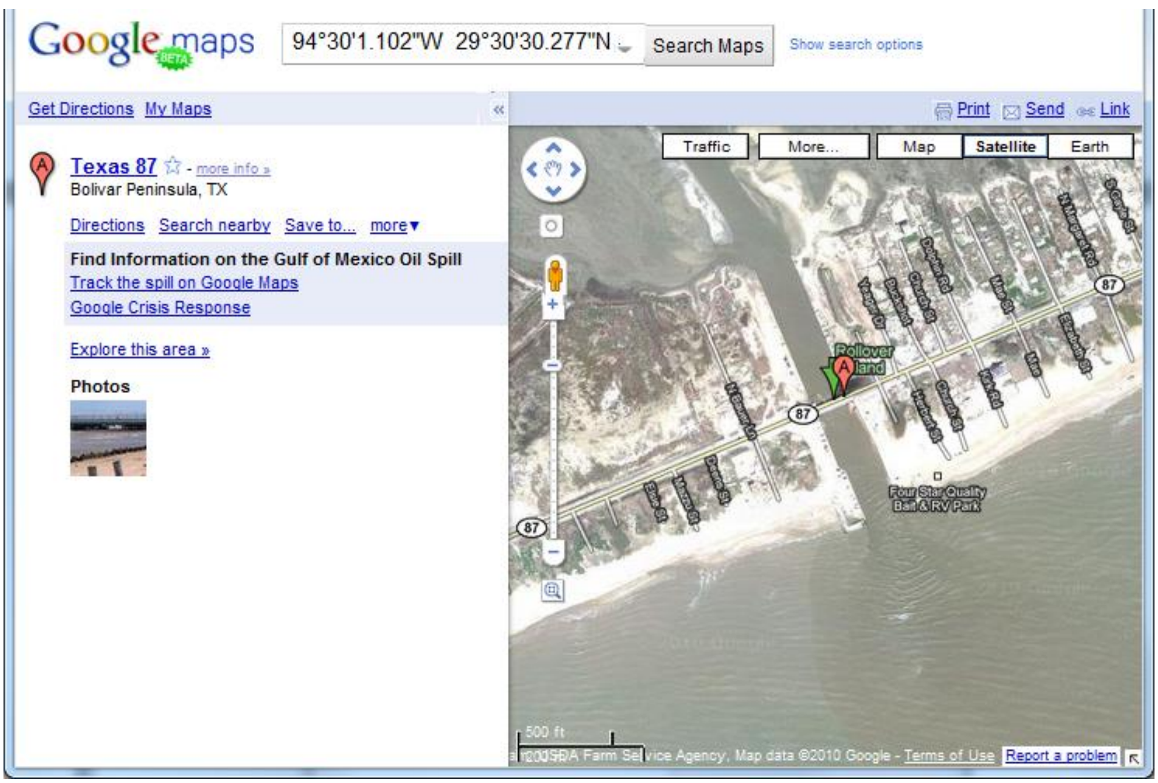
Use ***Identity*** tool to get the coordinates



Change the unit to ***Degrees Minutes Seconds***

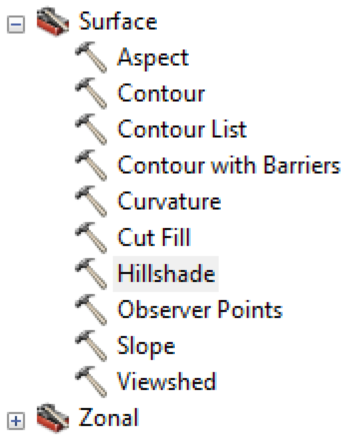


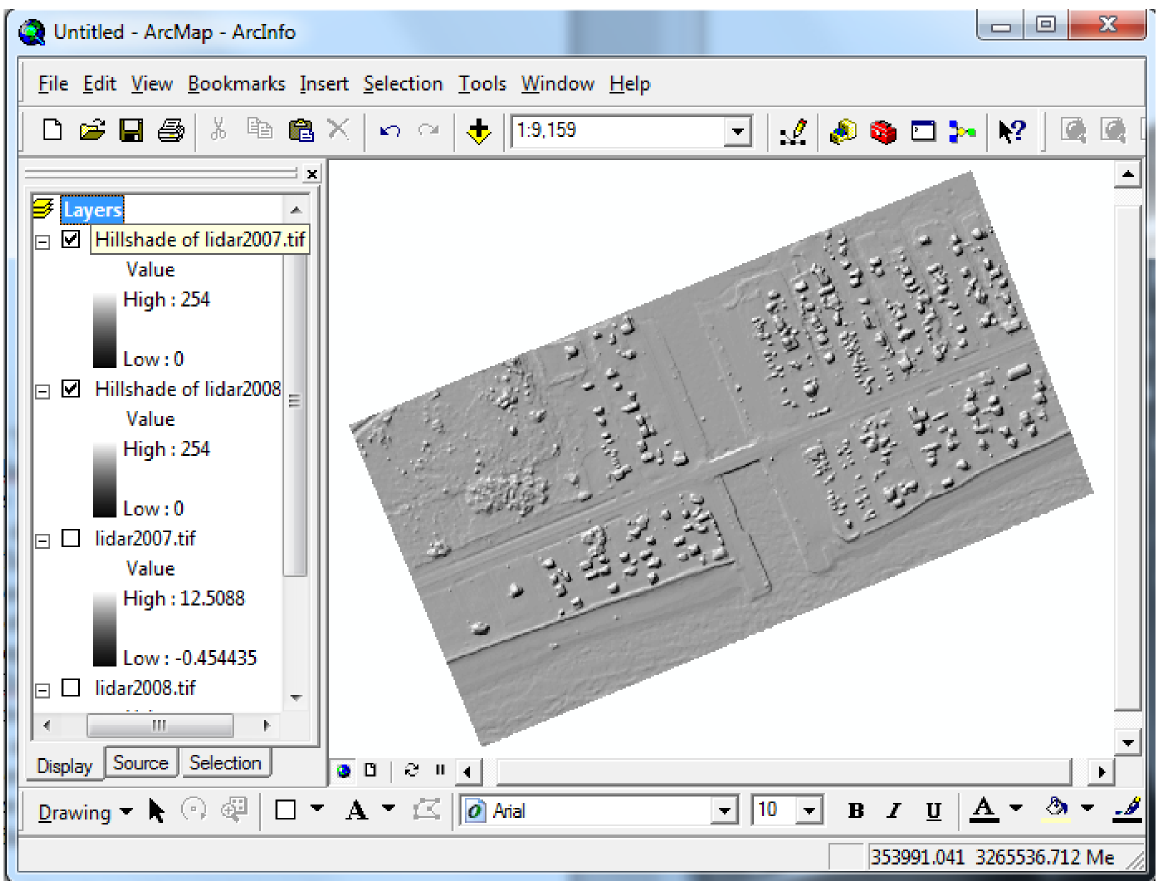
Copy and Paste the Coordinates to the Google Maps Search Box.

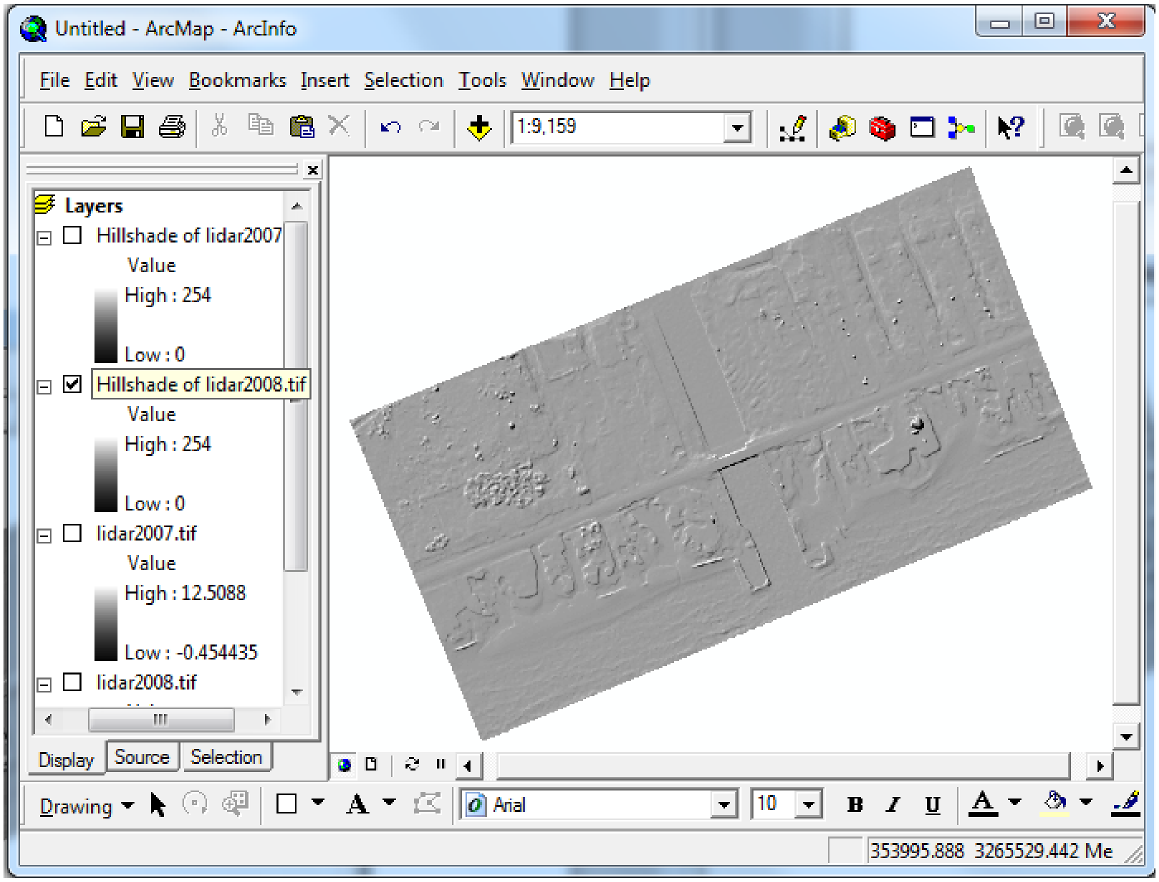


2. Generating Hill-shading Images

Use the Hillshade tool in Spatial Analyst to create a hill-shading images respectively from the digital surface model "lidar2007" and "lidar2008", and visually interpret the surface feature changes caused by the Hurricane Ike.





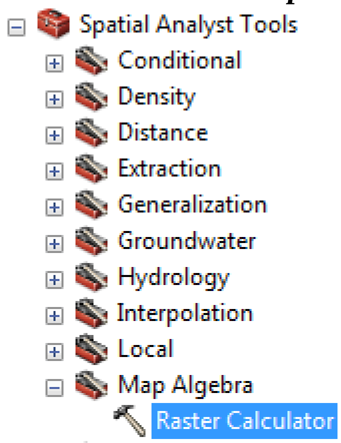


Use the ***Swipe Layer*** tool on ***Effects*** toolbar to visually check the changes between the two hill-shading images.

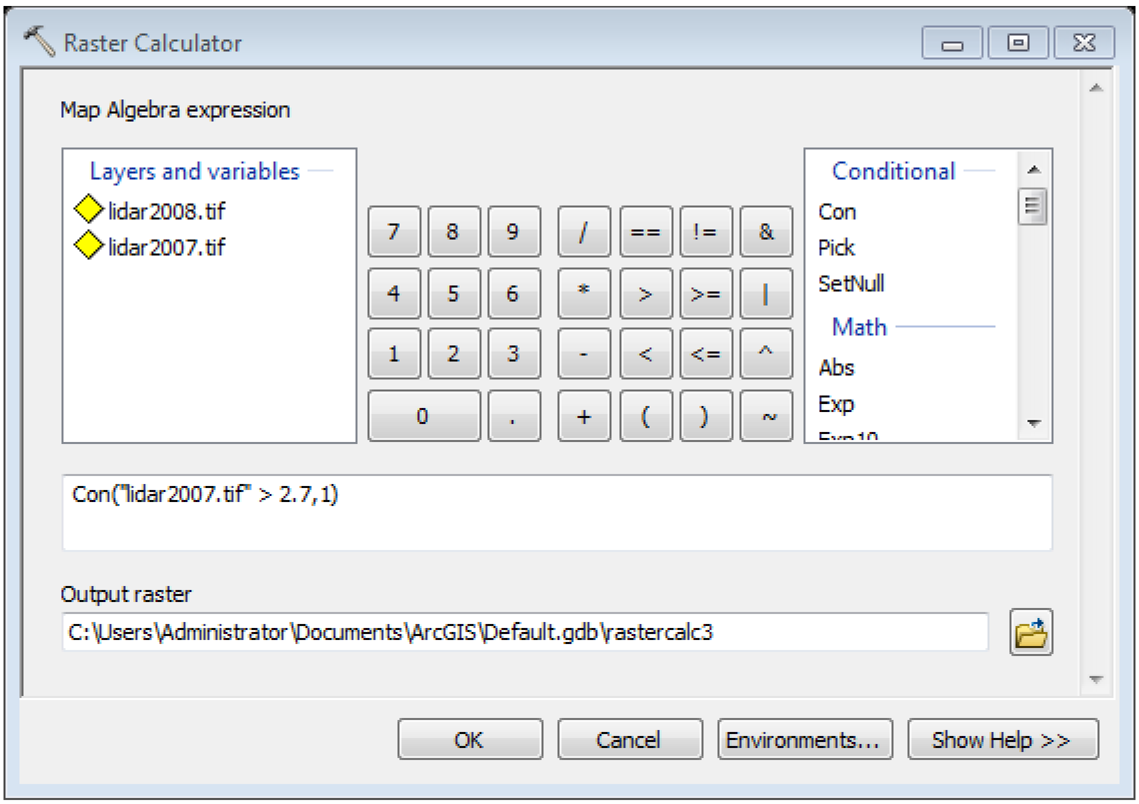
3. Extracting Building and Tree Boundaries

Extract buildings and trees from LiDAR DSM "lidar2007". Use the ***Raster Calculator*** in ***Spatial Analyst*** to extract buildings and trees that higher than a threshold value from "lidar2007". Convert the resulting grid to polygon shape file and then overplay the polygons on top of the hill-shaded image of "lidar2007" to show the extracted buildings and trees. Include this map in your report.

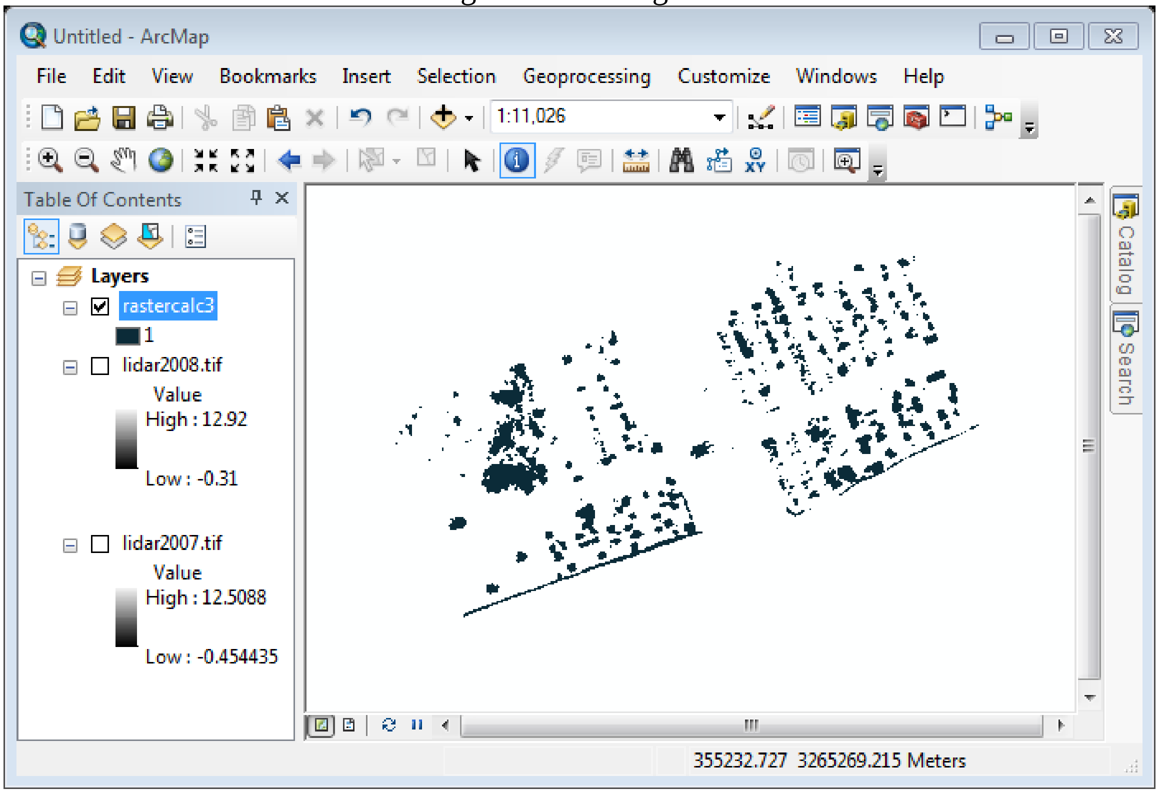
Raster Calculator in ***Spatial Analyst***



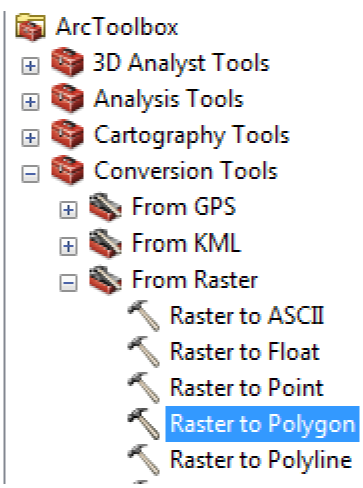
Write Condition Statement in ***Raster Calculator***



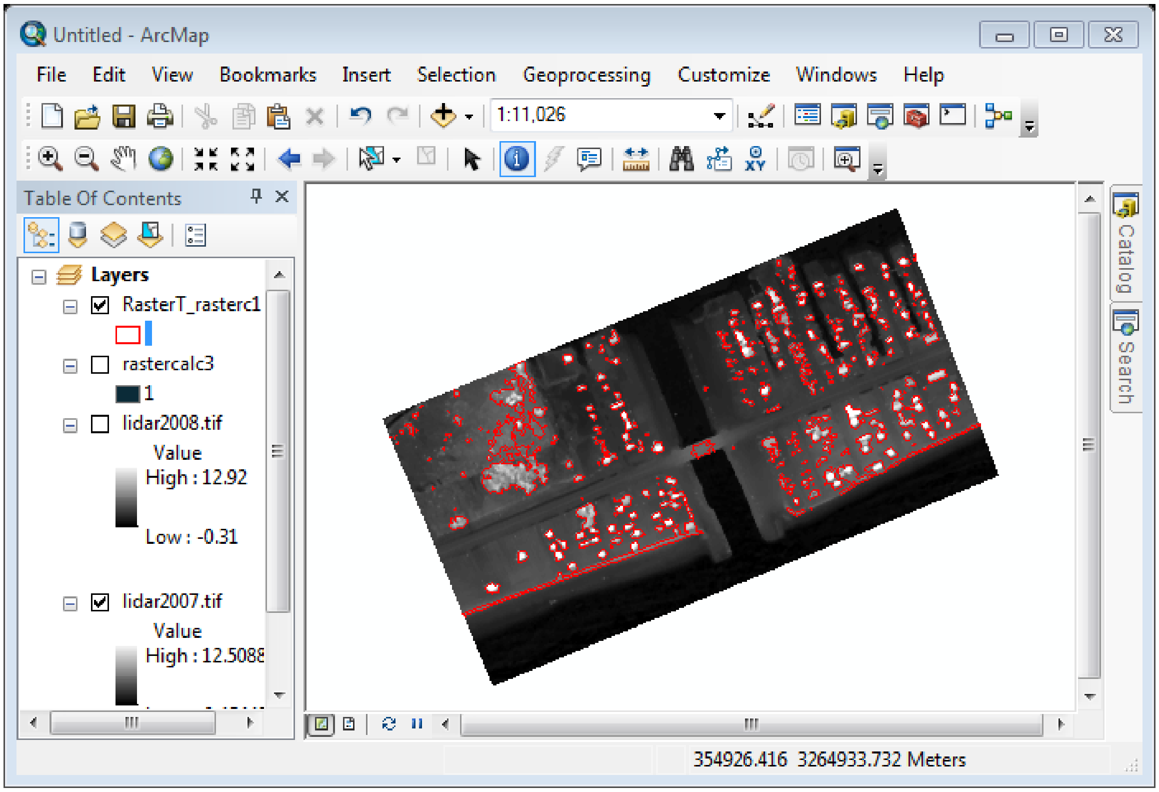
The extracted boundaries of buildings and trees in grid format



Convert Raster to Vector:

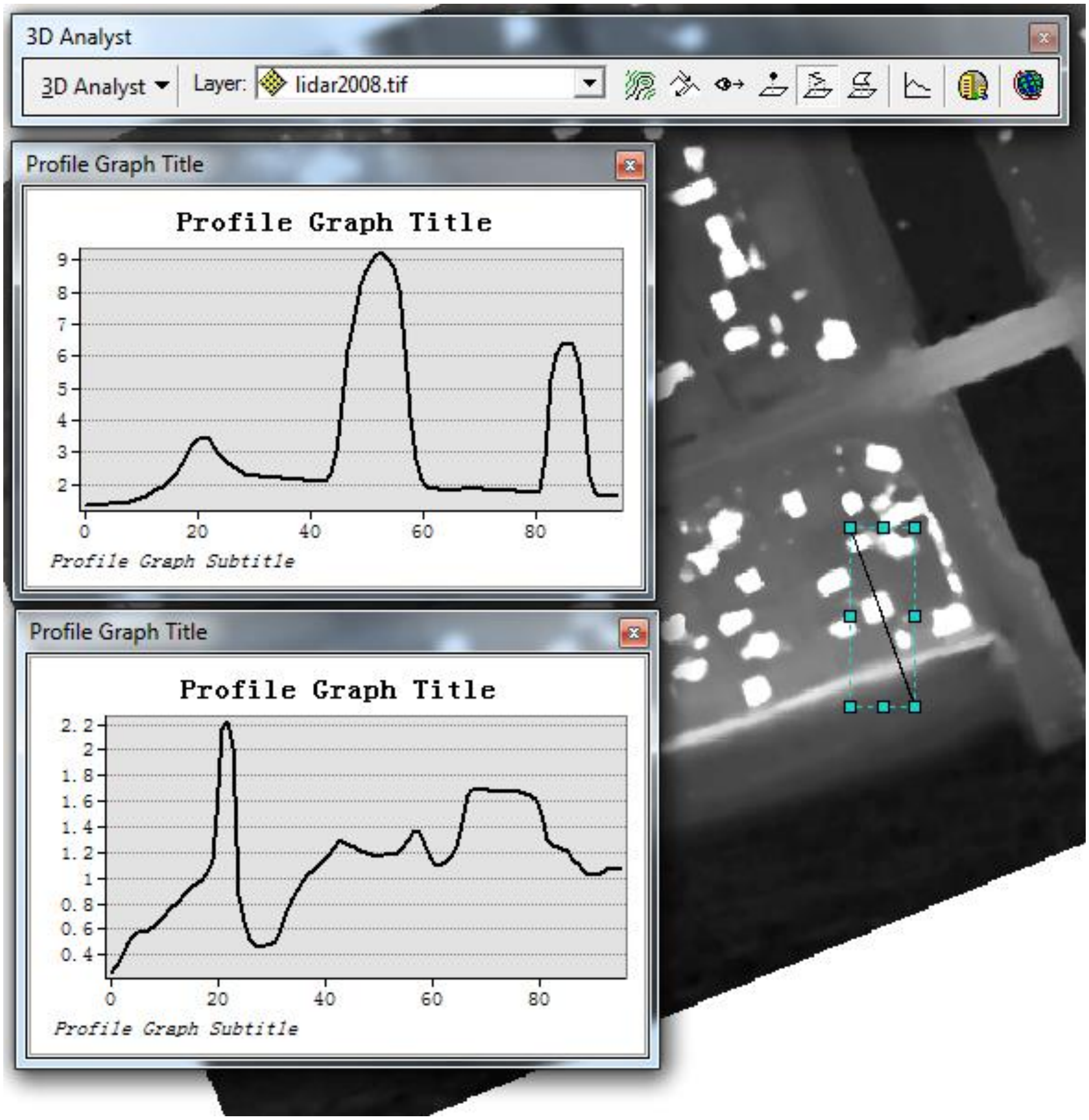


The extracted boundaries of buildings and trees in vector format



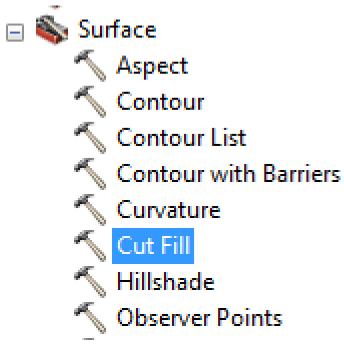
4. Comparing the Cross-section Profiles

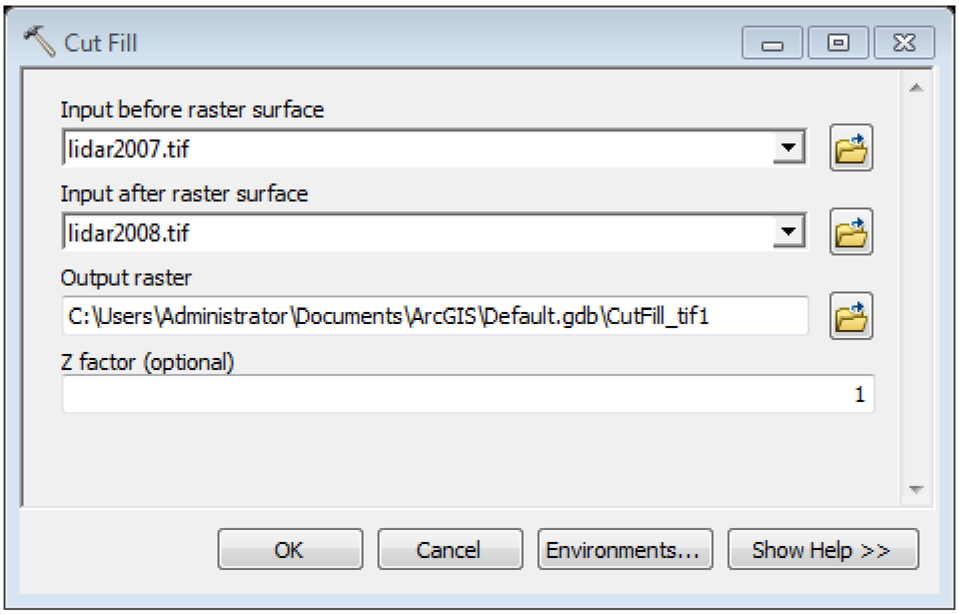
Use the ArcMap profile tool to inspect and observe geomorphologic changes across the beach and shoreline. Select two separate locations to compare the cross-section profiles of the 2007 and 2008 LiDAR.

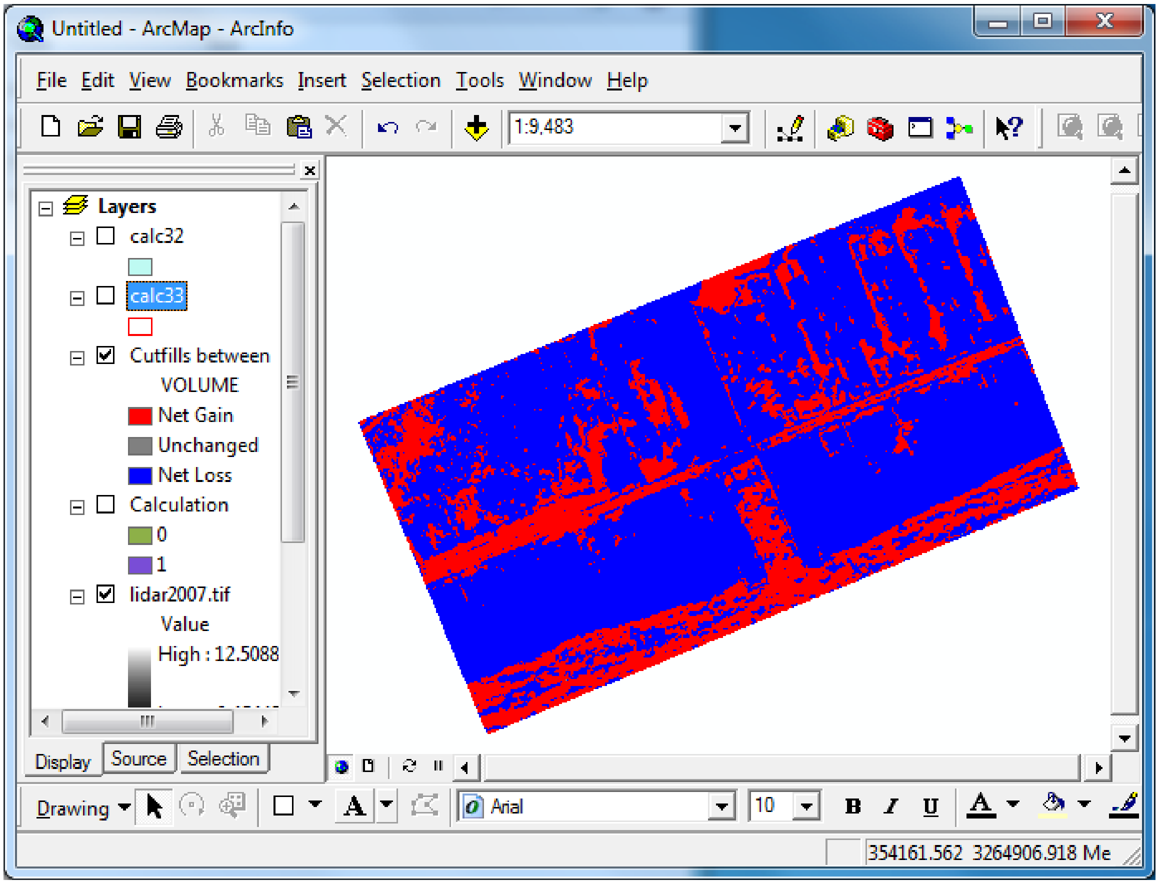


5. Analyzing Morphology Changes

Use the ***Cut/Fill*** tool in ***Spatial Analyst*** to analyze the morphology changes caused by the Hurricane Ike, with the input grids of “lidar2007” and “lidar2008”. Identify major erosion and deposition zones.


Surface
Aspect
Contour
Contour List
Contour with Barriers
Curvature
Cut Fill
Hillshade
Observer Points


Cut Fill
Input before raster surface
lidar2007.tif
Input after raster surface
lidar2008.tif
Output raster
C:\Users\Administrator\Documents\ArcGIS\Default.gdb\CutFill_tif1
Z factor (optional)
1
OK
Cancel
Environments...
Show Help >>



Attributes of Cutfills between

Rowid	VALUE *	COUNT	VOLUME	AREA
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799	800	50852	-6560.744629	50852
619	620	22417	-2951.151123	22417
253	254	8035	-830.113525	8035
530	531	6727	-528.216309	6727
94	95	4745	-1233.608643	4745
1014	1015	2999	329.813293	2999
1553	1554	2569	182.371185	2569
338	339	2492	-156.763733	2492
53	54	2410	-500.57843	2410
7	8	2090	-251.293365	2090
559	560	2052	721.374512	2052
1012	1013	1852	-305.24472	1852
431	432	1704	-121.261314	1704
1476	1477	1608	118.286285	1608
78	79	1434	-284.305817	1434

Record: 1 Show: All Selected Records (0

Create morphologic and volumetric change map. Use ***Raster Calculator*** to subtract “lidar2007” from “lidar2008” to create the difference grid. Identify the minimum, maximum, and average values for elevation changes caused by the Hurricane Ike.