Guide for Downloading and Initial Processing of High Resolution Topographic data for short course "LIDAR Derived DEMs applied to Landslide, Fault, Earthquake Rupture, and Landscape Changes"*(Modelos Digitales de Elevación de LIDAR Aplicados a Deslizamientos de Tierra, Fallas, Ruptura por Sismos y Cambios del Paisaje)*

http://www.opentopography.org/index.php/resources/short_courses/15_UNAM

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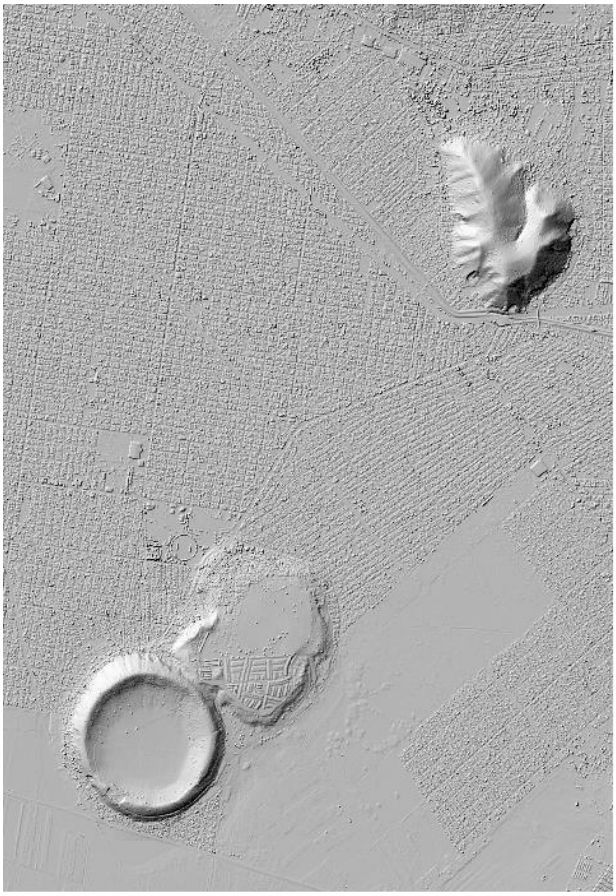
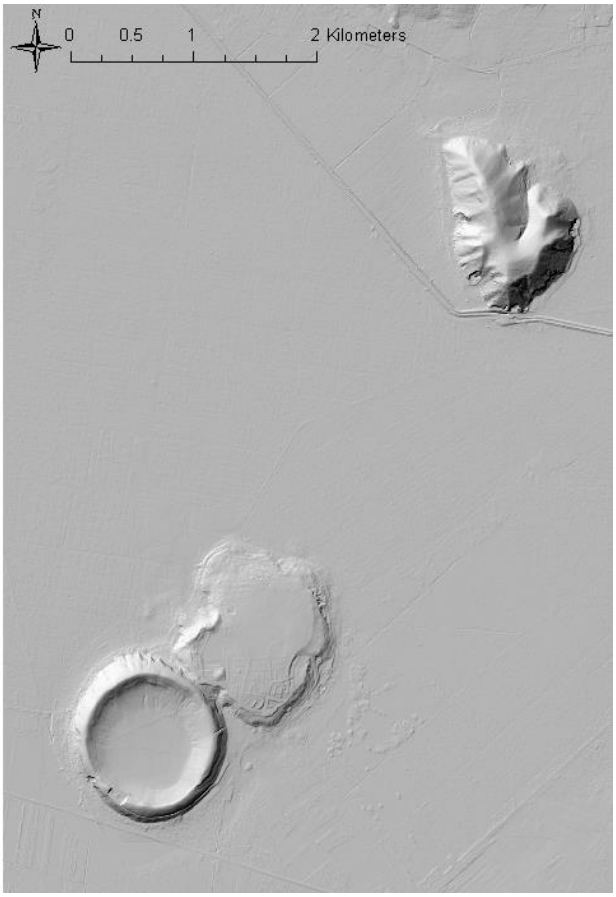
This guide explains how to download high resolution topographic data of México from INEGI (Instituto Nacional de Estadistíca y Geografía). The goal is to download the data and prepare it for working in ArcGIS for analysis.

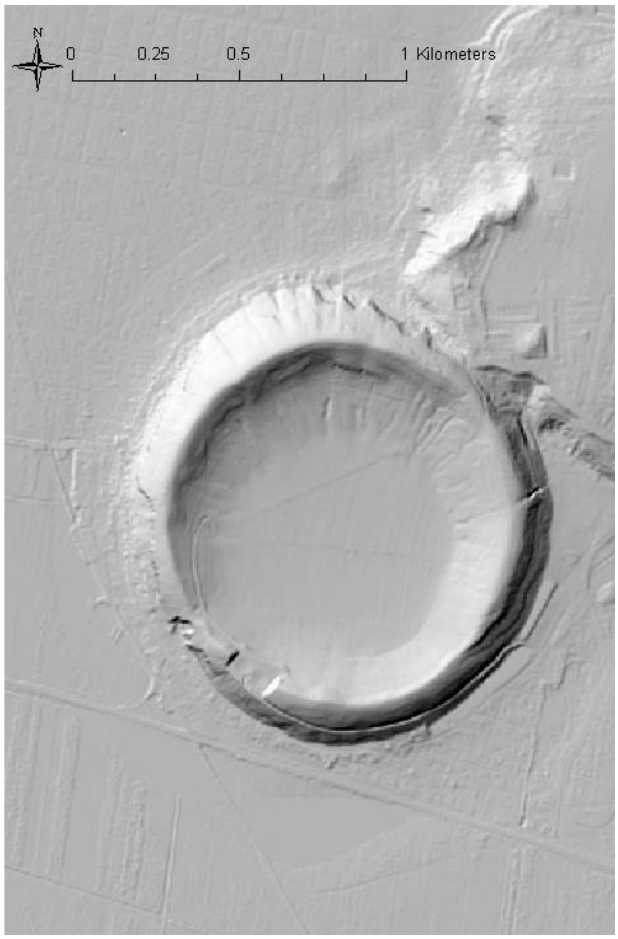
There are two types of gridded data available (this is not the LAS format point clouds):



Superficie (surface or highest hit)-



Terreno (bare earth)



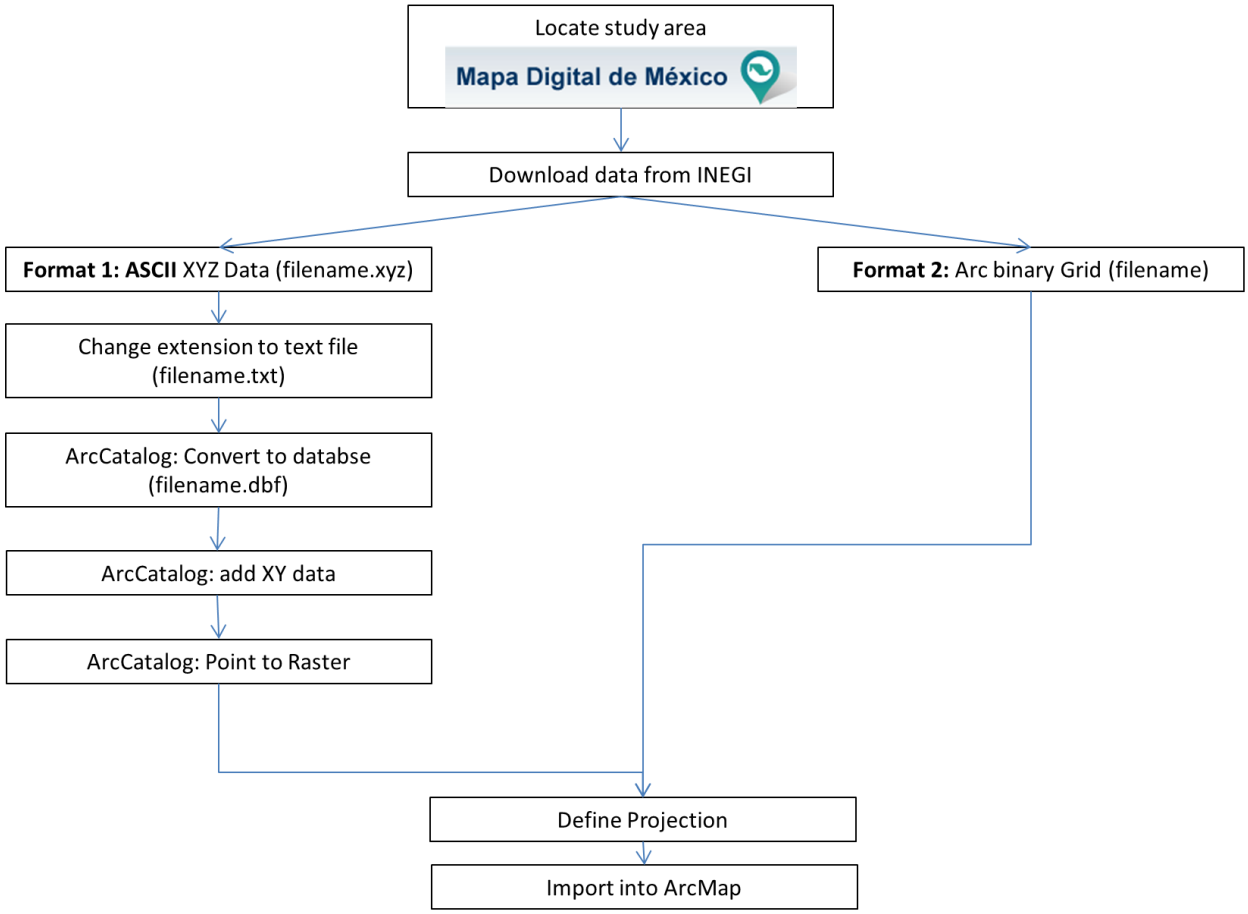
Superficie (surface or highest hit)- ***Terreno (bare earth)***

[These data are from INEGI: E14B31D3 & E14B31D4; 5 meters per pixel digital elevation models (Modelo digital de elevación de alta resolución Lidar) from the area of Parque Xicotencatl).

Software needed

- ESRI ArcGIS. We will use ArcCatalog and ArcMap
- Software to extract data from .zip files
    - Free options- 7-zip: http://www.7-zip.org/download.html
    - WinRAR: http://winrar.en.softonic.com/download

Flow chart below illustrates import pathways depending on gridded data depending format (.xyz or binary grid).

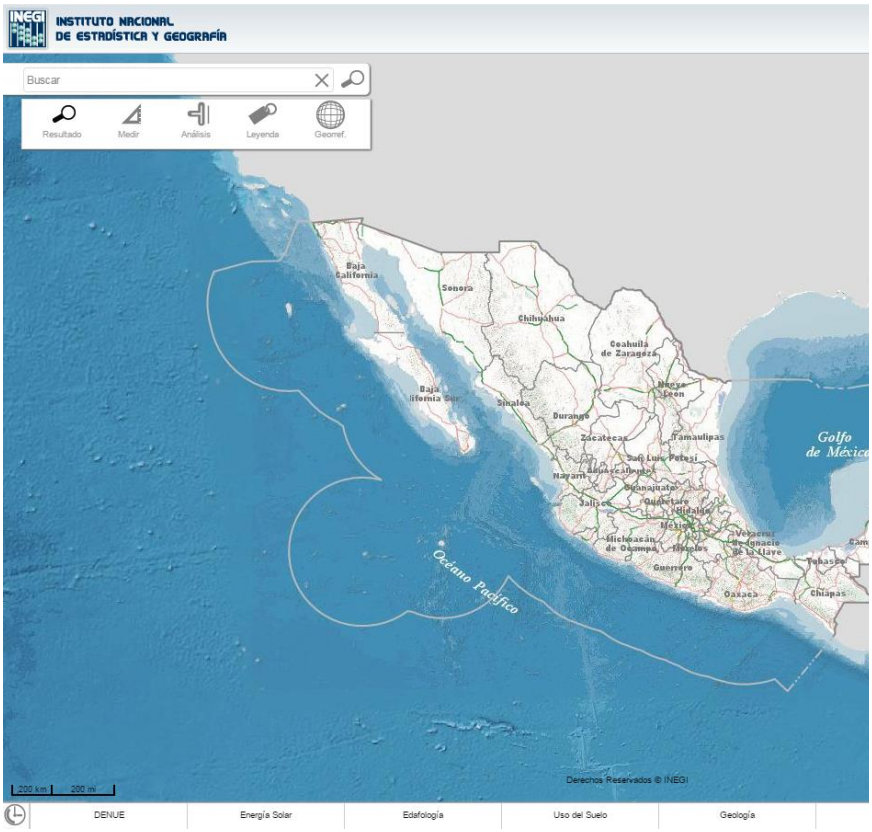


STEP 1- LOCATE DATA FOR DOWNLOAD

Before downloading data, you need to find the data areas you are interested in using INEGI's Mapa Digital de Mexico.

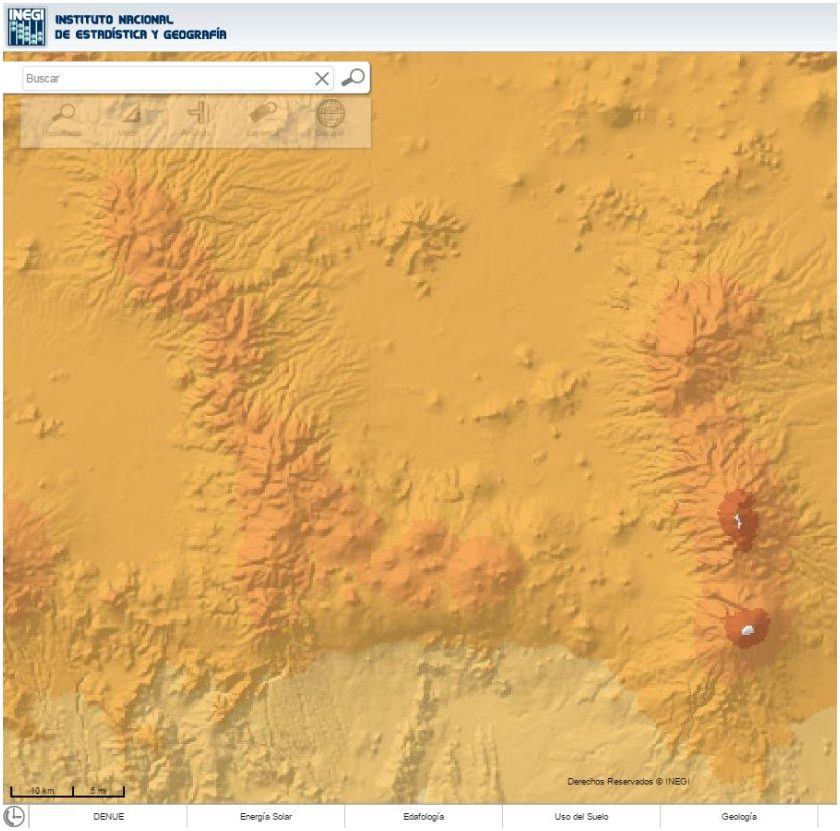
Mapa Digital de México

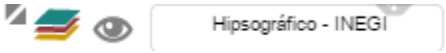
http://gaia.inegi.org.mx/mdm6/



There are layers on the right side. Select the layer that will best show the area you are interested in. We are interested in topographic data, so the "topográfico con sombreado - INEGI" is the best.

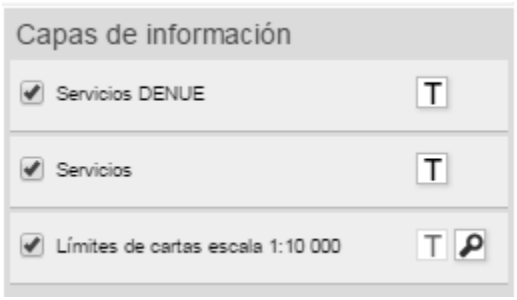
Zoom to your area of interest.

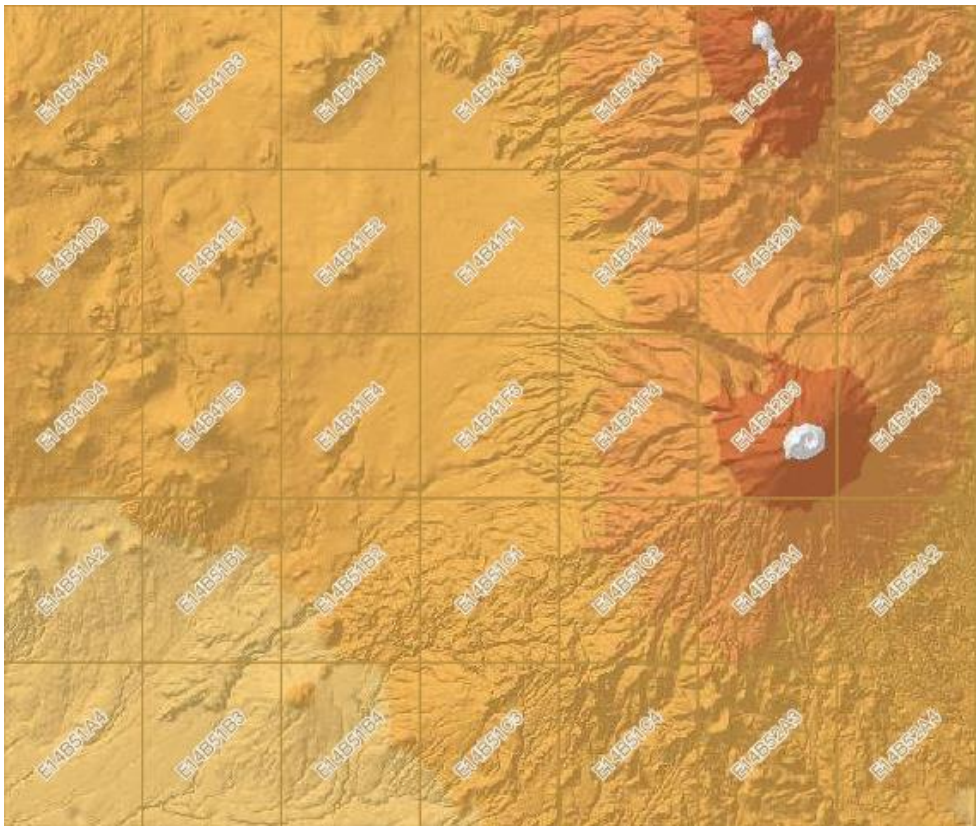




Select the “Capas” or layer symbol (green, red, yellow layer symbol below map) to bring up the layers that are available.

Scroll to “Marco cartográfia”, select box next to “Límites de cartas escala 1: 10 000” and select the T symbol. It will be added to the column on the right and added to your map. You can then close the Capas window.





IF THE T IS NOT SELECTED, THE DATA INFORMATION WILL NOW SHOW. Make sure that it is turned on. Depending on your internet browser, it may take a few seconds to show the tile names.

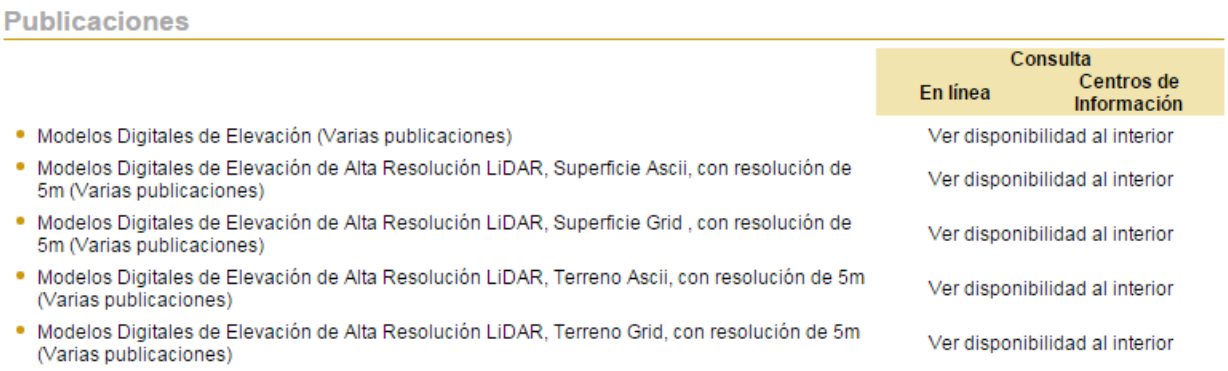
You can also select individual tiles to see what their title is

Make note of the tiles you are interested in downloading by copying the code from above for the data you want to download (Example: E14A49F2).

STEP 2- DOWNLOAD DATA FROM INEGI

Follow this link to download the data:
http://www3.inegi.org.mx/sistemas/productos/ContenidosSD2.aspx?cl=209010000&cs=0&ac=0&N=0&A=0&Nv=2&titulo=Continental

You will have the option of downloading data in GRID or ASCII format for surface or bare earth DEMs. Click on the link.

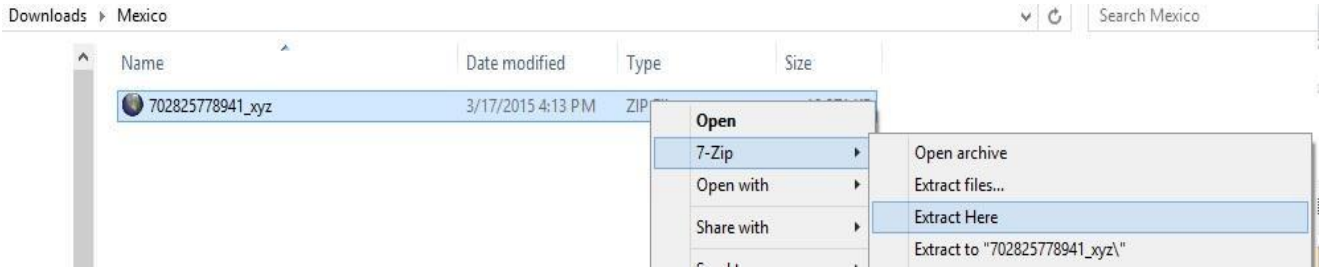


You will be given an option to search for the data, enter the tile code in the box.
Note: Not all tiles contain all data. Some regions are missing ASCII (filename.xyz), GRID (filename) or both.

The first page has the metadata about the file. It is important to note the “Proyección” and “DATUM”. We will need this information later. For example, the file below is in Universal Transvera de Mercator, or UTM, with ITRF92 datum.

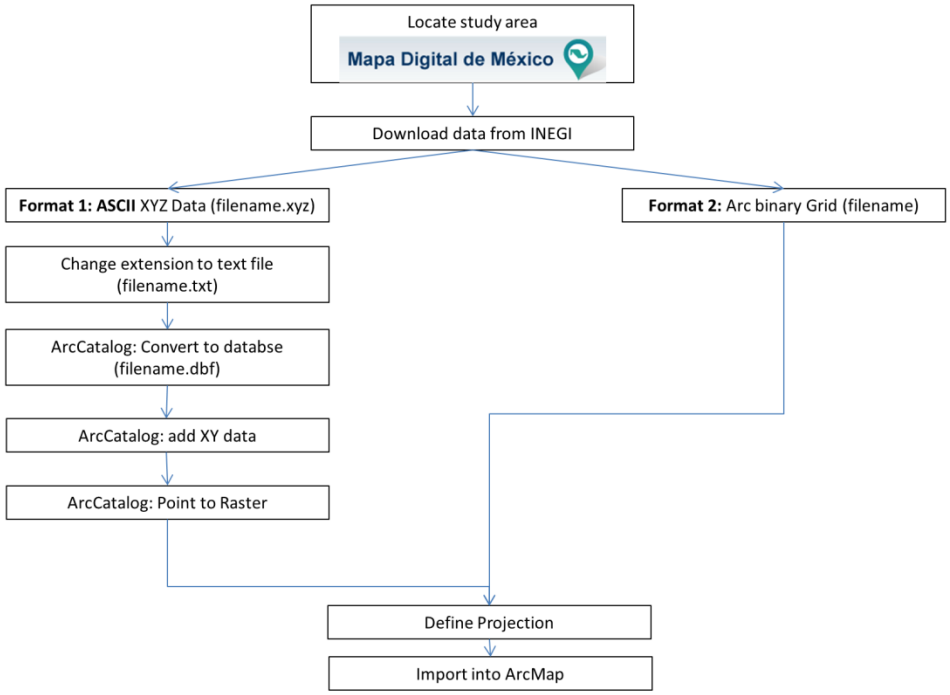
Click on the title of the result you want to download, and switch the tab to “Descarga”. Click on the XYZ icon to download the data.

Right click on the zip to extract the files you have downloaded.

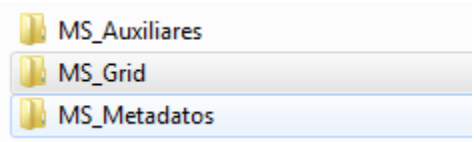


There are two formats of data that are downloaded from INEGI: XYZ data (filename.xyz) or Arc Grid (filename). They may be different based on your area of interest so please take note.

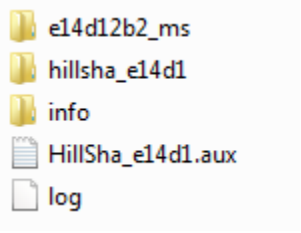
Take a look at this flow chart to see which process you must follow to access your data.



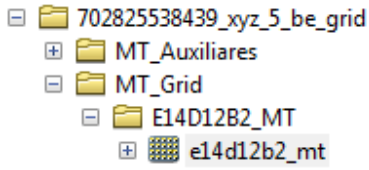
Format 1, GRID format- Grid is an elevation file data format



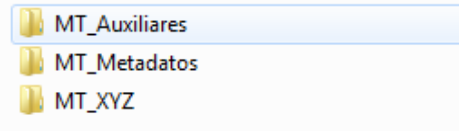
The folder "MS_Grid" contains a grid file that looks like this in windows explorer. To view the file, you have to use a piece of GIS software like ArcMap or ArcCatalog



File in ArcCatalog,



Format 2, ArcGrid format- ASCII is the same as a text file

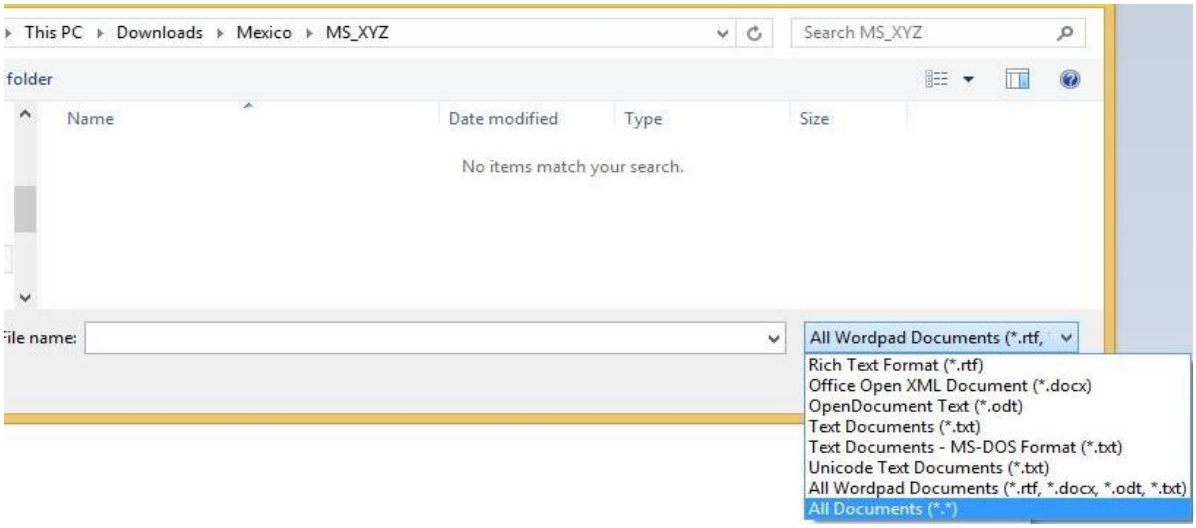


The folder "MT_XYZ" contains a text file like this one, "E14D12B2_MT.xyz"

```
552797.500 1983187.500 1205.520
552802.500 1983187.500 1203.670
552807.500 1983187.500 1201.870
552812.500 1983187.500 1200.000
552817.500 1983187.500 1198.100
552822.500 1983187.500 1196.020
552827.500 1983187.500 1193.730
552832.500 1983187.500 1191.750
552837.500 1983187.500 1189.710
552842.500 1983187.500 1187.480
```

The 3 columns are x coordinates (UTM Easting), y coordinates (UTM Northing, and z coordinates (elevation) for lidar points. We will need to convert these data to dbf files to open them up in ArcGIS.

First, open files in Wordpad or other .txt document. You may need to change the file type to "all file types" if you cannot locate XYZ.

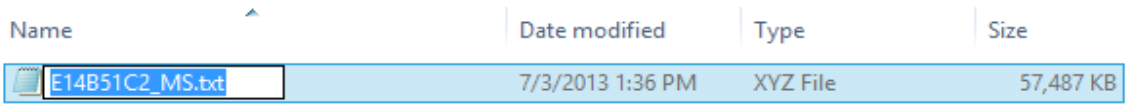


https://www.youtube.com/watch?v=sQRM3hD_Iy8

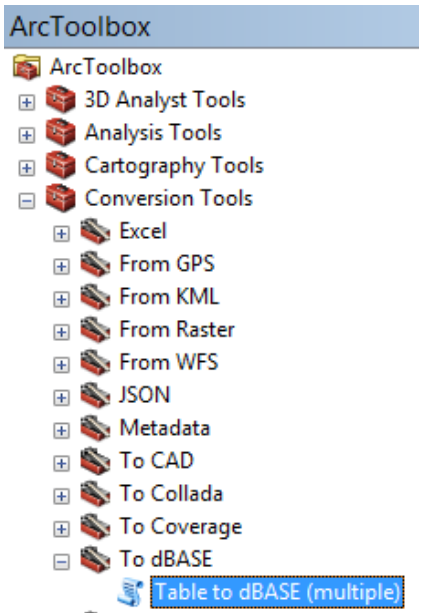
YouTube video explaining the following process of converting .xyz files to Arc Binary Grid files.

The results should look like the three rows of numbers shown above, with the X value column equally spaced in 5 meter intervals, and the Y values in 0 meter intervals. These represent the Easting and Northing values. So no change in the Northing values means the data was taken in an east-west line and represents a Digital Elevation Model, and not a random point cloud.

Next, go into your folder, right click on the file and select "rename file" and change the file name to ".txt".



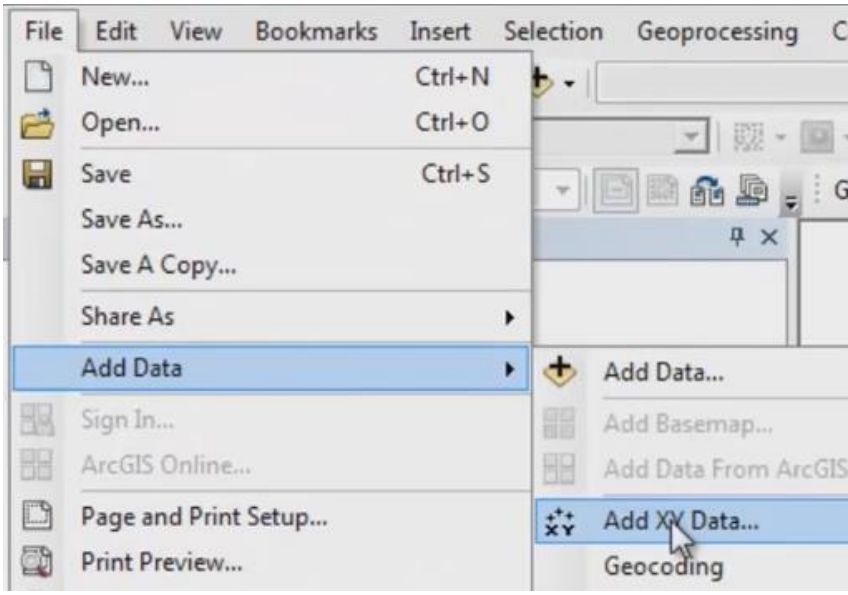
You may have to make this file name change at the command line to truly turn it in to a .txt file:

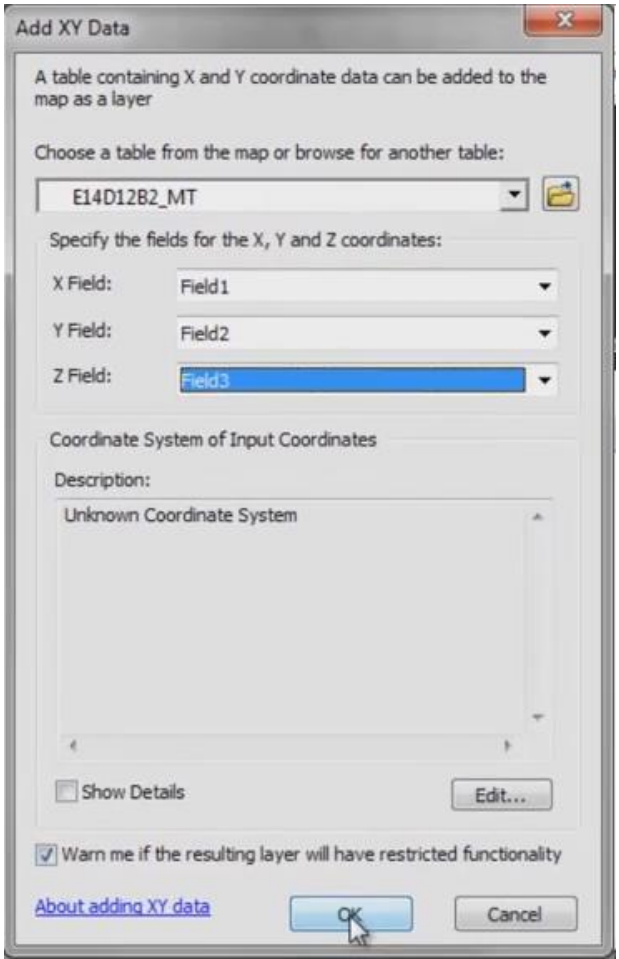


Now open up Arc and use the Toolbox → Conversion Tools → To dBASE → Table to dBASE (multiple) to import the file.

Select your .txt file as the “input” and select the same folder for your “output” location. You can place it in any folder, just remember where you put it.

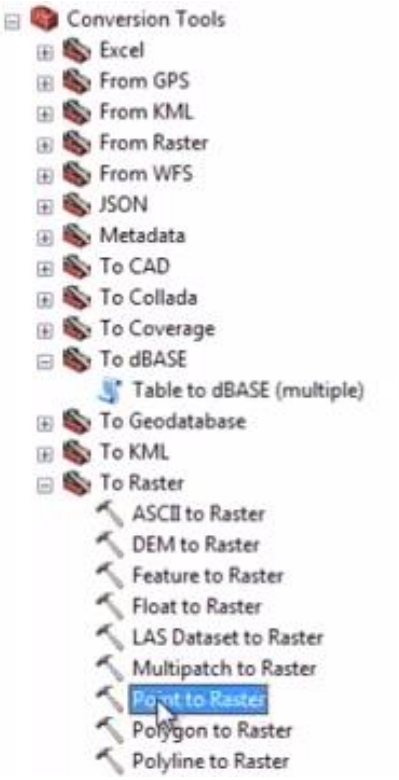
When this is complete go to File → Add Data → Add XY Data





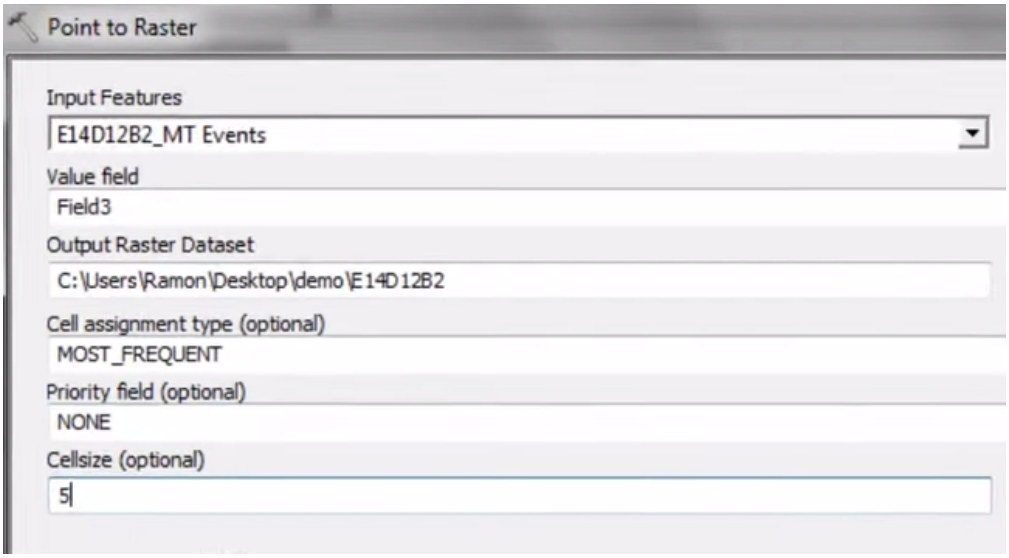
Add the DBF file where it asks you to choose a table, and make sure that the X Field says “Field 1”, the Y Field says “Field 2”, and the Z Field says “Field 3”.

The result will be evenly spaced points. It will look like a black square, but if you zoom in you will see the individual data points. You can click on the Info tool and click a dot to see it's specific X, Y, and Z value.

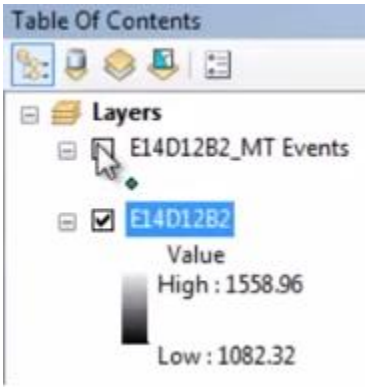


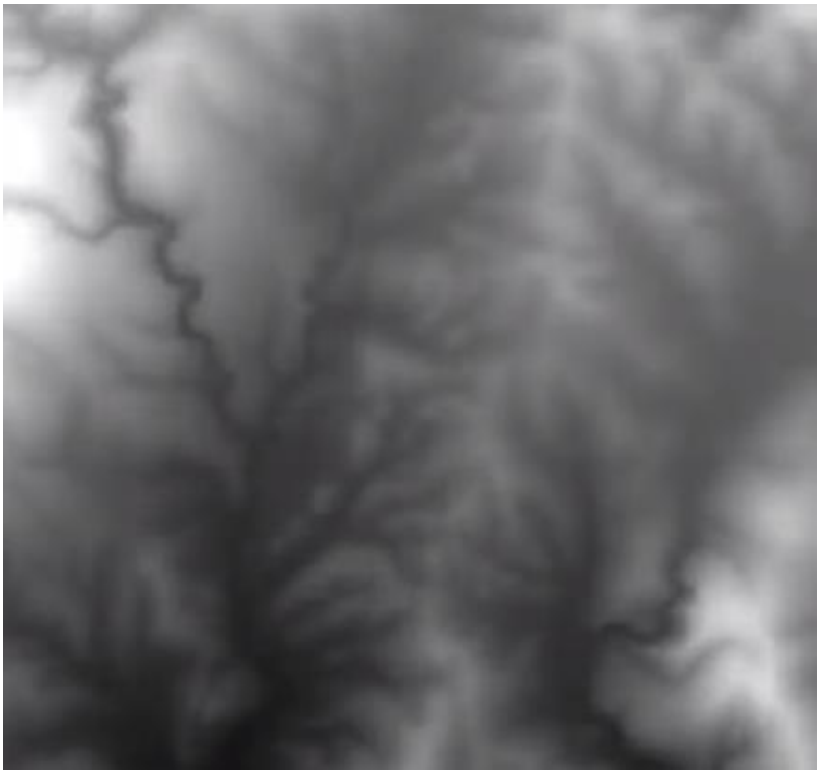
Now you can convert these files to raster by going to Toolbox → Conversion Tools → To Raster → Point to Raster.

In the boxes provided choose the "Event" file for your input, and change the field to you Z values "Field 3", and change the output to your same folder, and give it the binary name to keep things consistent. You should leave the Cell Assignment Type and Priority Field as "Most Frequent" and "None". The Cell size should be changed to 5 meters.



Finally, go into your Table of Contents and turn off your Points by unchecking the box next to your event file, and the finished product is your Digital Elevation Model.





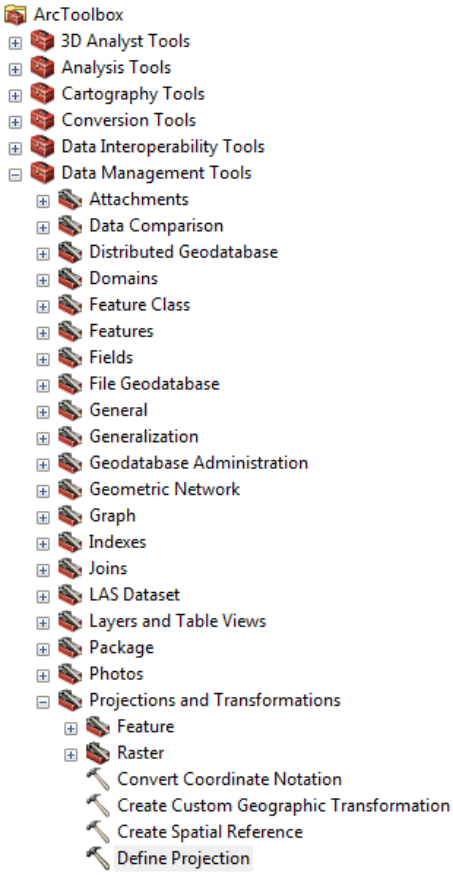
From this point you can continue on to make contour interval layers and hillshades, etc.

STEP 3: DEFINE PROJECTION

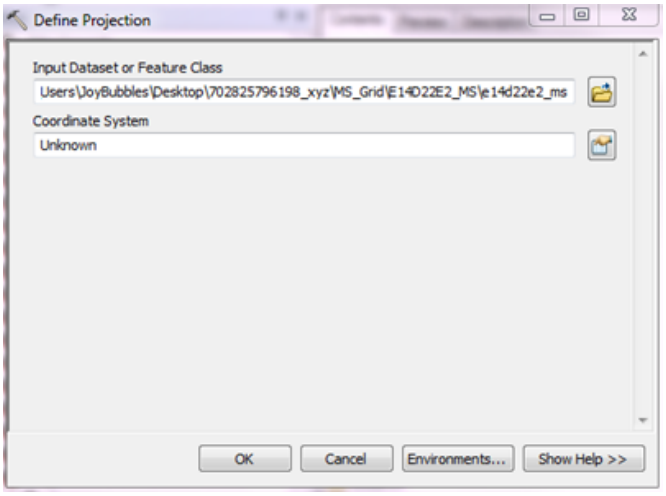
Before loading data into ArcGIS, the coordinate system must be identified for the file. This is important for placing your map in the correct area and lining up with any previous mapping done or GPS points.

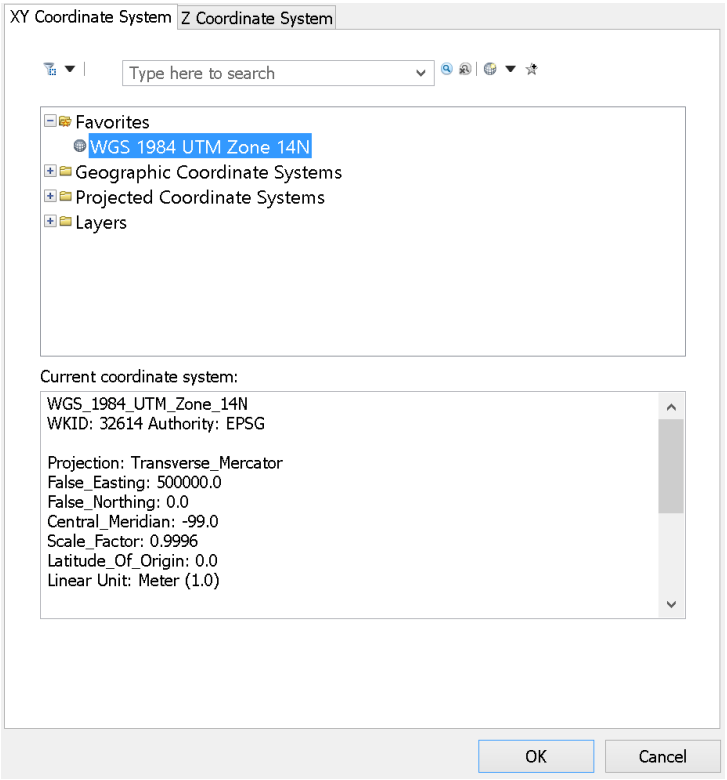
You should have found the projection information for your file in step 2. If not, go back to the INEGI website and locate it. You can also find it in the MS_Metadatos metadata file.

To define projection you go to ArcToolbox > Data Management Tools > Projections and transformations > Raster > Define Projection



Add the DEM file. Click the  symbol to select your coordinate system.



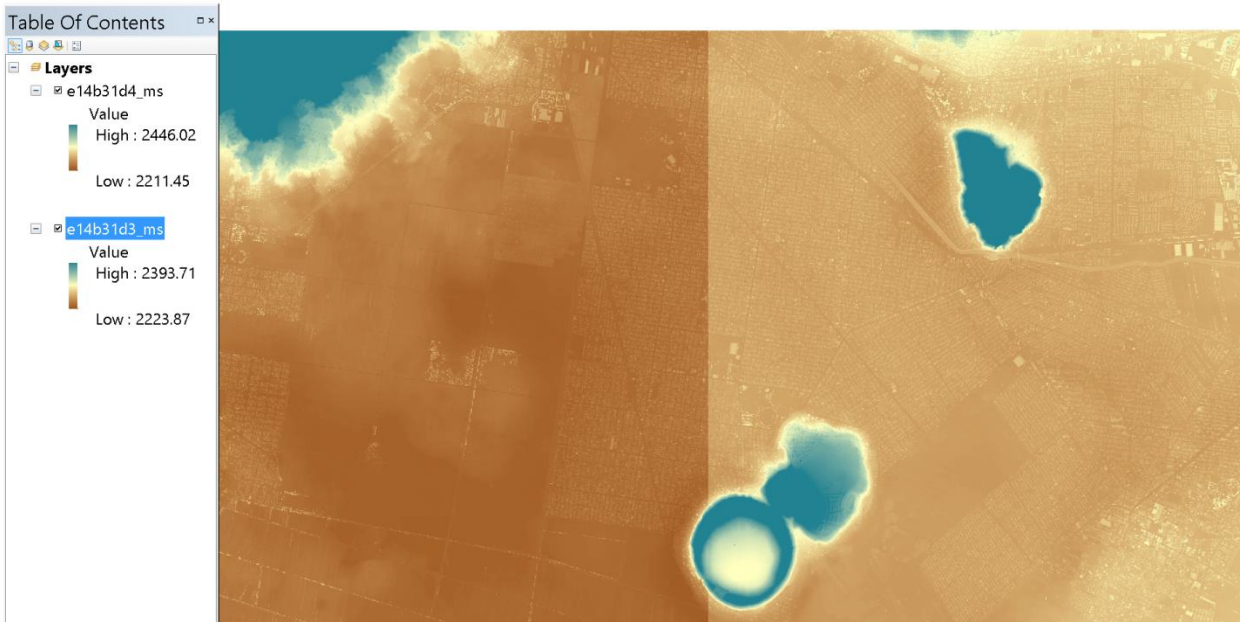


You can search for the coordinate system by typing it into the search box. The example from earlier was in ITRF 1992. **However, ArcGIS does not support projected ITRF datums so we will use WGS84 UTM with appropriate zone.**
Click ok to apply to your DEM.

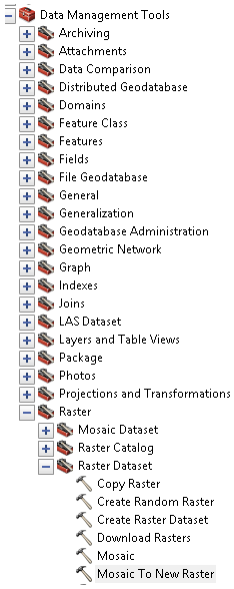
Once you've defined your coordinate system, you are ready to start DEM analysis in ArcMap!

STEP 4 (OPTIONAL): Project multiple DEM tiles to new raster

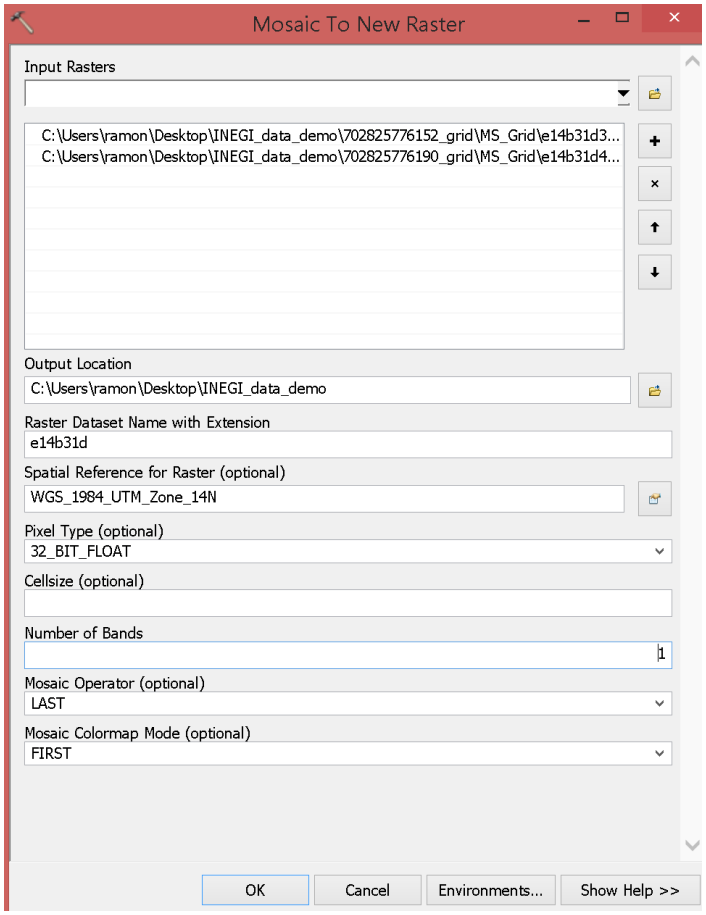
Each INEGI DEM tile is ~6 km E-W and ~7 km N-S and we will most certainly have study areas larger than that or which span tile boundaries (like the volcano of Parque Xicotencatl).



Therefore we should Mosaic them to New Raster:



ArcToolBox->Data Management Tools -> Raster -> Rster Dataset ->Mosaic to new Raster



Parque Xicotencatl area projected and mosaicked surface colored DEM semi-transparent over hillshade.