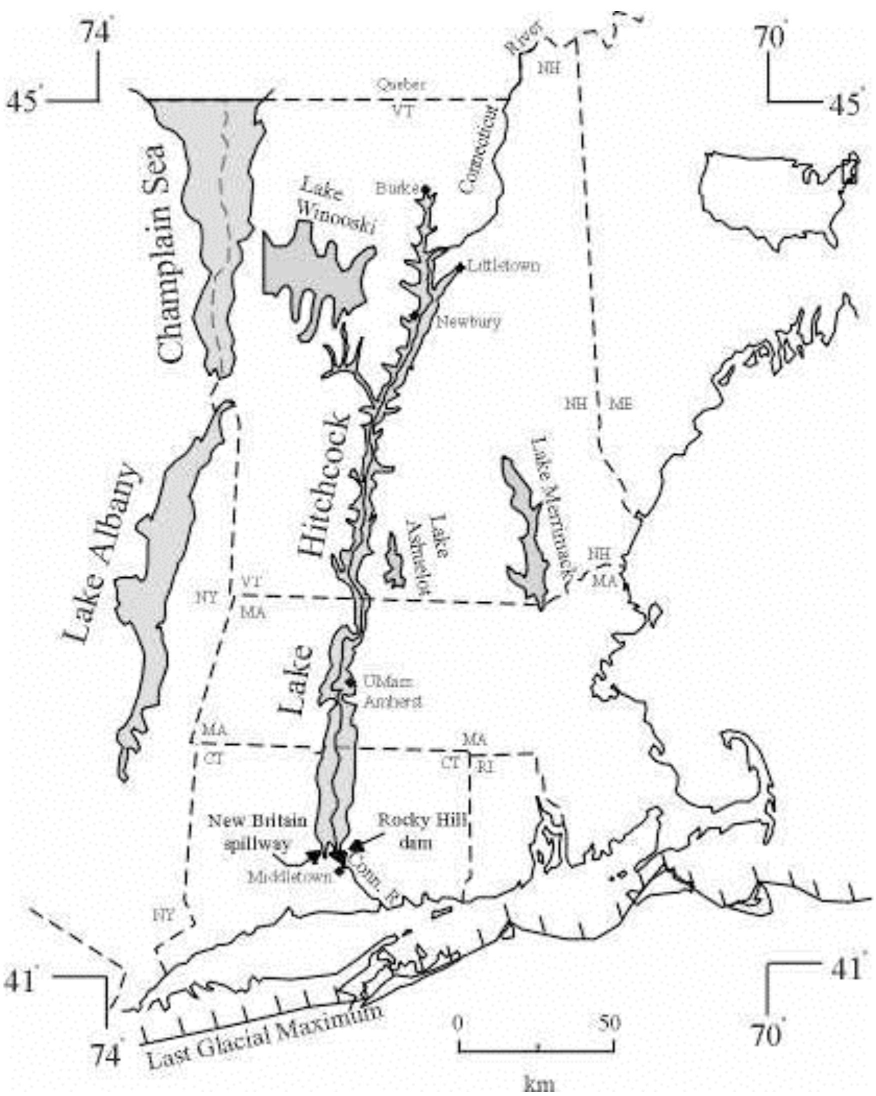
Geology 251
Geomorphology

Shorelines of Lake Hitchcock

Lake Hitchcock was a glacial lake dammed by stratified drift at Rocky Hill Connecticut with a bedrock spillway in New Britain Connecticut. The presence of the bedrock spillway ensured that the lake level would be stable as it limited downcutting. The lake existed for approximately 2000 - 3000 years until the drift dam failed catastrophically causing the lake to drain. The lake formed approximately 13,000 years ago as the glacier retreated from southern Connecticut. At its maximum the lake extended 320km northward to about St Johnsbury in Vertmont.

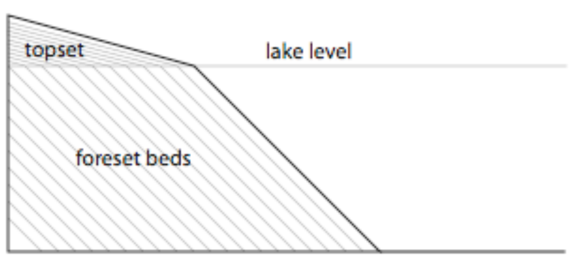


map from T.M. Rittenour http://www.bio.umass.edu/biology/conn.river/hitchcock.html

Study of a continuous sequence of 1,389 varves from the Hadley Basin and nearby terraces of the Connecticut River provide confirming evidence for the timing of glacial ice retreat and local drainage of Glacial Lake Hitchcock. Based upon extrapolation to the oldest local varve/till contact, the Laurentide ice sheet retreated from the Amherst/Hadley area by 12.8 ka 14C yrs (15.4 ka cal. yrs BP). An AMS 14C age of 12,370 +/-120 (14.3 +1.2/-0.4 cal kyr BP) between Antevs' varve year 5761-5768 and optical luminescence ages between 14.0 cal. ka and 14.4 cal. ka on fossil sand dunes superimposed on the lake floor indicate that Lake Hitchcock drained from this part of the valley by 12.0 ka 14C yrs (14.0 cal. yrs BP). Grette and Rittenour (2001, NE GSA).

Deltas

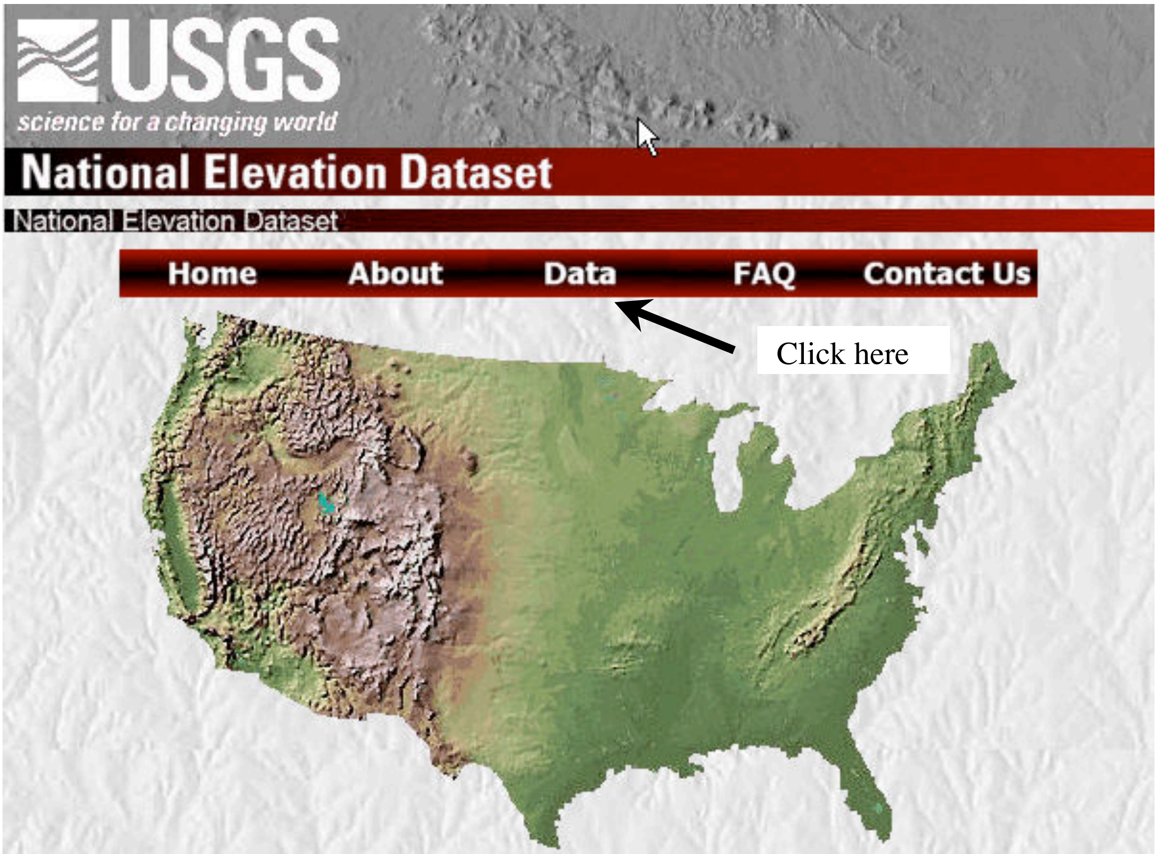
The elevation of the topset-foreset contact of deltas indicates the elevation of the surface of lake Hitchcock. The topset-foreset contacts do not all occur at the same elevation. There is a gradual increase in elevations as you move to the north. This is due to differential isostatic rebound that occurred after the lake drained. Koteff et al. (1993) reported a rebound rate of 0.889 m/km along a direction of N 20.5˚W.

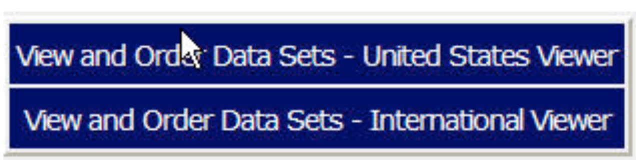


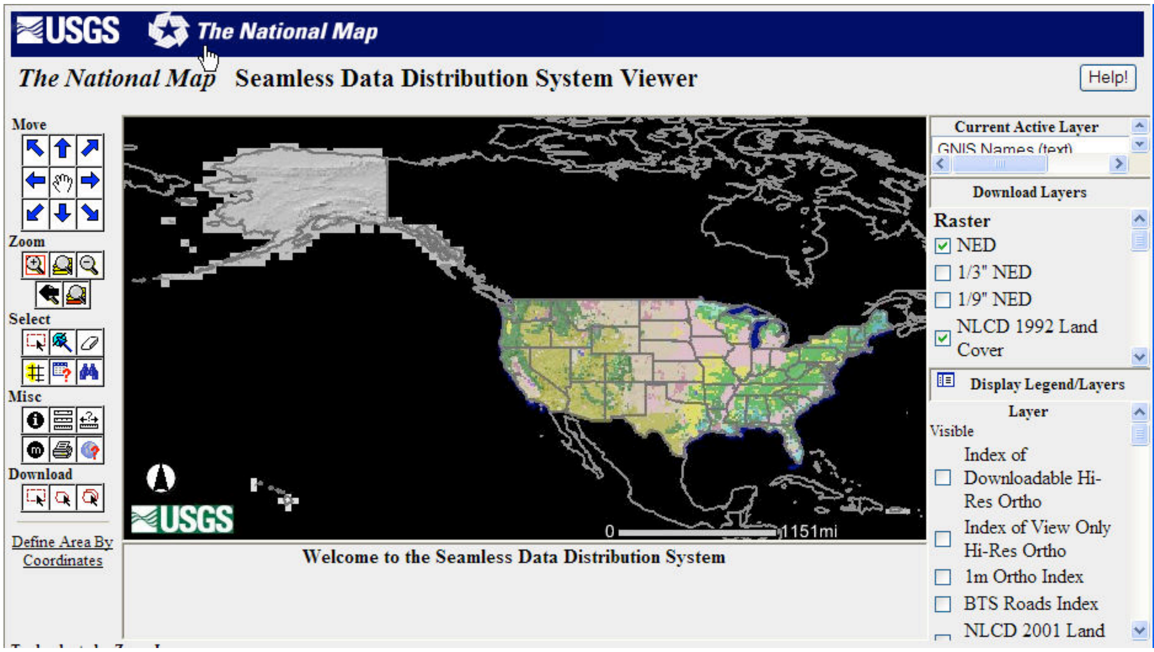
Tilt Landscape

In order to correct for isostatic rebound we will tilt the DEM that represents the current landscape. Tilting will be accomplished by subtracting a tilt surface grid from the DEM. The tilt surface grid will be constructed from a 3 dimensional polygon created in ArcMap. Each vertex in a 3D polygon has three coordinates (x,y,z). The 3D polygon will then be turned into a Triangular Irregular Network (TIN). Both TINs and GRIDs can be used to display landscapes, but where the GRID is made up of regularly spaced rows and columns of elevation data, the TIN has data points only where there is a change in slope. Since isostatic rebound was linear, we can model it with a 4 point TIN. This will define the tilt surface that we can then turn into a GRID that has tilt values at the same coordinates as the DEM. Since the DEM is a GRID we can now simply subtract the tilt GRID from the DEM using the raster calculator. The result will be a pre-isostatic rebound DEM.

Source of Digital Elevation Models
http://gisdata.usgs.net/ned/default.asp






USGS
The National Map
The National Map Seamless Data Distribution System Viewer
Help!
Move
Zoom
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Define Area By Coordinates
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Welcome to the Seamless Data Distribution System
Current Active Layer
Download Layers
Raster
NED
1/3" NED
1/9" NED
NLCD 1992 Land Cover
Display Legend/Layers
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NLCD 2001 Land


Move
Zoom
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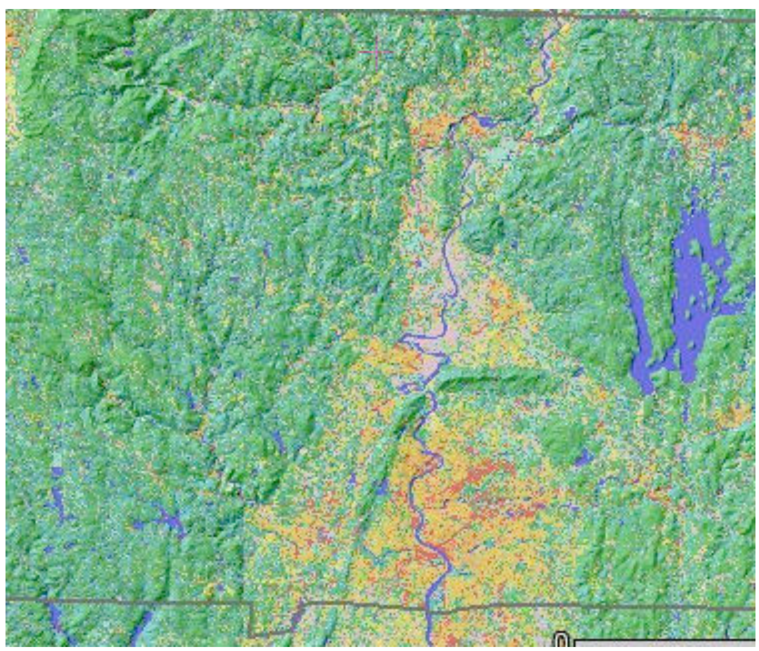
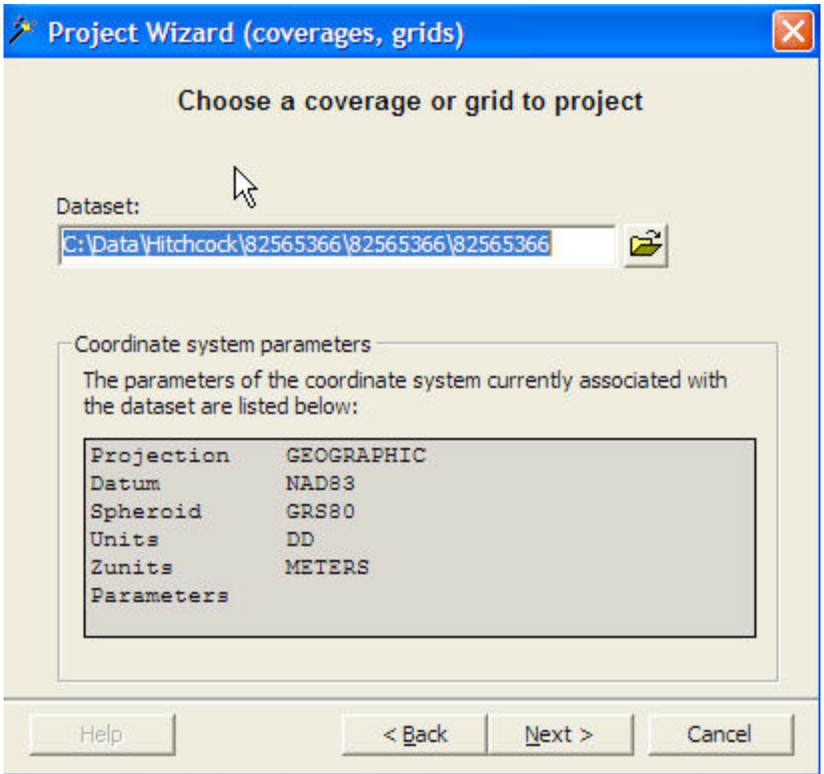
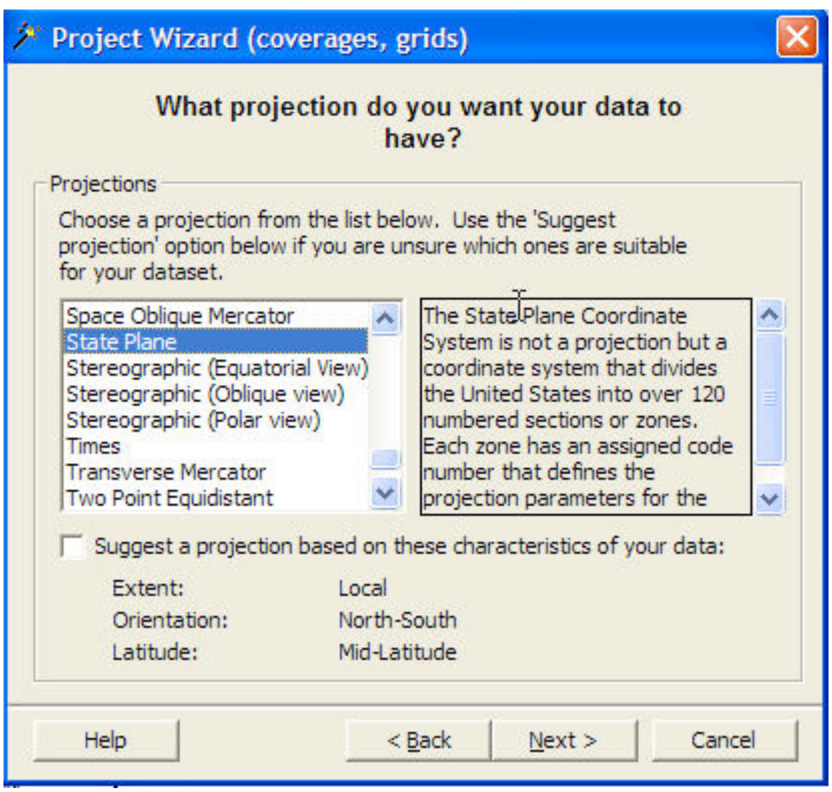
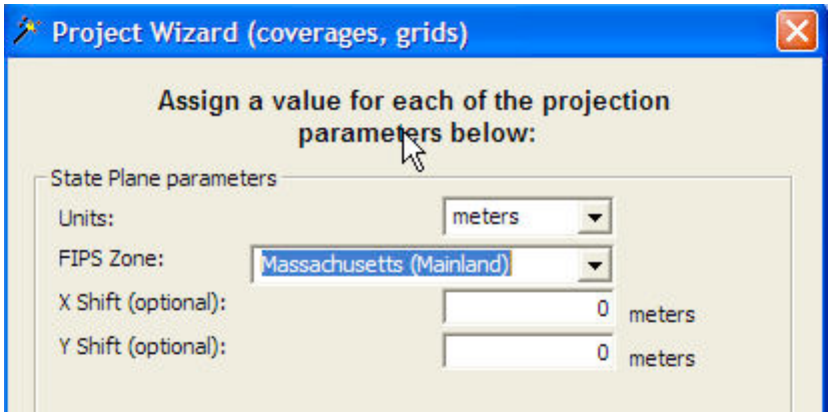
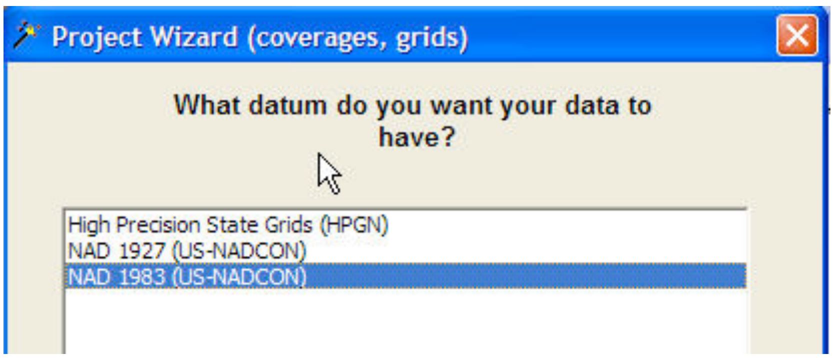


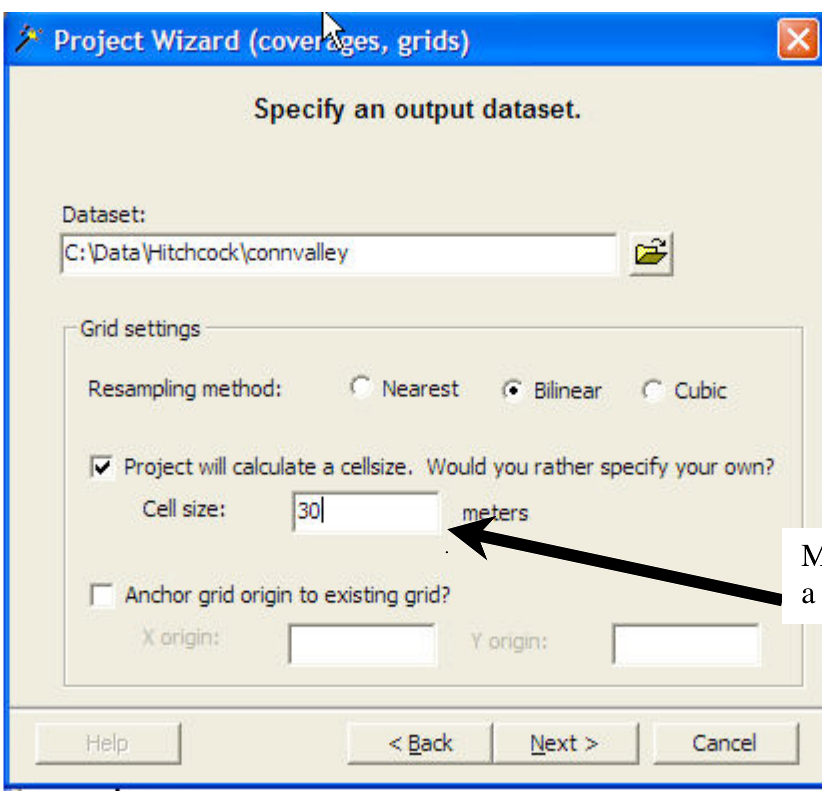
Re-project Raw DEM into Mass State Plane Coordinate System



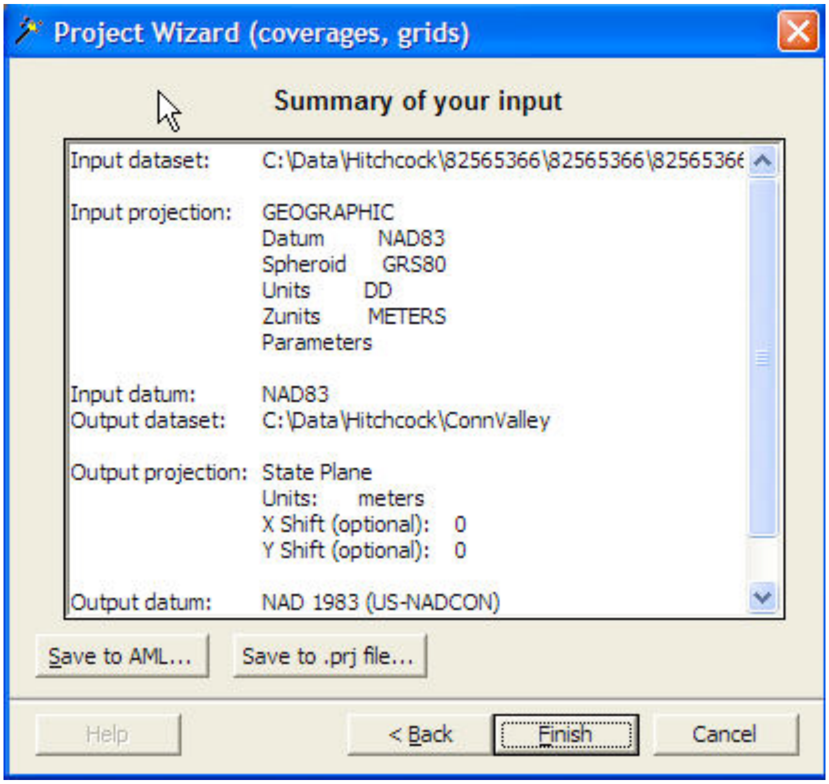




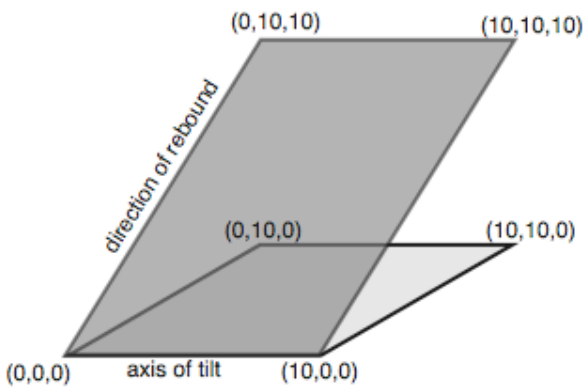




Make sure you select a 30 meter cell size.

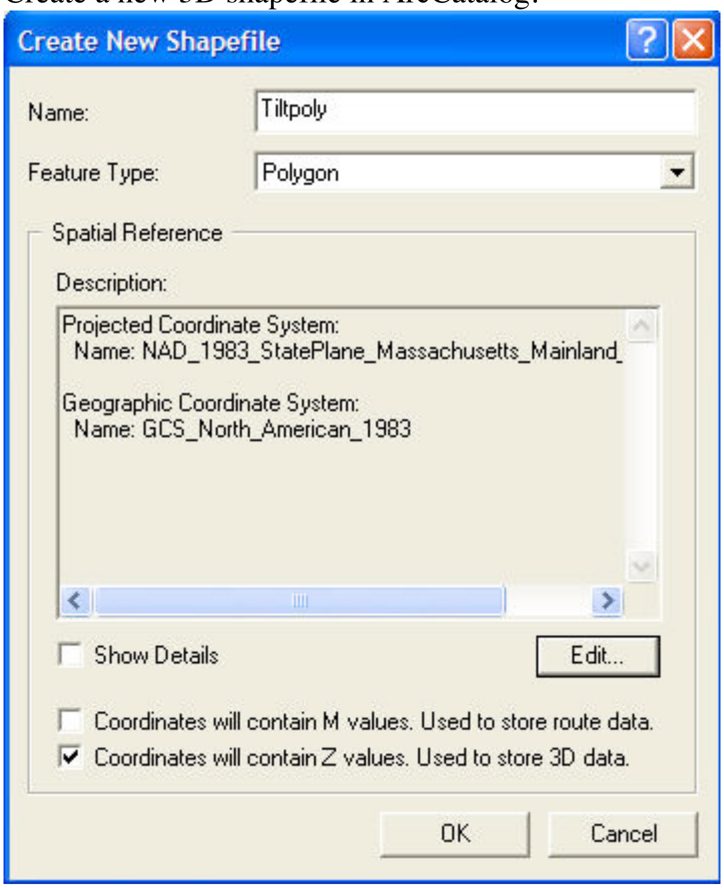

Project Wizard (coverages, grids)
Summary of your input
Input dataset: C:\Data\Hitchcock\82565366\82565366\8256536(
Input projection: GEOGRAPHIC
Datum NAD83
Spheroid GRS80
Units DD
Zunits METERS
Parameters
Input datum: NAD83
Output dataset: C:\Data\Hitchcock\ConnValley
Output projection: State Plane
Units: meters
X Shift (optional): 0
Y Shift (optional): 0
Output datum: NAD 1983 (US-NADCON)
Save to AML...
Save to .prj file...
Help
< Back
Finish
Cancel

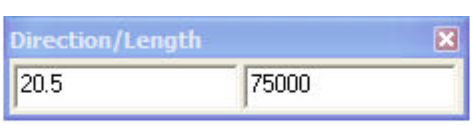
Create a 3D polygon



A 3-dimensional polygon has 3 coordinate values at each vertex; x, y, and z. The z coordinate is the elevation value. In this exercise you will create a 3D polygon oriented so that one side is perpendicular to the direction of rebound and the other is parallel to it. Elevation values will be assigned on the basis of the rebound rate.

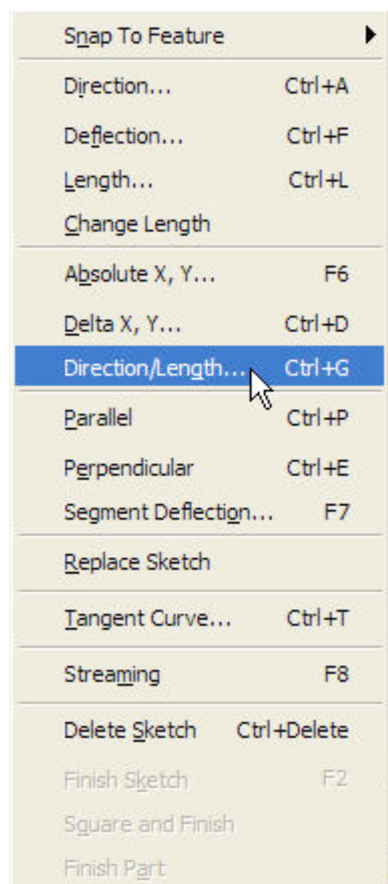
Create a new 3D shapefile in ArcCatalog.

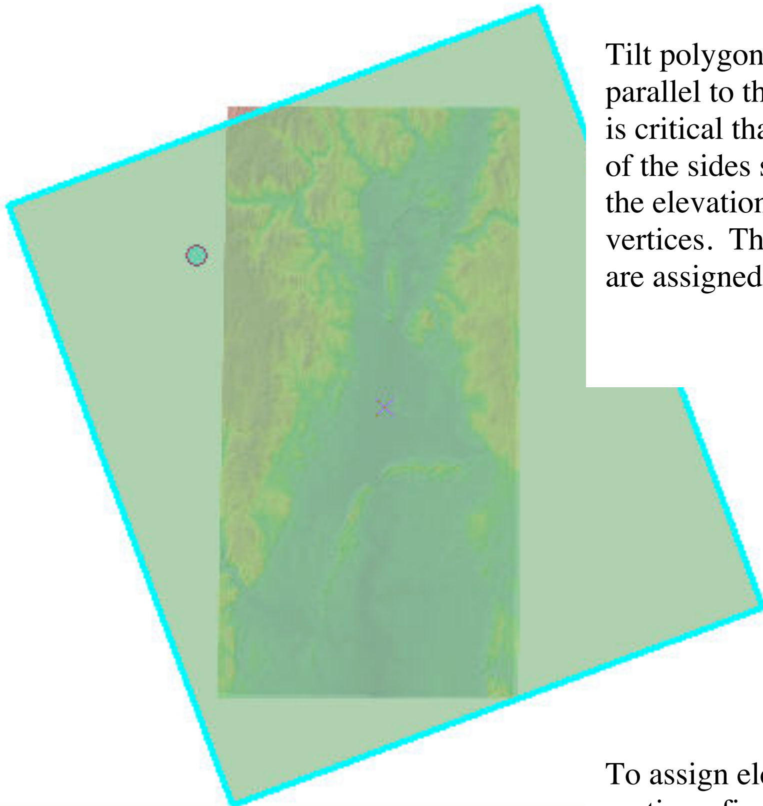




Dialogue box to enter direction and distance. Keep track of distances!

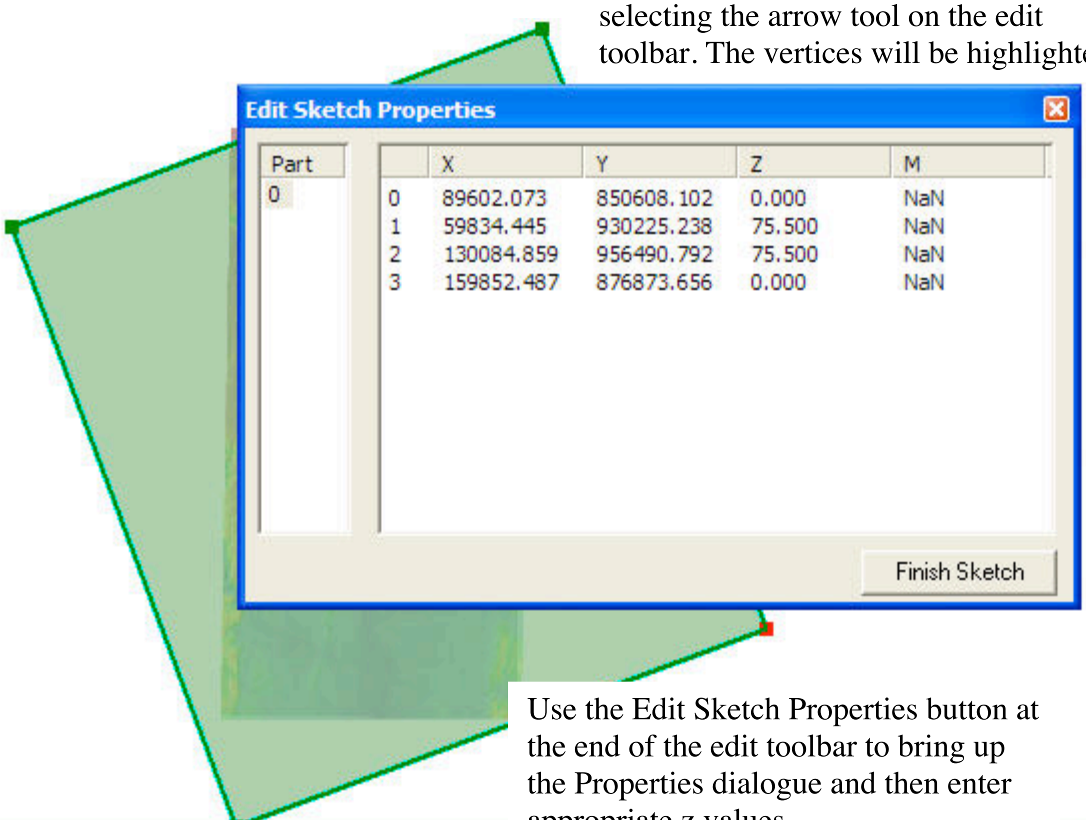
Start editing, create the first vertex then right click to make the second vertex. Use the Direction/Length option and enter the appropriate the appropriate direction and distance. Keep track of distances to ensure a rectangle.





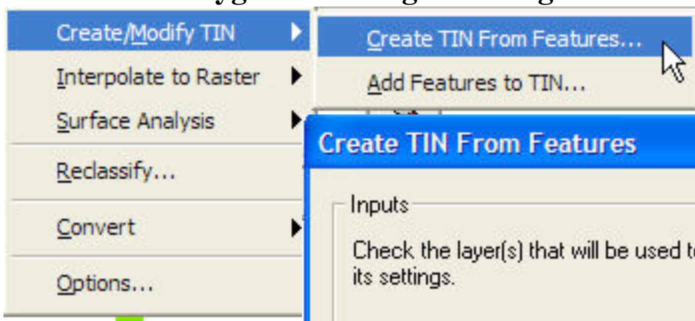
Tilt polygon, with two sides oriented parallel to the direction of rebound. It is critical that you record the length of the sides so that you can calculate the elevation at the two northern vertices. The two southern vertices are assigned an elevation of zero.

To assign elevations to the polygon vertices, first click on the polygon after selecting the arrow tool on the edit toolbar. The vertices will be highlighted.

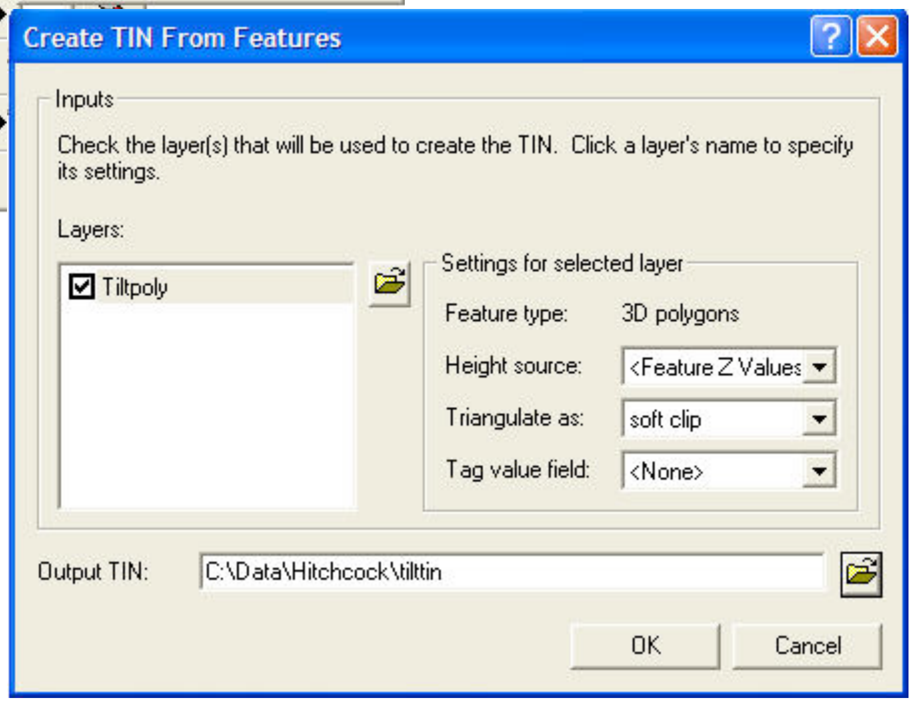


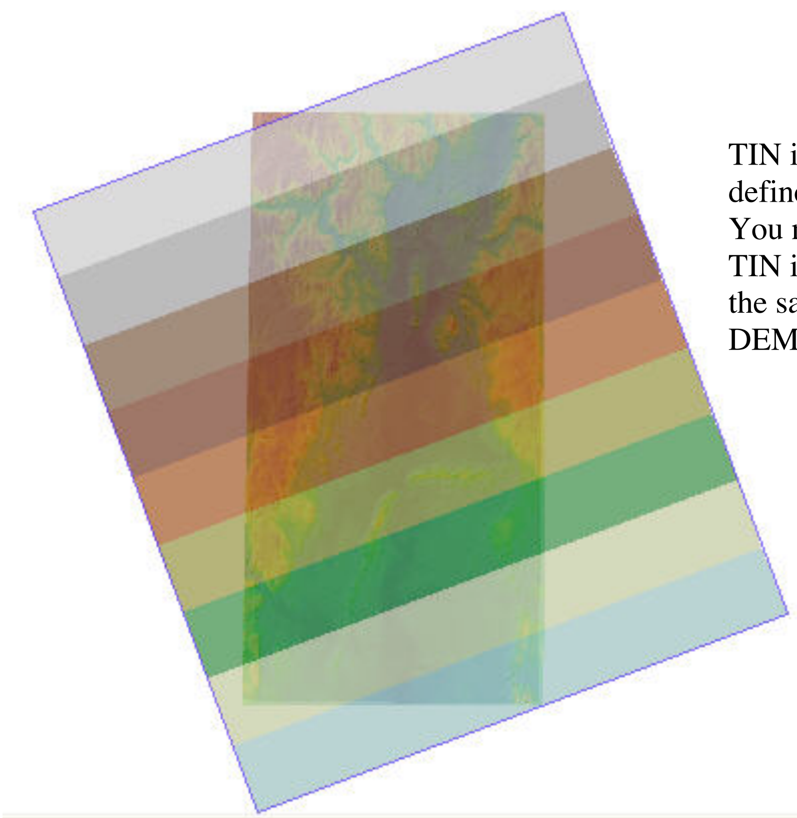
Use the Edit Sketch Properties button at the end of the edit toolbar to bring up the Properties dialogue and then enter appropriate z values.

Convert 3D Polygon to Triangular Irregular Network (TIN)

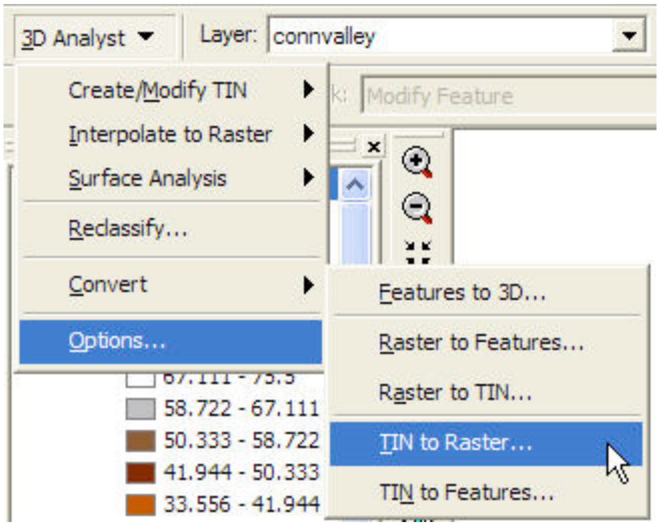


Use 3D Analyst tool –
Create TIN from Features

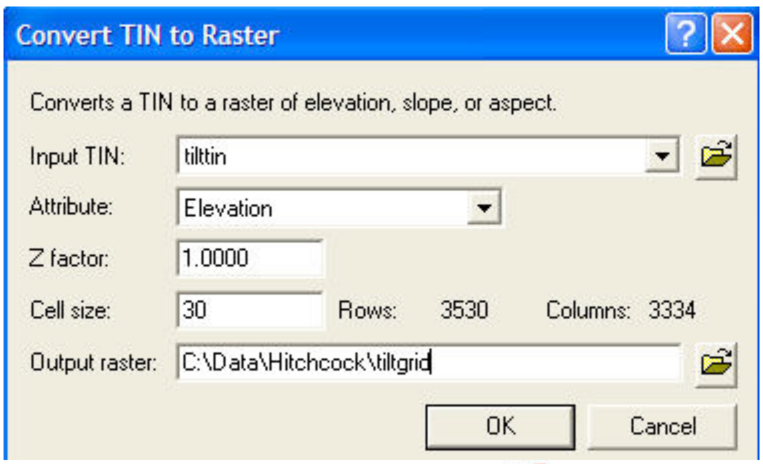




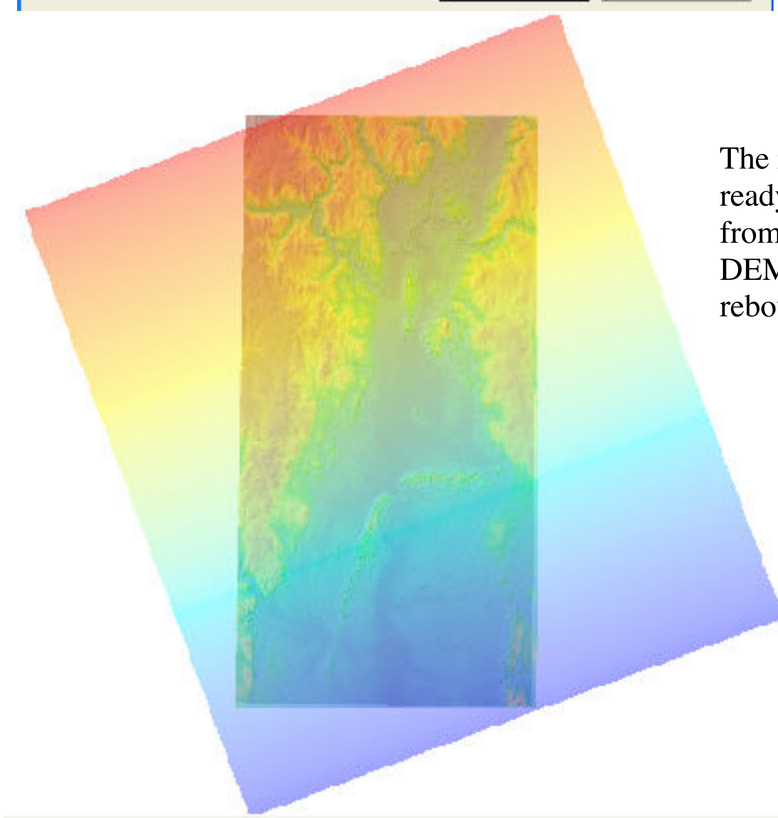
TIN is an inclined plane defined by the four vertices. You now need to convert the TIN into a grid with values at the same locations as the DEM.



Turn the TIN into a raster by selecting Options – TIN to Raster in 3D Analyst.

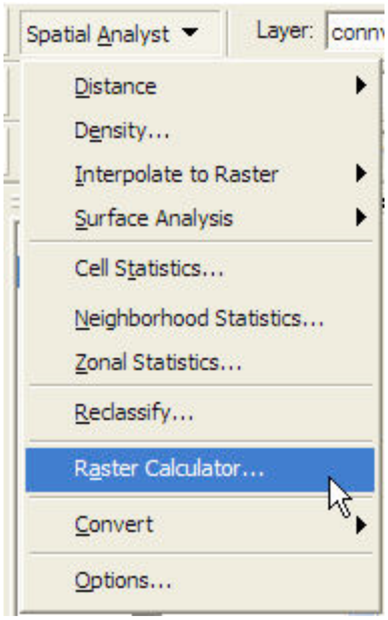


Make sure you set the cell size to 30 meters so that it will correspond to the DEM.

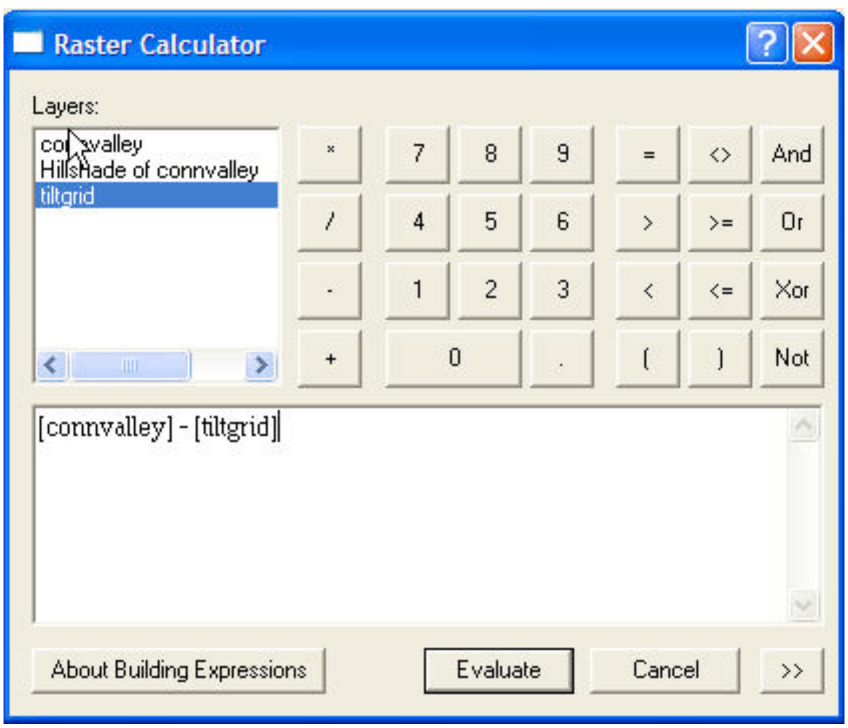


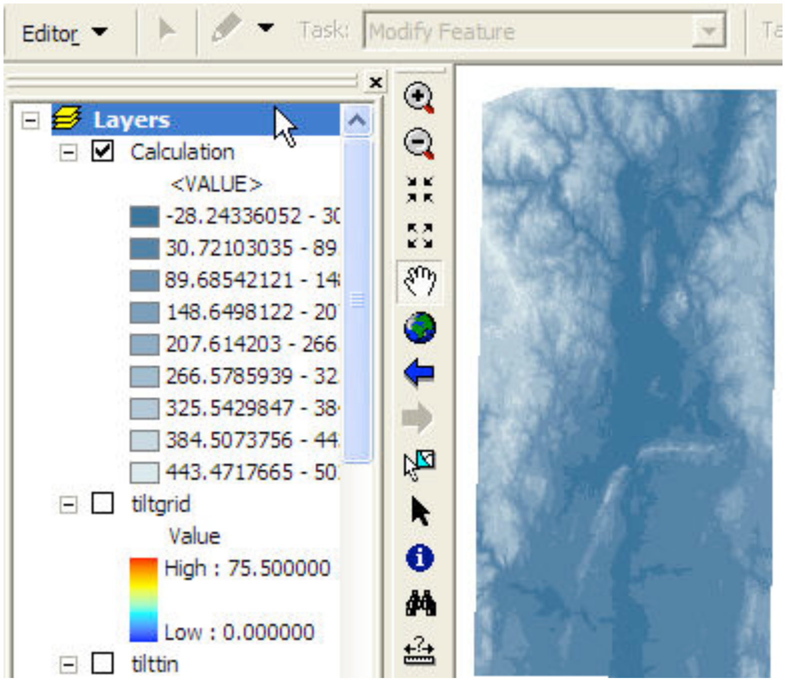
The resulting tilt raster is ready to be subtracted from the DEM to create a DEM with the isostatic rebound removed.

Using the Raster Calculator

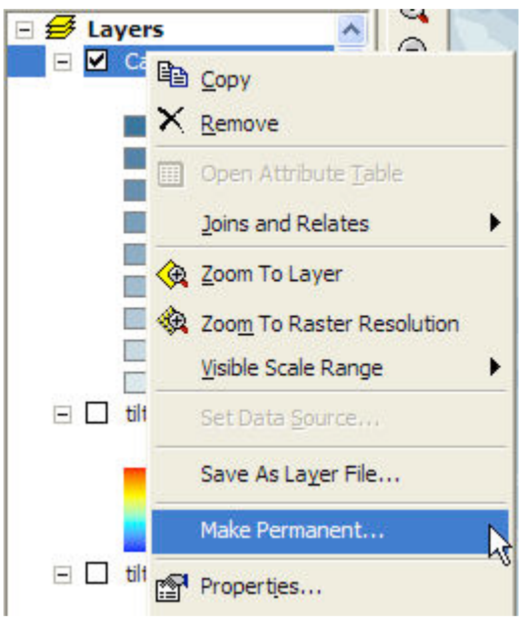


Use the raster calculator to subtract the isostatic rebound grid from the DEM. This will subtract the rebound value from the elevation value at each cell in the grid.

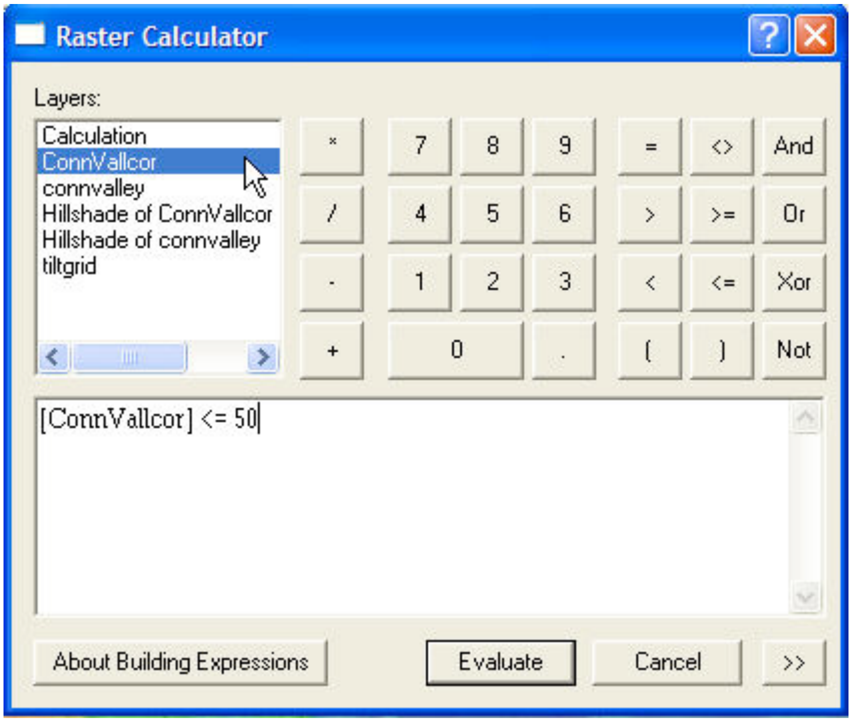




Results of the raster calculator is a DEM where the elevations have been corrected for isostatic rebound.



Right click on the calculation shapefile and used the Make Permanent option to convert to a permanent grid file.



Use the raster calculator to find the lake shoreline. Use the logical operators to query the DEM to locate the shore of the lake.

Results of the query will be a grid of zeros and ones where the zeros represent cells where the query was false and ones represent cells where it was true. You can also convert this raster to a polygon shapefile.