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# A P P U N T I

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MATERIA: Laboratory of GIS and Geospatial Service for engineering Applications labs exam project - Prof. Piras, Tamea, Pirra, Aicardi

# POLITECNICO DI TORINO

## Master in Civil Engineering

## a.y. 2019/2020

# Laboratory of GIS and Geospatial Service for Engineering Applications

**Part 1 – Laboratories Report**

**Part 2 – Hydrology Report**

**Part 3 – Transportation Report**

**Part 4 – Transportation Project**

**Extra! – Oral exam questions & Conceptual Model**

**Professors**
M. Piras
S. Tamea
M. Pirra
I. Aicardi

**Student**
Loredana Mihaela Chiforeanu

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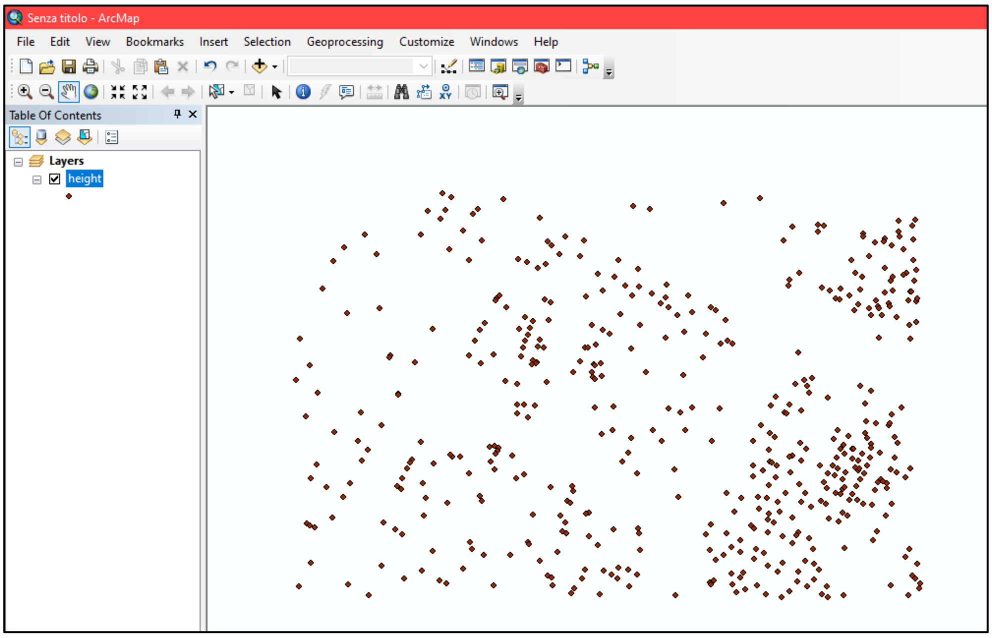
# 1 EX: CREATE A DTM FROM POINTS

We input the given shape file: 'height.shp' in ArcMap.

The **shapefile** format is a geospatial **vector data format** for geographic information system (GIS) software. It is developed and regulated by Esri as a mostly open specification for data interoperability among Esri and other GIS software products (Wikipedia).

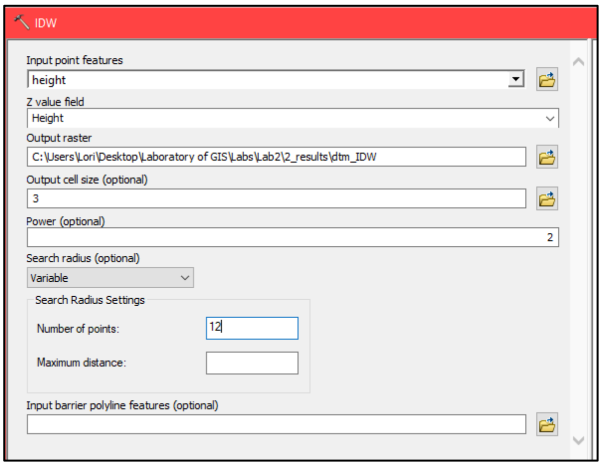



Now we use different algorithms to interpolate the points in order to create different surfaces. Interpolation is the process of using points with known values or sample points to estimate values at other unknown points. It can be used to predict unknown values for any geographic point data, such as elevation, rainfall, chemical concentrations, noise levels, and so on (http://www.gisresources.com/types-interpolation-methods_3/).

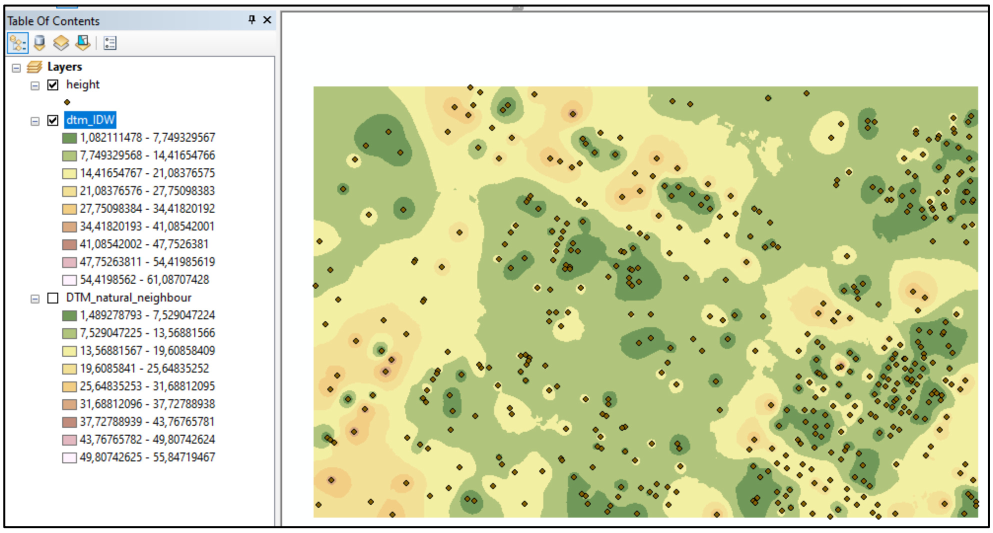
## 1.1 NATURAL NEIGHBOUR

Natural neighbor interpolation has many positive features, can be used for both interpolation and extrapolation, and generally works well with clustered scatter points. Another weighted-average method, the basic equation used in natural neighbor interpolation is identical to the one used in IDW interpolation. This method can efficiently handle large input point datasets. When using the Natural Neighbor method, local coordinates define the amount of influence any scatter point will have on output cells. The Natural Neighbour method is a geometric estimation technique that uses natural neighbourhood regions generated around each point in the data set. Like IDW, this interpolation method is a weighted-average interpolation method. This method is most appropriate where sample data points are distributed with uneven density. It is a good general-purpose interpolation technique and has the advantage that you do not have to specify parameters such as radius, number of neighbours or weights.

Now we choose Natural Neighbour and set the following options; it creates a Raster Surface:




The result is:




## 1.3 KRIGING

Kriging is a geostatistical interpolation technique that considers both the distance and the degree of variation between known data points when estimating values in unknown areas. A kriged estimate is a weighted linear combination of the known sample values around the point to be estimated.Kriging procedure that generates an estimated surface from a scattered set of points with z-values. Kriging assumes that the distance or direction between sample points reflects a spatial correlation that can be used to explain variation in the surface. The Kriging tool fits a mathematical function to a specified number of points, or all points within a specified radius, to determine the output value for each location. Kriging is a multistep process; it includes exploratory statistical analysis of the data, variogram modeling, creating the surface, and (optionally) exploring a variance surface. Kriging is most appropriate when you know there is a spatially correlated distance or directional bias in the data. It is often used in soil science and geology.



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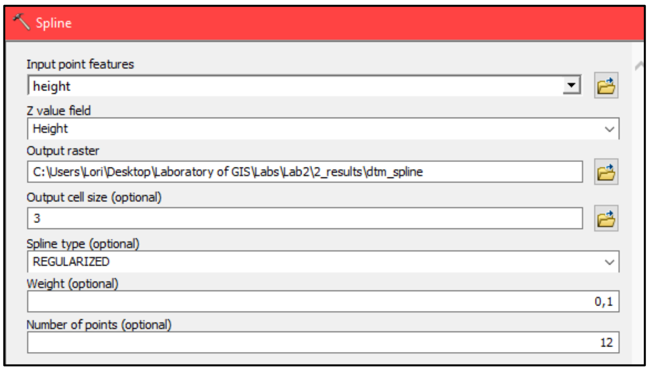
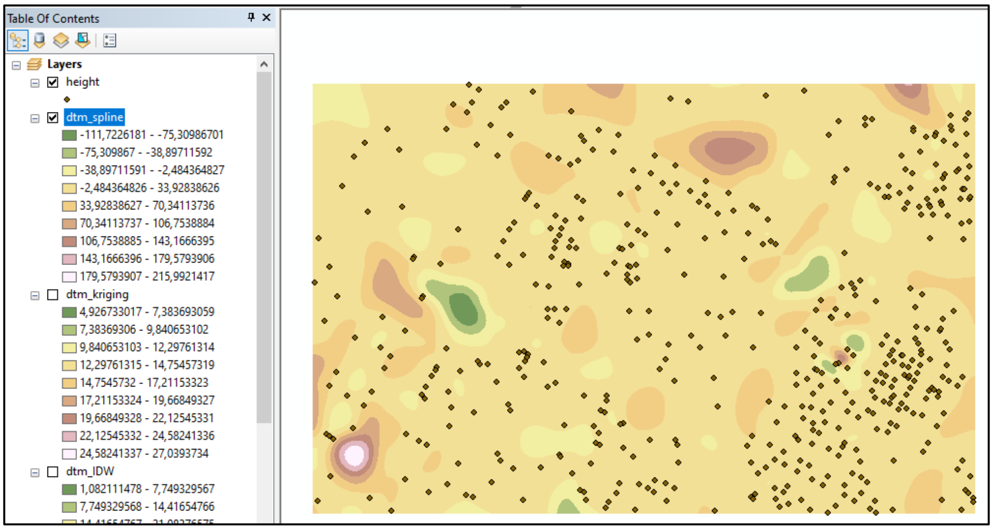
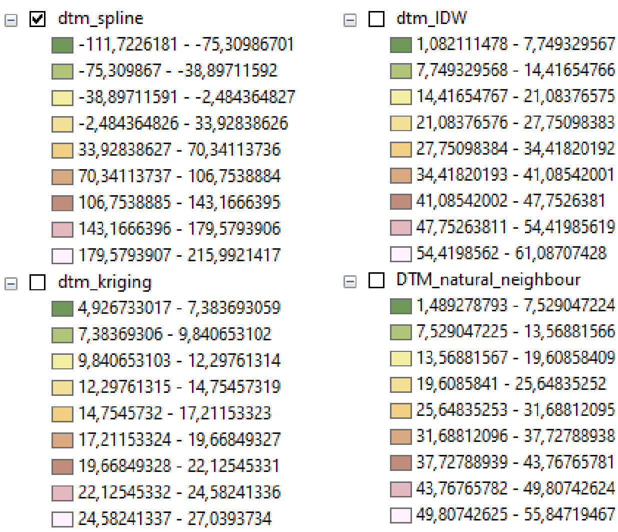



The result is:




**Raster** graphics are the most common type of image files. They are comprised of a **grid of pixels** where each pixel represents an individual colour within the image. Raster data type consists of rows and columns of cells, with each cell storing a single value. Raster data can be images raster images with each pixel (or cell) containing a colour value. Additional values recorded for each cell may be a discrete value, such as land use, a continuous value, such as temperature, or a null value if no data is available. While a raster cell stores a single value, it can be extended by using raster bands to represent RGB (red, green, blue) colours, colormaps (a mapping between a thematic code and RGB value), or an extended attribute table with one row for each unique cell value. The resolution of the raster data set is its cell width in ground units.

## 1.5 Comparison



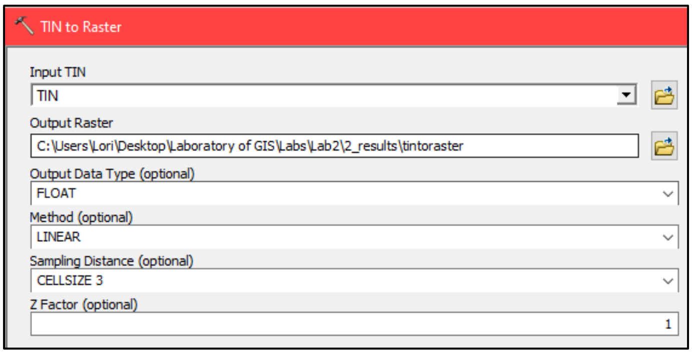

The different interpolation methods give similar results. The one that differ too much is the Spline Method, which is better not to use in this case.

# 3 EX: DTM-TIN CONVERSION

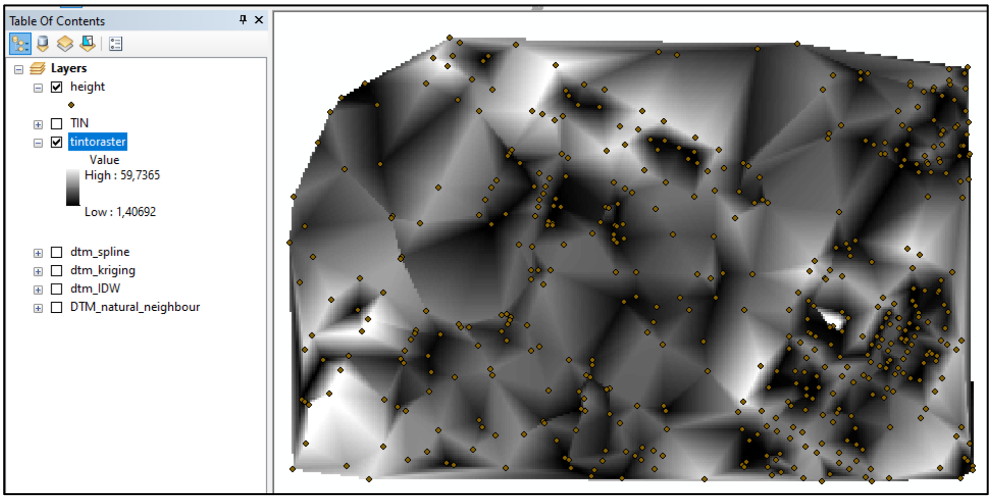
Now we can transform a DTM in a TIN and vice versa and compare the results with the ones obtained in the previous exercises.

## 3.1 TIN TO RASTER

As usual, we take the needed tool and set the options:

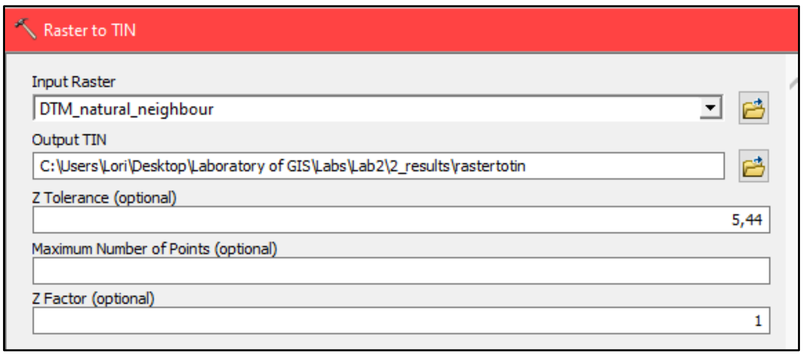



And the result is the following. We can see the pixel value: value of height in the DTM.




## 3.2 RASTER TO TIN

The same is done in the other way.




The tolerance is suggested by the software and we leave it as it is.

If we don't put anything in the 4th field, it means it will use all the needed points.

The result is:



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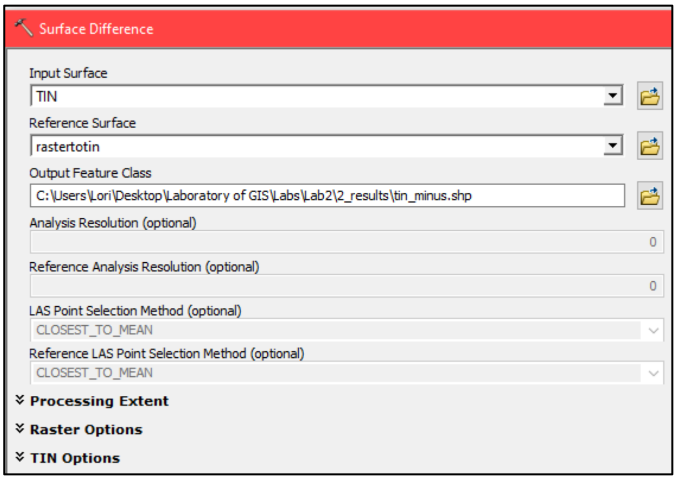
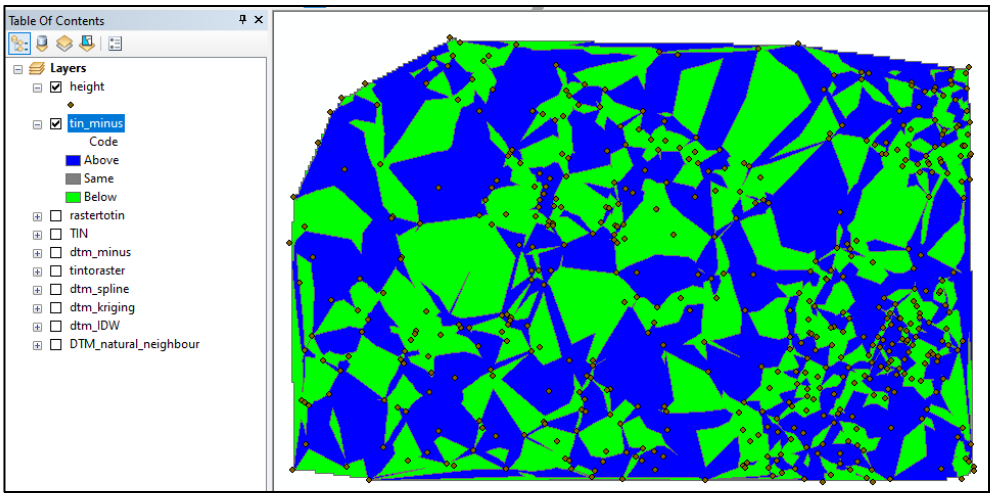
## 3.4 TIN COMPARISON

Now the idea is the same but the function to be used is different.

The options to set are:

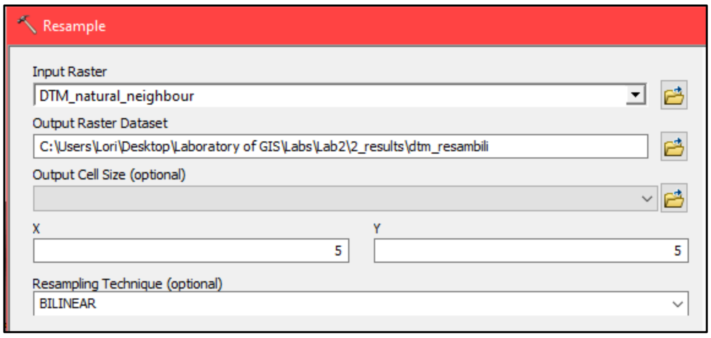



The results are not numbers but the areas above, below or at the same level of the layer 'rastertotin' with respect to the layer 'TIN'.

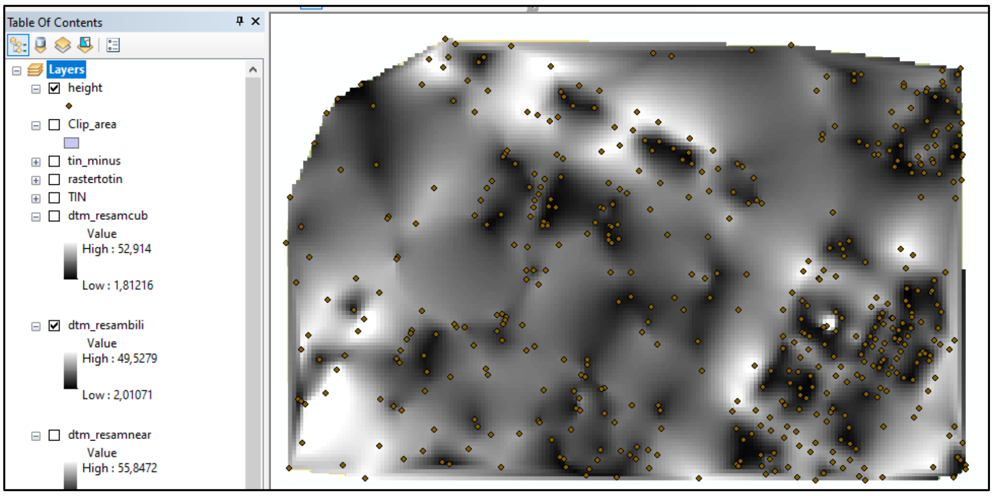



Most of the areas are 'Above' (blue) or 'Below' (green), which is in accordance with the result of section 3.3.

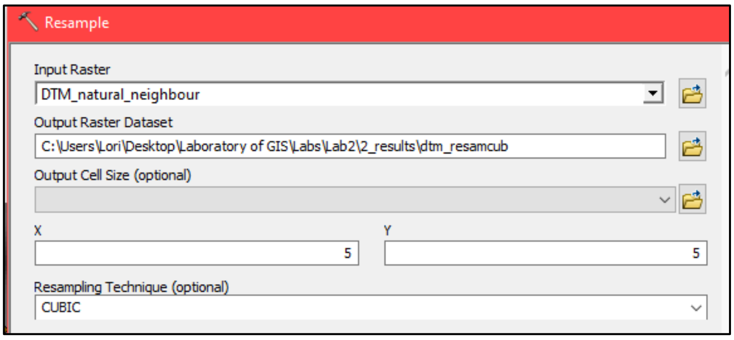
## 4.2 Resample Technique: Bilinear



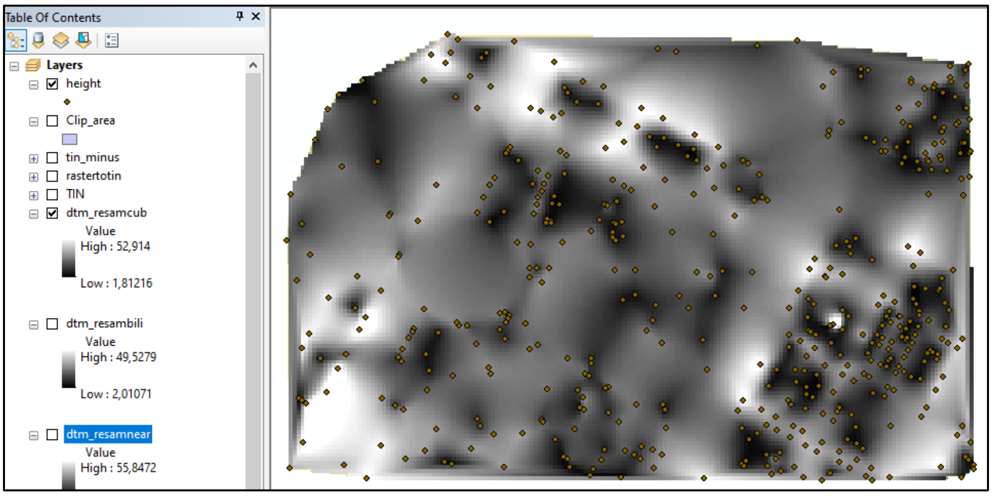

Performs a bilinear interpolation and determines the new value of a cell based on a weighted distance average of the four nearest input cell centres. It is useful for continuous data and will cause some smoothing of the data.




## 4.3 Resample Technique: Cubic

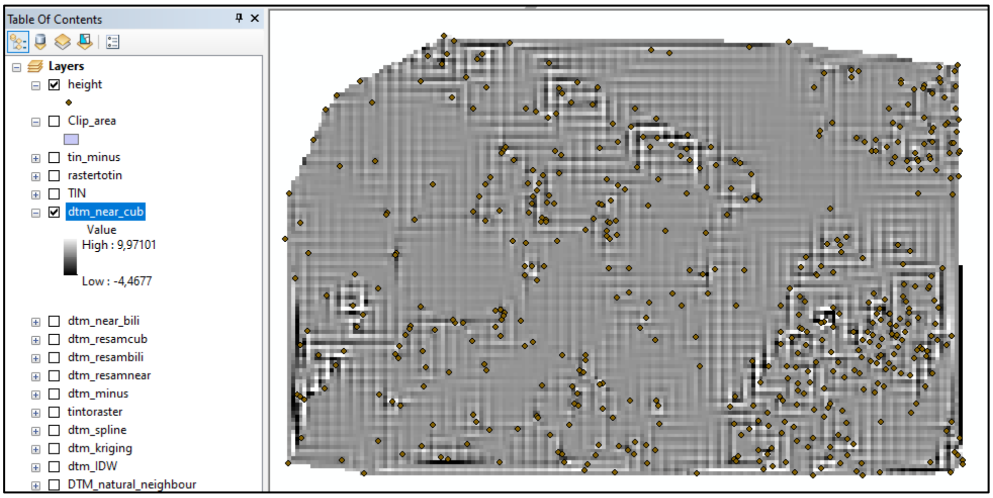



Performs a cubic convolution and determines the new value of a cell based on fitting a smooth curve through the 16 nearest input cell centres. It is appropriate for continuous data, although it may result in the output raster containing values outside the range of the input raster. It is geometrically less distorted than the raster achieved by running the nearest neighbour resampling algorithm.

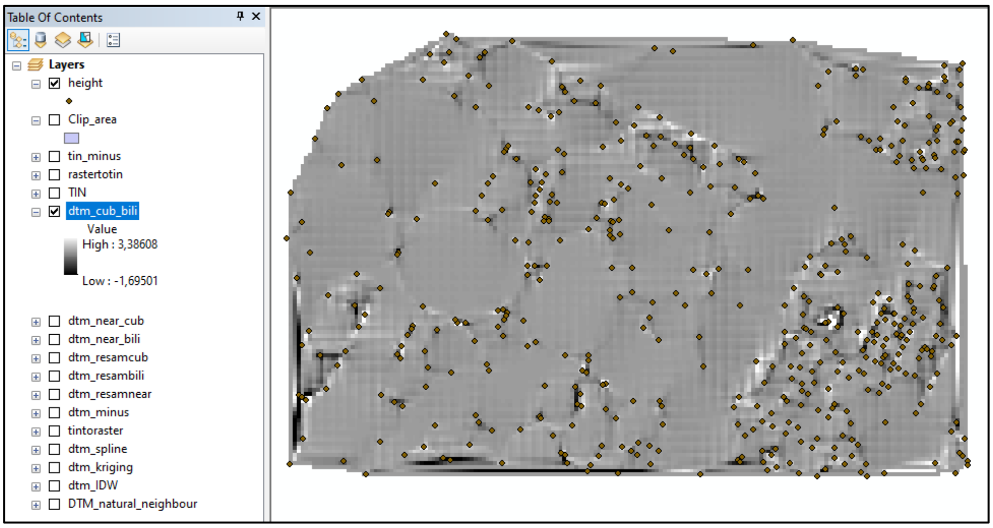



The disadvantage of the Cubic option is that it requires more processing time. In some cases, it can result in output cell values outside the range of input cell values. If this is unacceptable, use Bilinear instead.

The result from Nearest minus Cubic is:

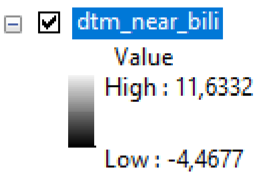



The result from Cubic minus Bilinear is:

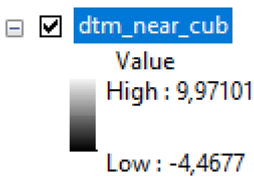



We can resume in the following table the obtained results:

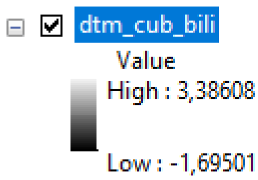
**Nearest - Bilinear**




**Nearest - Cubic**



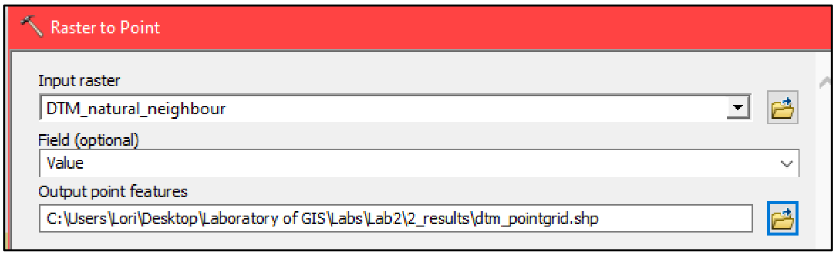

**Cubic - Bilinear**




The difference closest to 0 value is Cubic – Bilinear. The other differences give a bigger range of variability.

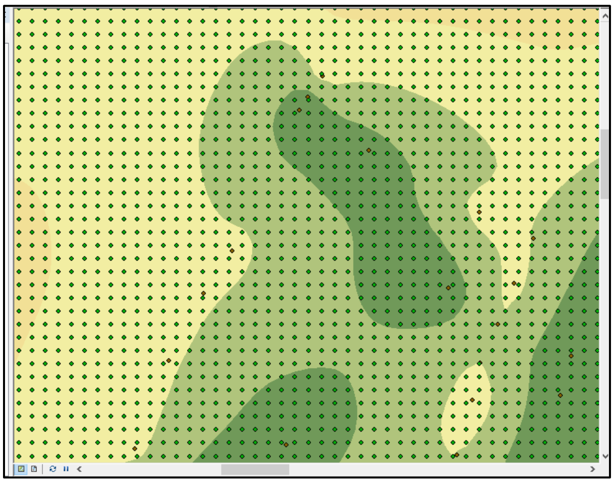
# 5 EX: CONVERT THE DTM TO A POINTS GRID

From the same DTM created in section 1.1, we create a grid of points of regular spacing, by introducing the following parameters:

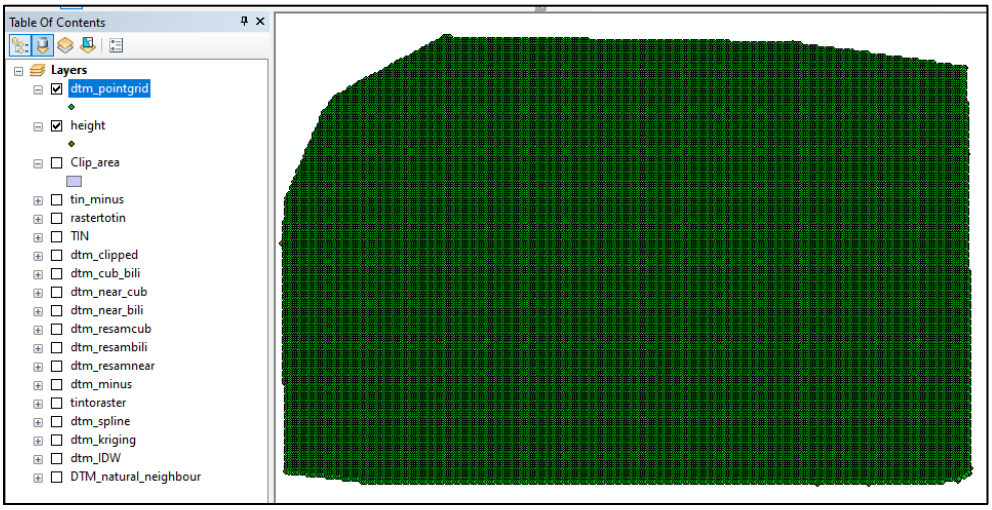



The output file is a shape file, which is a vector dataset. It's a grid of points with distance made by the same size of the cell size. This kind of data is very heavy.

A zoomed area is shown below:



The entire area is shown in the following picture. With this zoom it's not possible to see the grid clearly.



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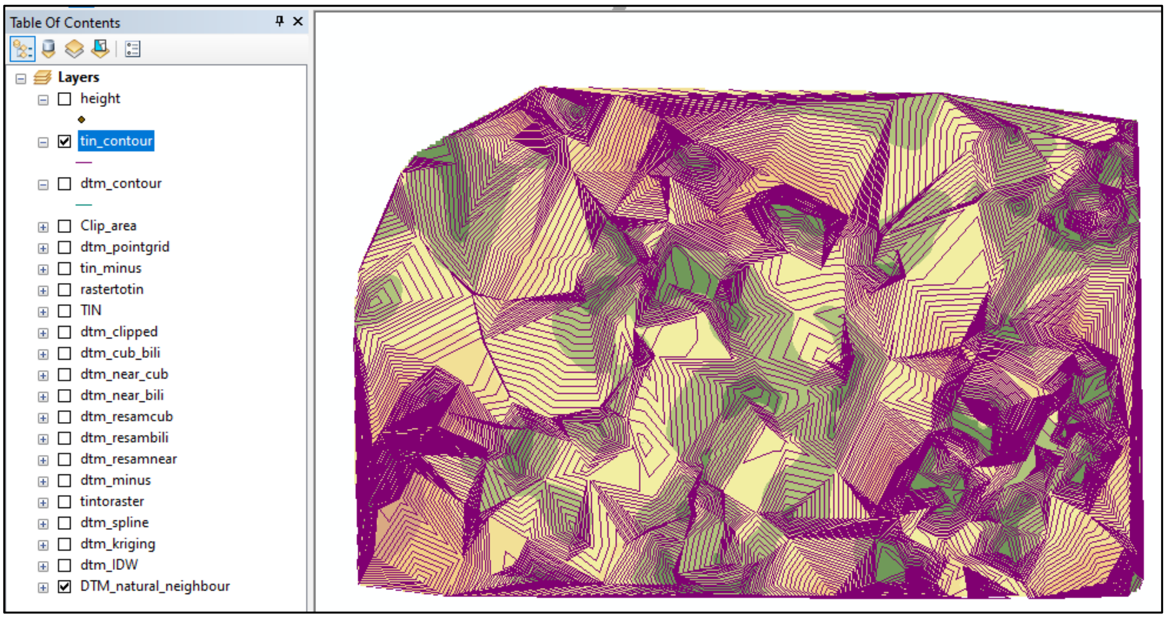
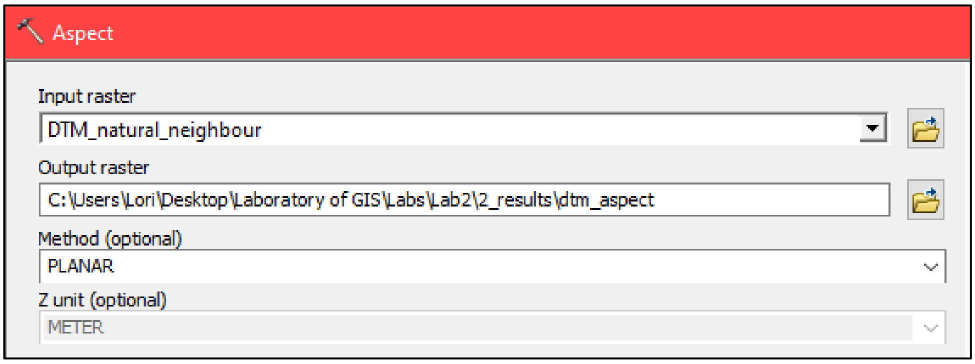


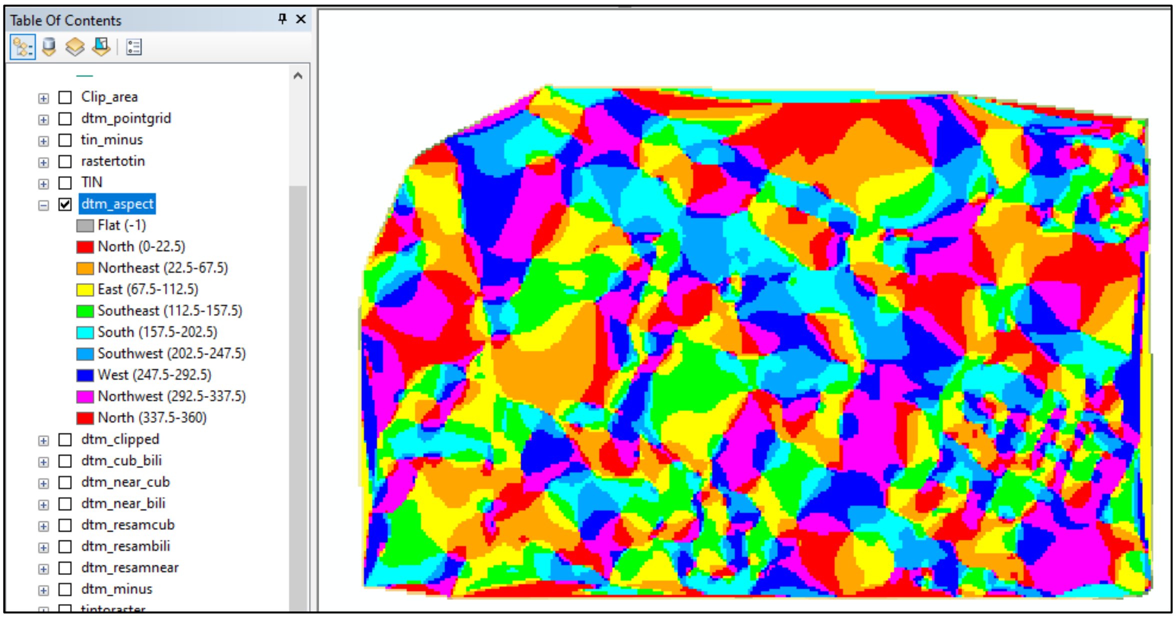

## 6.3 DTM: Aspect map

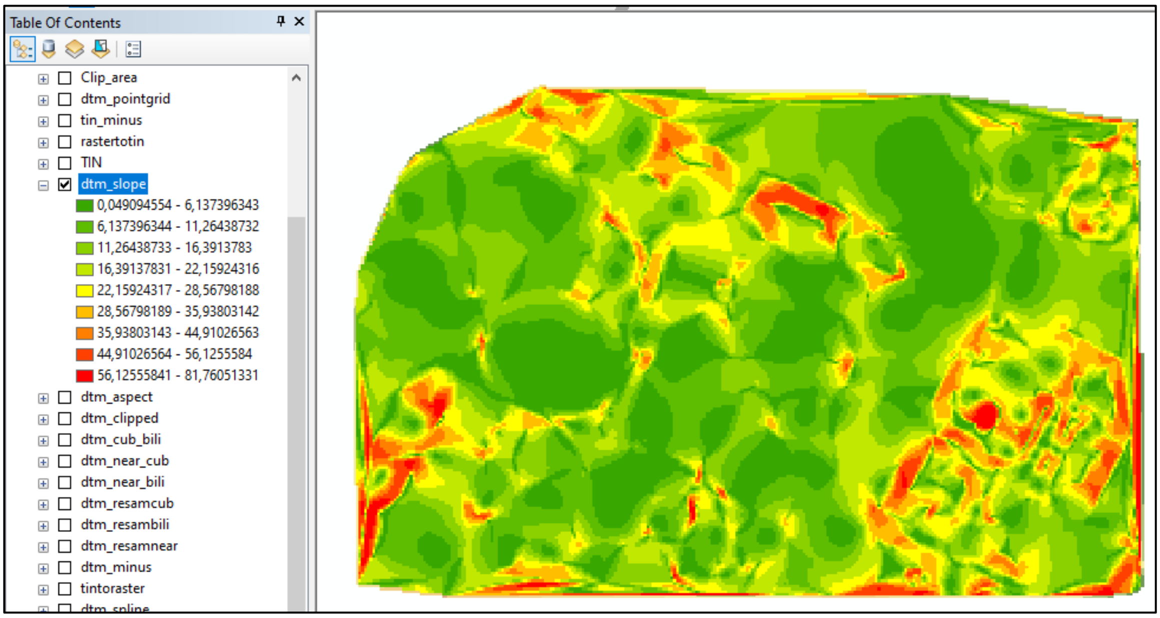
Aspect values indicate the directions the physical slopes face.

Now we follow the same procedure for the other maps.

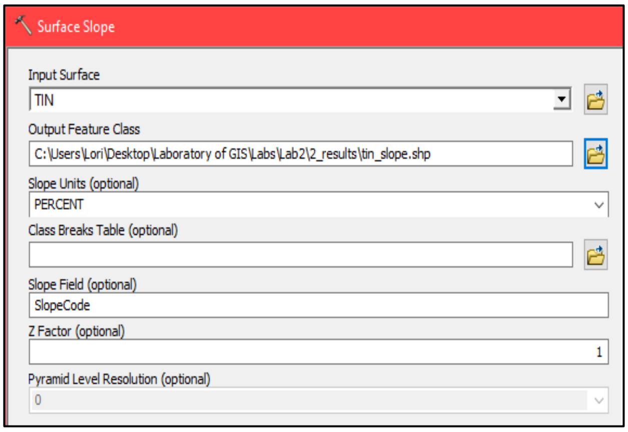


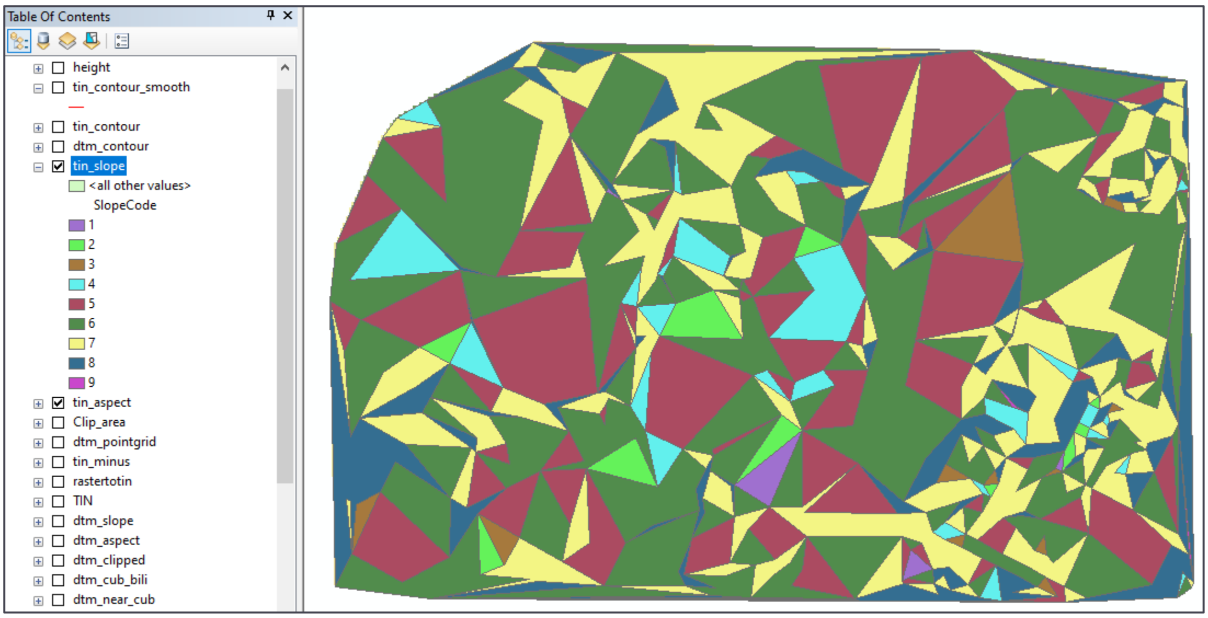

The result is:



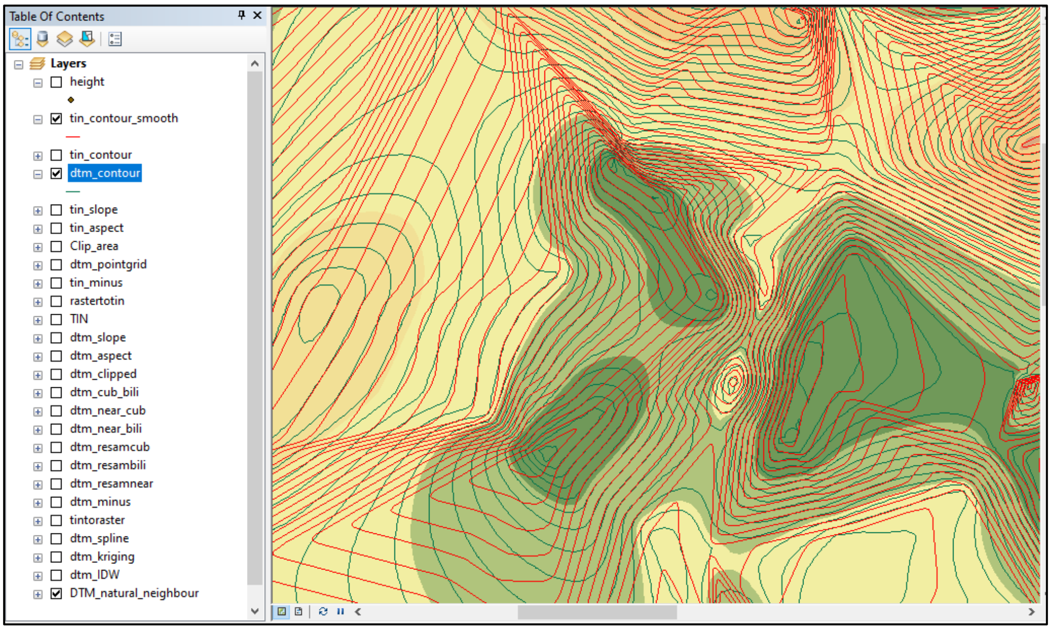



## 6.6 TIN: Slope map



The difference between the TIN smoothed contour and the DTM contour is very clear:

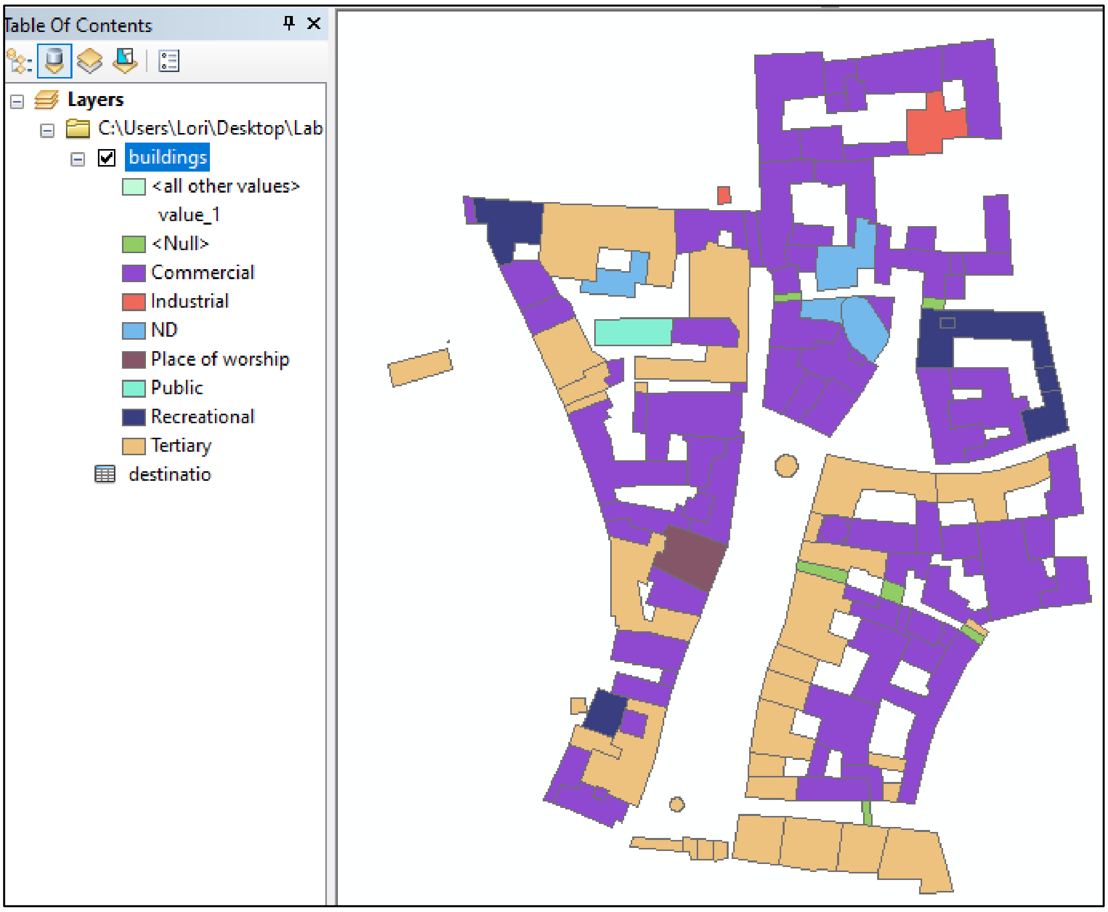


Table

buildings

| FID | Shape * | ENTITY | n_floors | destinatio | OID | ID * | value_1 |
|---|---|---|---|---|---|---|---|
| 0 | Polygon | Polyline | 4 | 1 | 1 | 2 | Commercial |
| 1 | Polygon | Polyline | 4 | 2 | 2 | 3 | Tertiary |
| 2 | Polygon | Polyline | 6 | 5 | 5 | 6 | Recreational |
| 3 | Polygon | Polyline | 2 | 7 | 7 | 8 | ND |
| 4 | Polygon | Polyline | 5 | 1 | 1 | 2 | Commercial |
| 5 | Polygon | Polyline | 5 | 1 | 1 | 2 | Commercial |
| 6 | Polygon | Polyline | 4 | 2 | 2 | 3 | Tertiary |
| 7 | Polygon | Polyline | 4 | 1 | 1 | 2 | Commercial |
| 8 | Polygon | Polyline | 6 | 1 | 1 | 2 | Commercial |
| 9 | Polygon | Polyline | 5 | 1 | 1 | 2 | Commercial |
| 10 | Polygon | Polyline | 8 | 1 | 1 | 2 | Commercial |
| 11 | Polygon | Polyline | 3 | 1 | 1 | 2 | Commercial |
| 12 | Polygon | Polyline | 3 | 2 | 2 | 3 | Tertiary |
| 13 | Polygon | Polyline | 1 | 1 | 1 | 2 | Commercial |
| 14 | Polygon | Polyline | 4 | 6 | 6 | 7 | Place of worship |
| 15 | Polygon | Polyline | 1 | 1 | 1 | 2 | Commercial |

We can see now the different destinations of the buildings.



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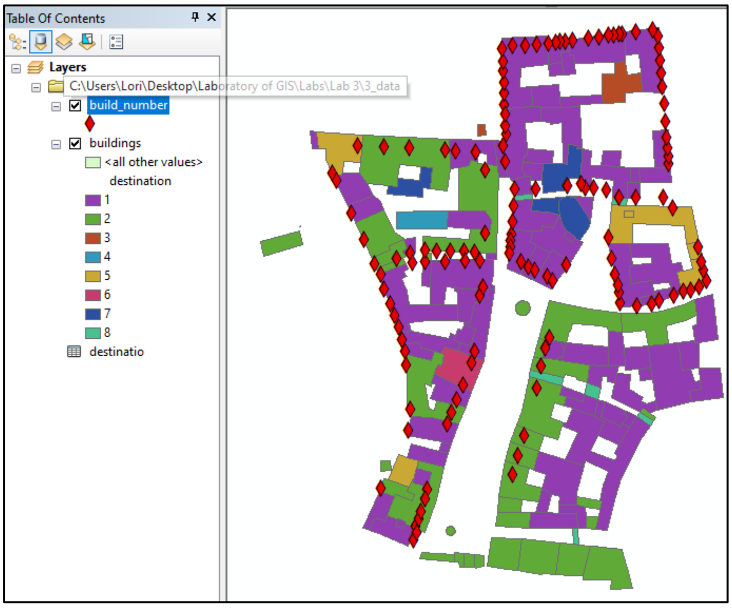
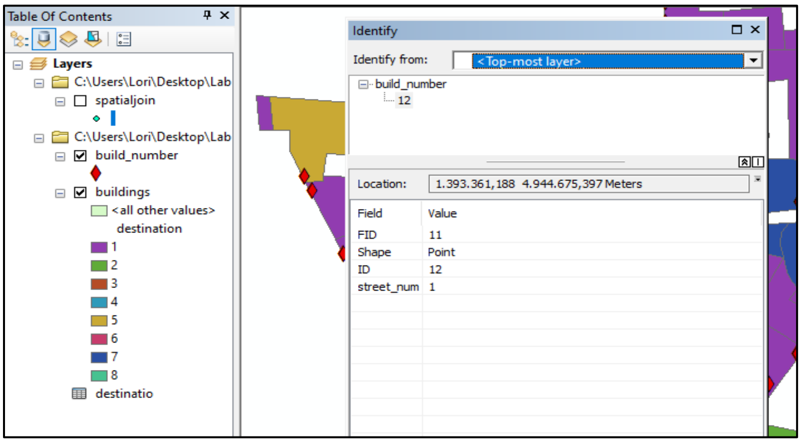
# 10 EX: SPATIAL JOIN

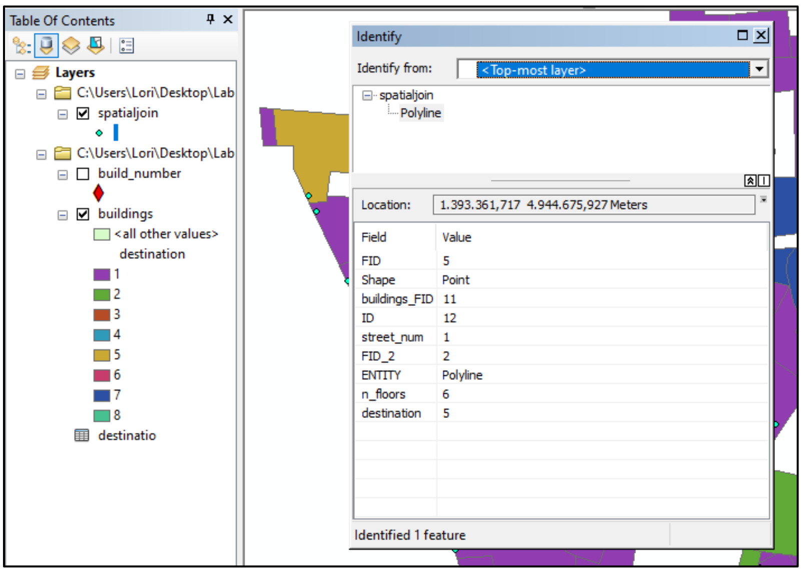
We add the file 'buildingnumber.shp' to do a join through a spatial location.



The Spatial Join creates a new shape file. To do this type of join, we have to select the other option: 'join data from another layer based on spatial location'.

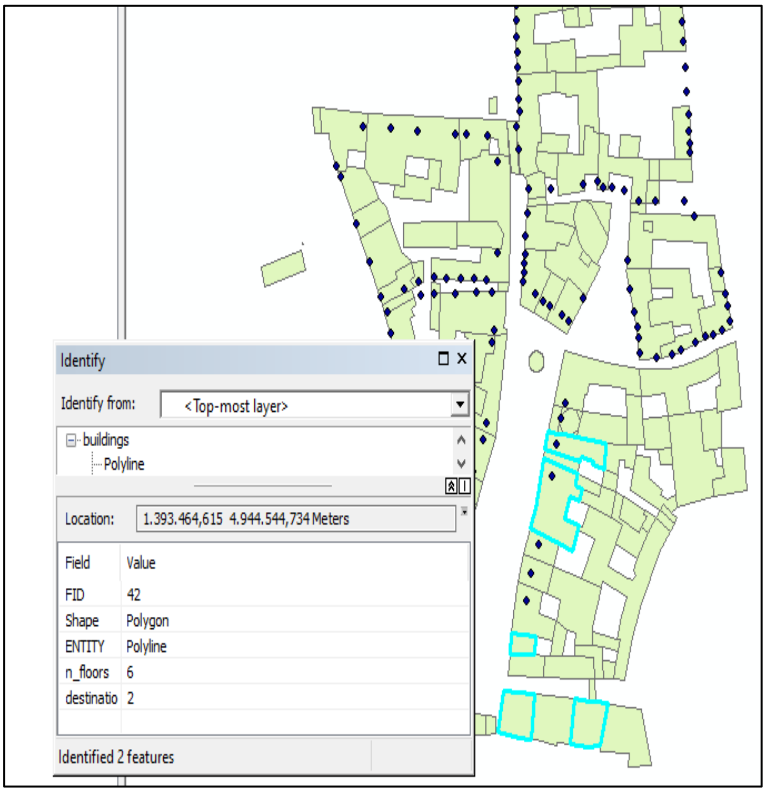


If we identify a point of the original shape file 'build_number', we have info only about that point.



But if we identify the same point of the new shape file 'spatialjoin', we can see information also about the building.

We can identify the selected polygons to check that the selection has been done properly. Far more the selected entities are highlighted also in the attributes table.



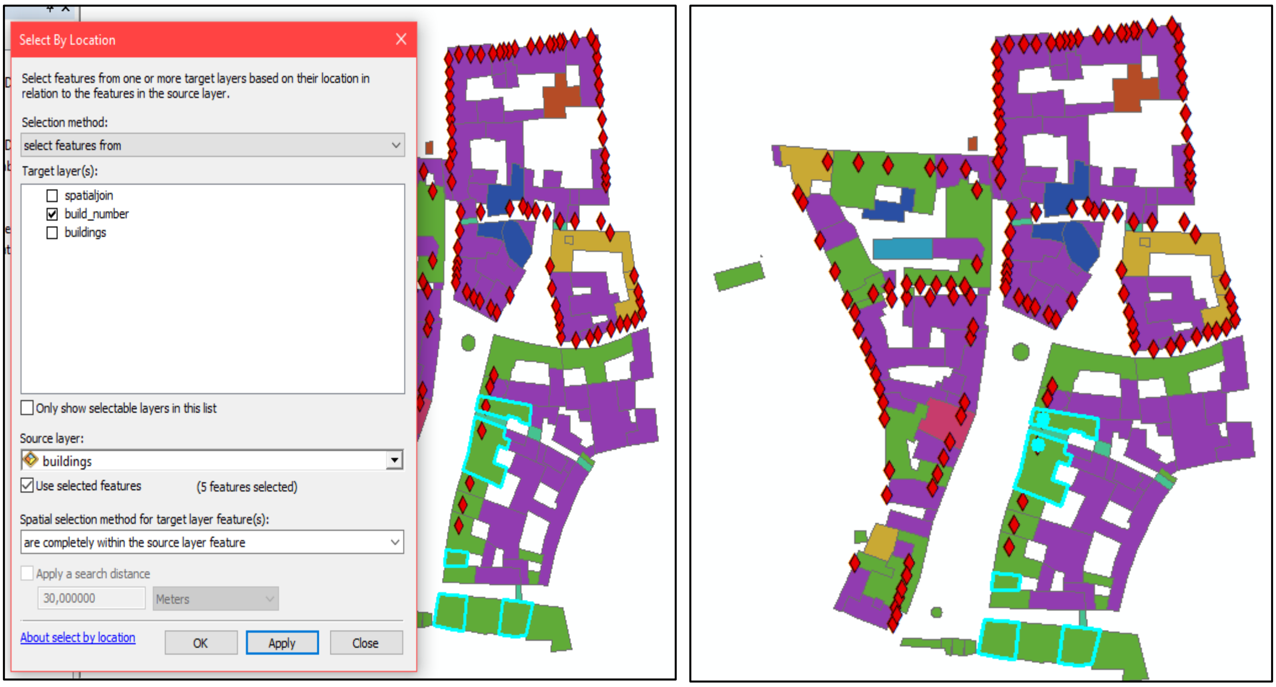

Table

buildings

| FID | Shape * | ENTITY | n_floors | destinatio |
|---|---|---|---|---|
| 36 | Polygon | | 1 | 2 |
| 37 | Polygon | | 1 | 3 |
| 38 | Polygon | | 8 | 1 |
| 39 | Polygon | Polyline | 5 | 2 |
| 40 | Polygon | Polyline | 4 | 1 |
| 41 | Polygon | Polyline | 5 | 2 |
| 42 | Polygon | Polyline | 6 | 2 |
| 43 | Polygon | Polyline | 3 | 2 |
| 44 | Polygon | Polyline | 5 | 2 |
| 45 | Polygon | Polyline | 6 | 2 |
| 46 | Polygon | Polyline | 4 | 1 |
| 47 | Polygon | Polyline | 4 | 1 |
| 48 | Polygon | Polyline | 5 | 2 |
| 49 | Polygon | Polyline | 5 | 1 |
| 50 | Polygon | Polyline | 4 | 1 |
| 51 | Polygon | Polyline | 3 | 2 |
| 52 | Polygon | Polyline | 5 | 2 |
| 53 | Polygon | Polyline | 2 | 1 |
| 54 | Polygon | Polyline | 4 | 1 |
| 55 | Polygon | Polyline | 3 | 1 |
| 56 | Polygon | Polyline | 2 | 1 |
| 57 | Polygon | Polyline | 3 | 2 |
| 58 | Polygon | Polyline | 4 | 1 |
| 59 | Polygon | Polyline | 3 | 1 |
| 60 | Polygon | Polyline | 4 | 1 |
| 61 | Polygon | Polyline | 2 | 1 |
| 62 | Polygon | Polyline | 2 | 1 |
| 63 | Polygon | Polyline | 5 | 1 |
| 64 | Polygon | Polyline | 4 | 2 |
| 65 | Polygon | Polyline | 3 | 2 |
| 66 | Polygon | Polyline | 4 | 1 |
| 67 | Polygon | Polyline | 3 | 1 |
| 68 | Polygon | Polyline | 6 | 2 |
| 69 | Polygon | Polyline | 4 | 2 |
| 70 | Polygon | Polyline | 4 | 8 |
| 71 | Polygon | Polyline | 6 | 2 |
| 72 | Polygon | Polyline | 6 | 2 |
| 73 | Polygon | Polyline | 4 | 2 |
| 74 | Polygon | Polyline | 4 | 8 |

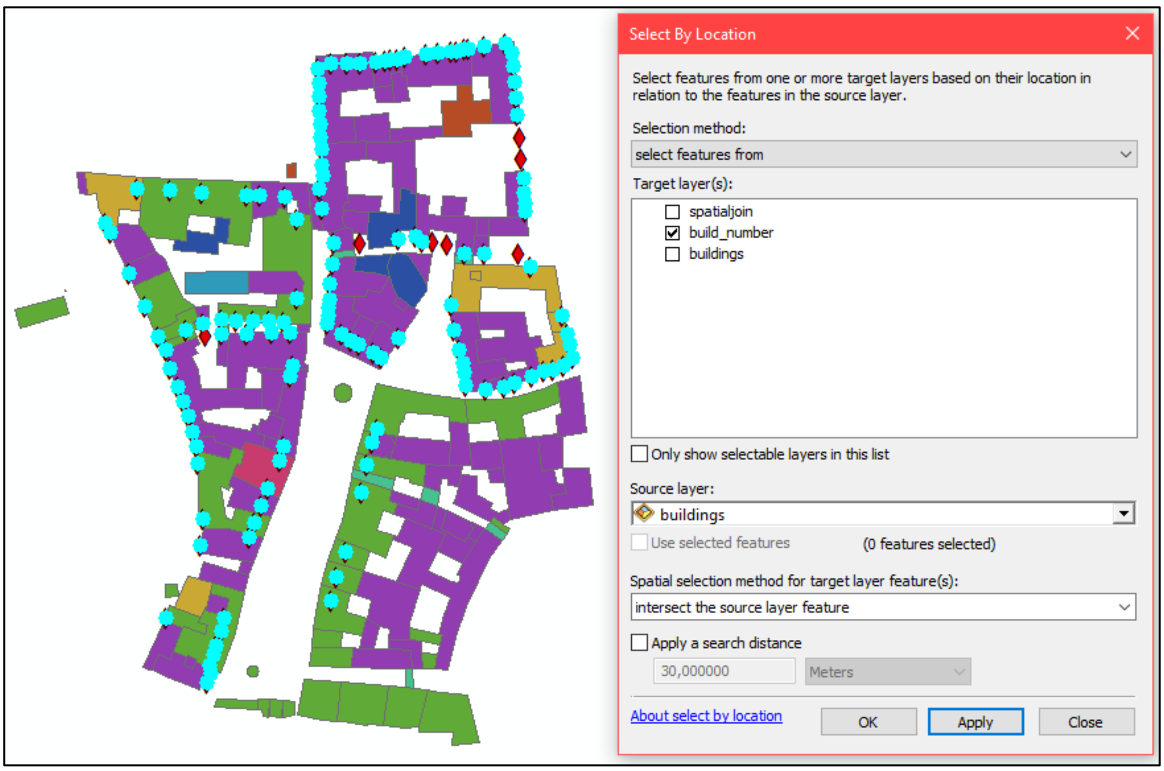
## 12.1 SELECTION: 'ARE WITHIN'

Select also the building numbers that are inside the selected building of Section 4.2.




## 12.2 SELECTION: 'INTERSECTION'

Clear all the selections. Select all the building numbers that intersect the buildings.



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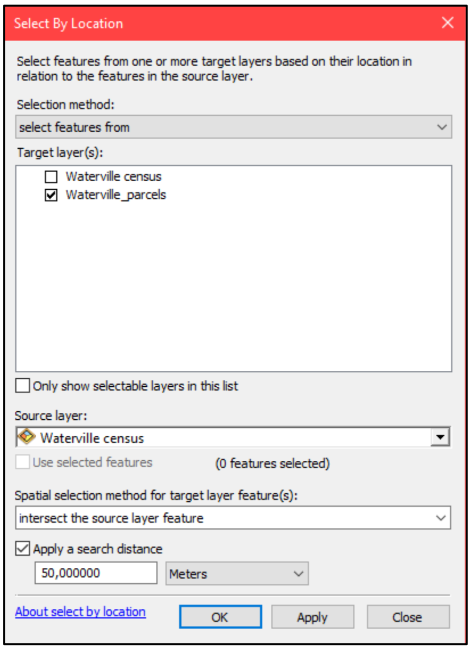
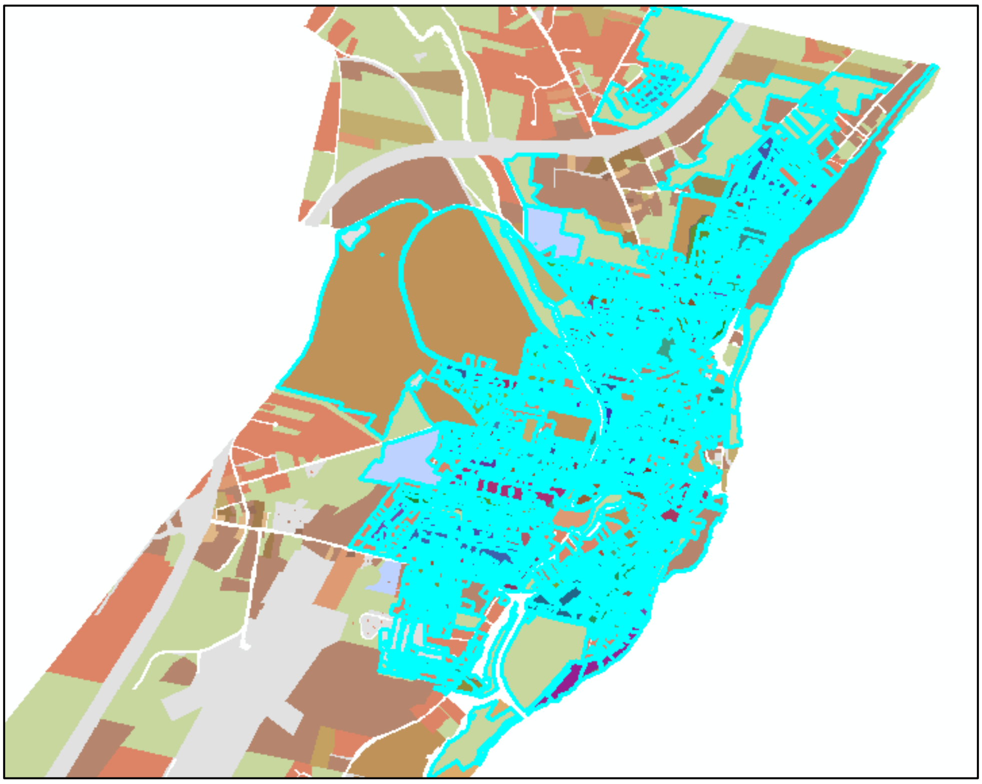
The result is a subset of the layer; only the entities satisfying the query are shown (the data file has not been changed).

Now we want the closest vacant slots near this selection: we do a selection by location because we want a distance of 50 m.



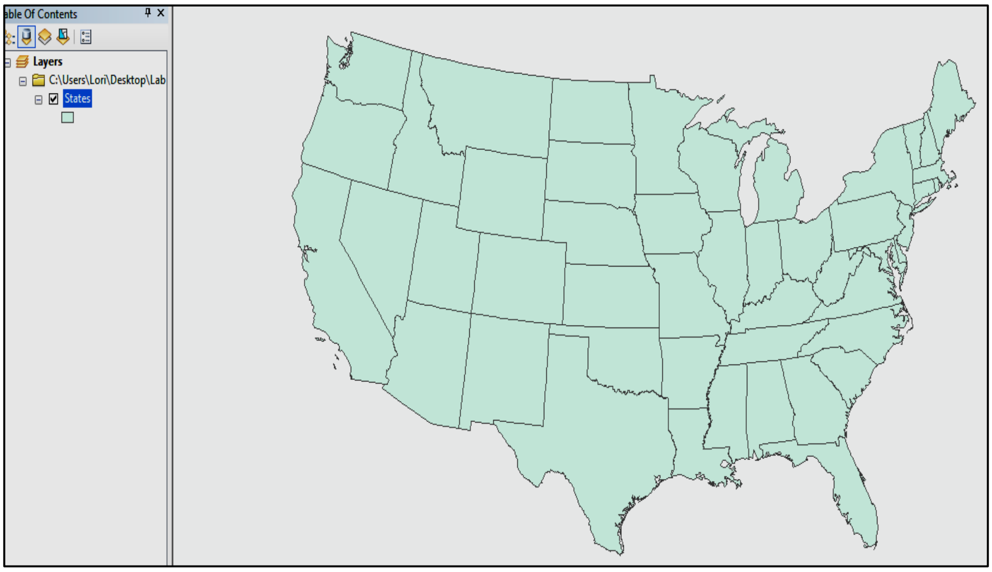

The result is the selection of all parcels (vacant or not) that are within 50 m of the highest youth population density census blocks:



However, we want only the vacant lots: we do a selection of selection (by attribute):

# 14 EX 1: SYMBOLOGY

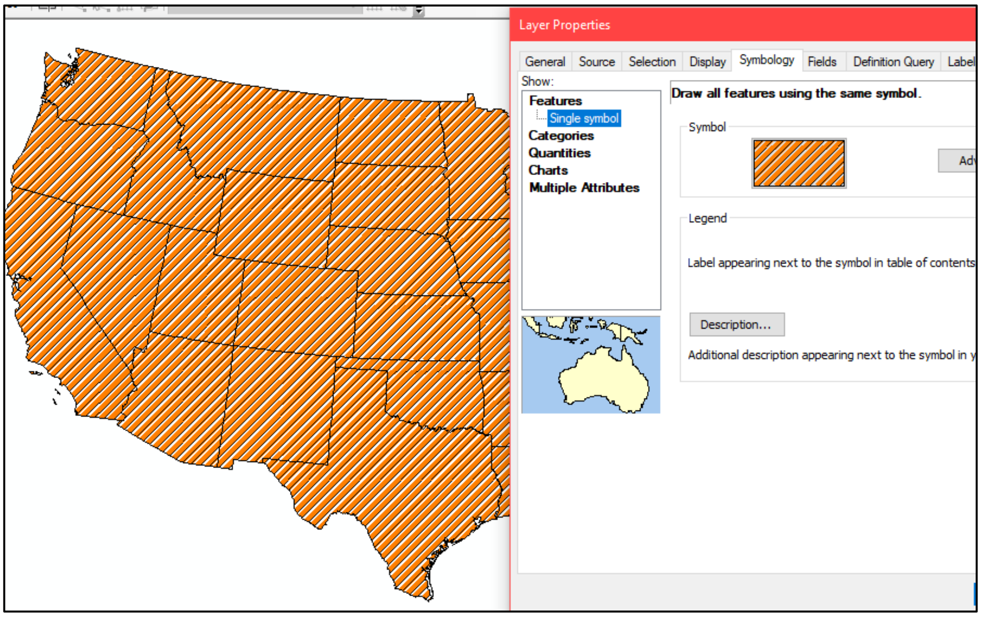
Open file 'States.shp'.




We can change colours to:

- all layers;
- by category: from the values of the list of attributes of the file;
- by classes: there are different ranges of values.

## 14.1 SINGLE SYMBOL



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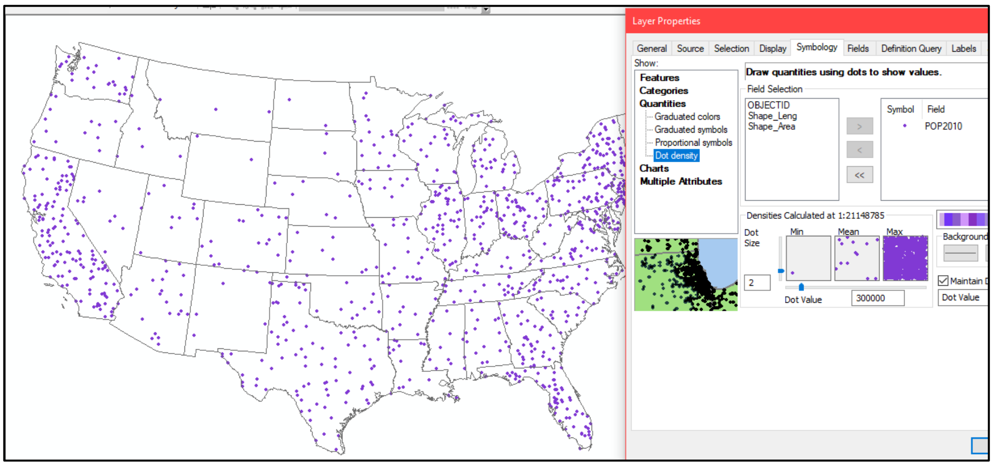
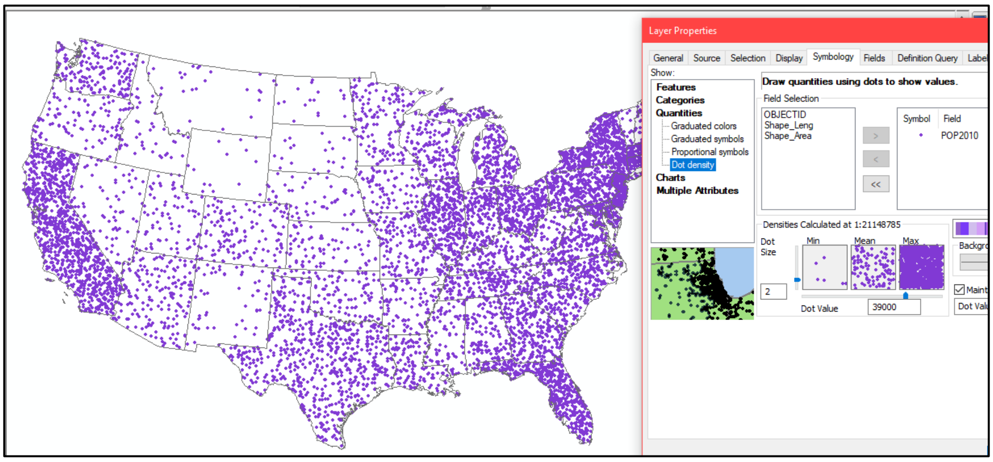
- Dot density



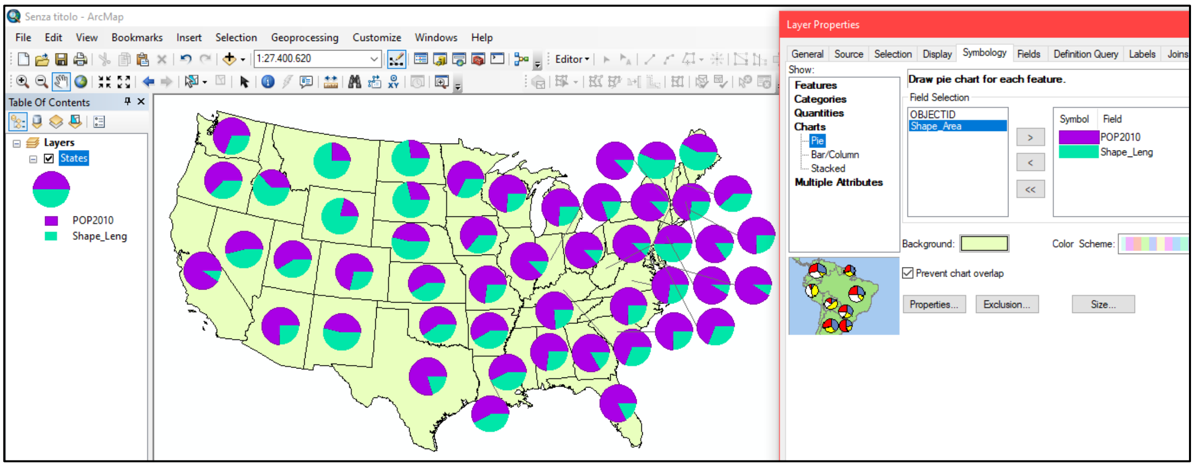

If we want to have more points where there is a bigger number, we can change the 'dot value':




This is useful to have a direct info about the population in the different states.

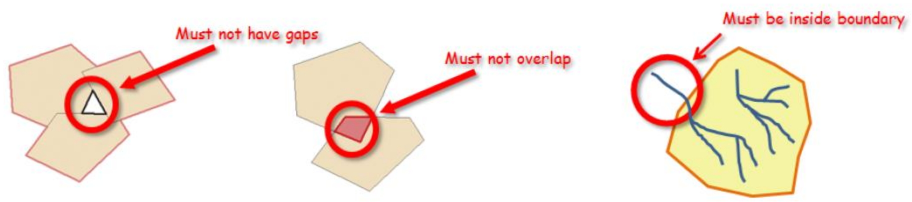
## 14.4 CHARTS

- Pie

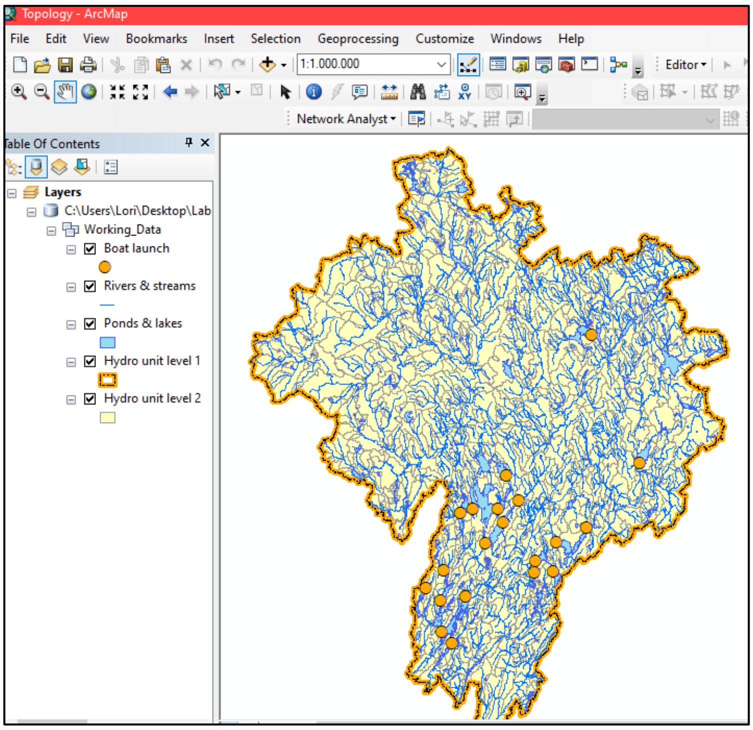


# 15 EX: TOPOLOGY

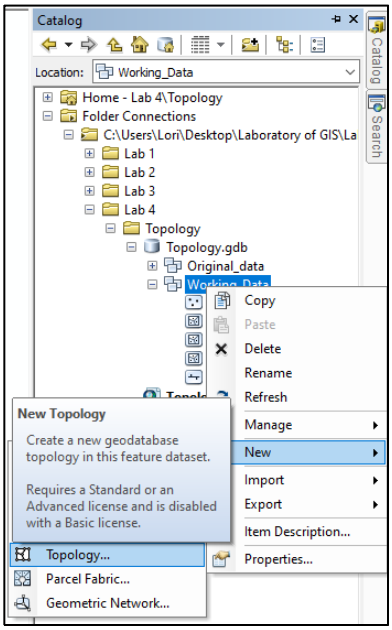
The purpose of this exercise is to create a new topology and identify topological errors in order to preserve the following topological relationships:



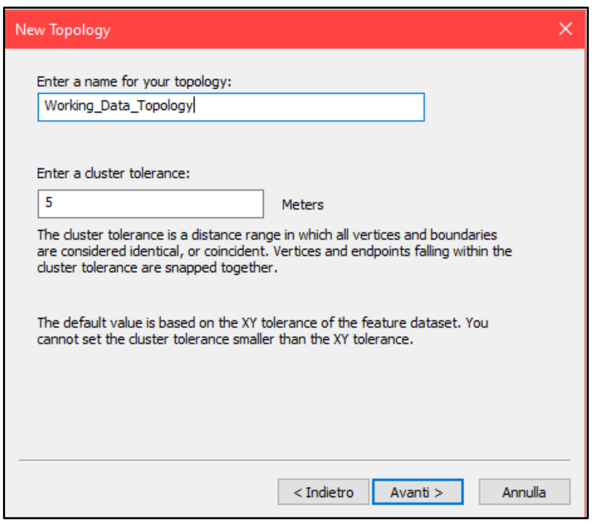

So, we create a new topology and insert different kind of rules because we want to verify if our project respects them: open 'Topology.mxd'.



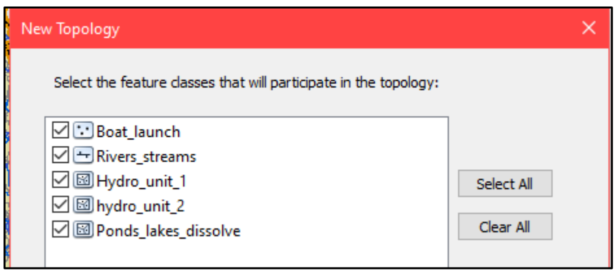

To create a new topology, follow these steps:



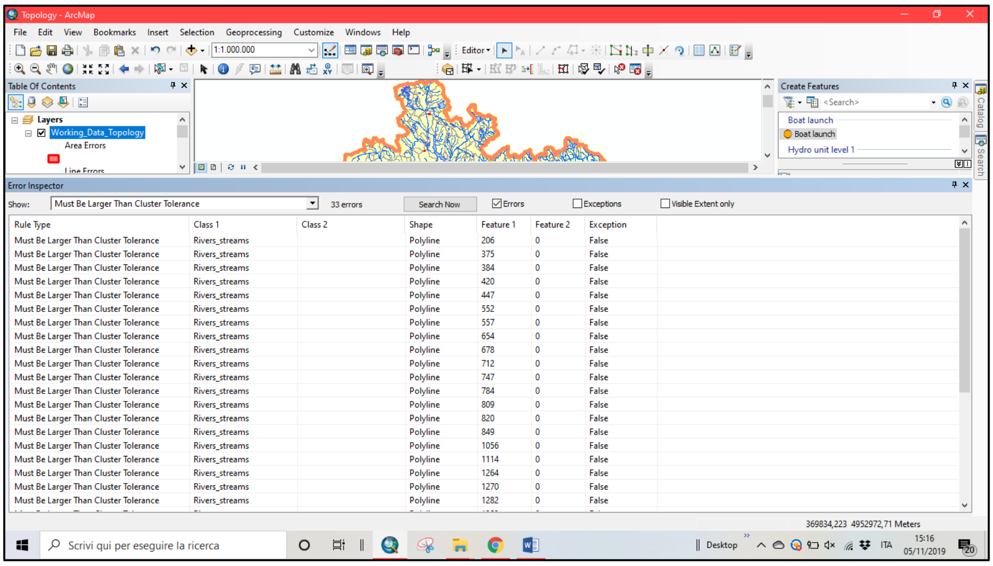

The cluster tolerance defines the minimum spacing between vertices within a feature class and across feature classes taking part in the topology. The tolerance distance should be chosen equal to 5 m.



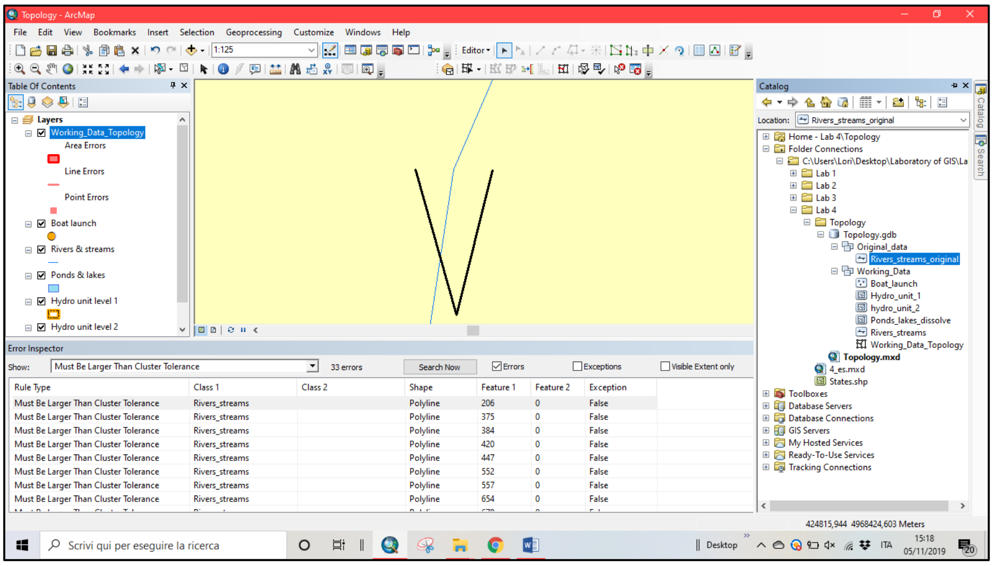

Select all feature classes to participate in the topology:



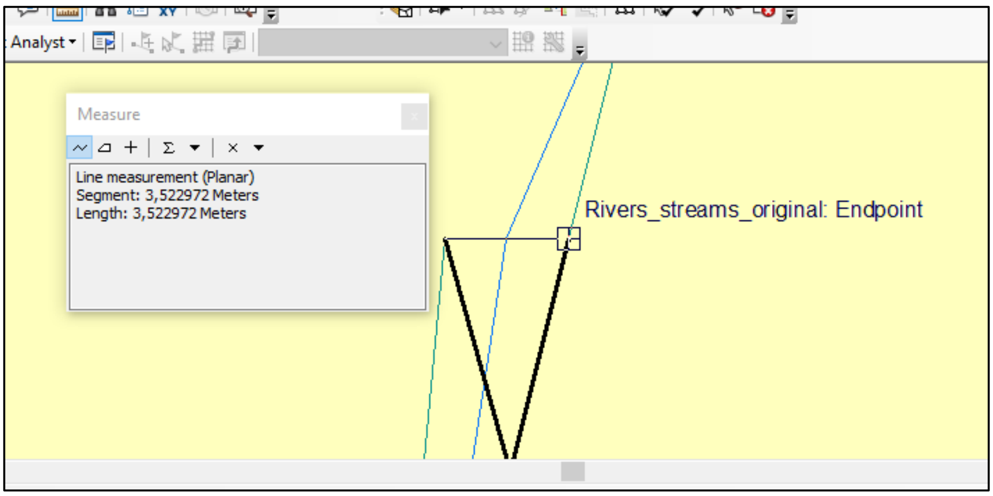
## 15.1 1° RULE: LARGER THAN CLUSTER TOLERANCE



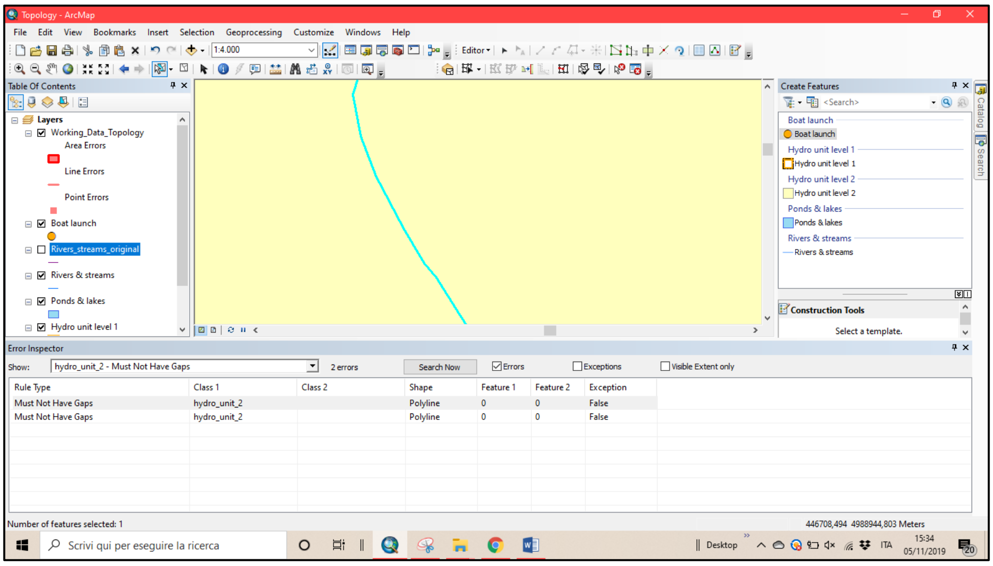
The black V line is the original data (the blue line is the corrected one with the topology rule). We can see this after including the original layer of the rivers:



In addition, if we measure, we can see that the two lines have distance less than 5 m:

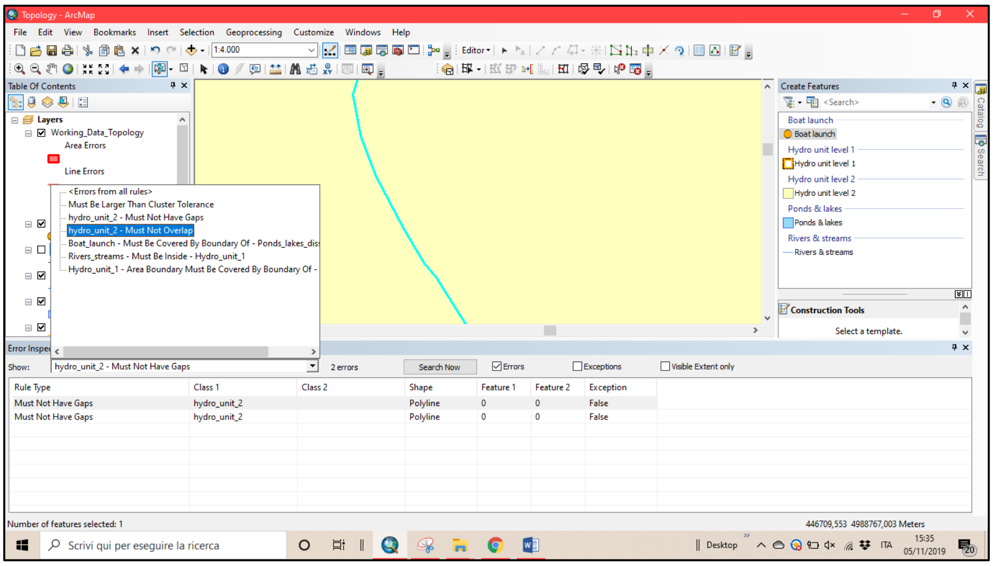


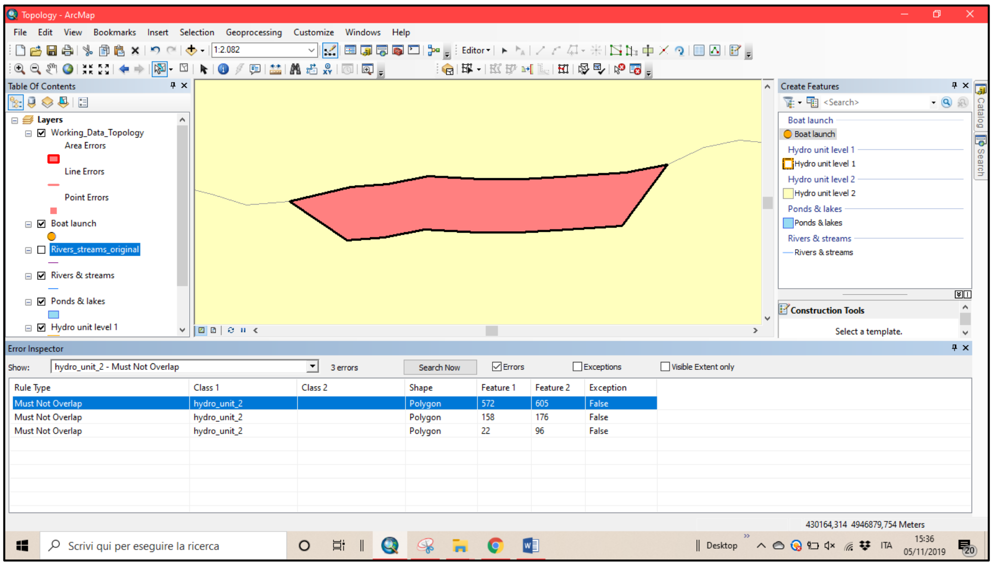
Now we have to merge them. The result is: no more gap, as shown in the picture below.



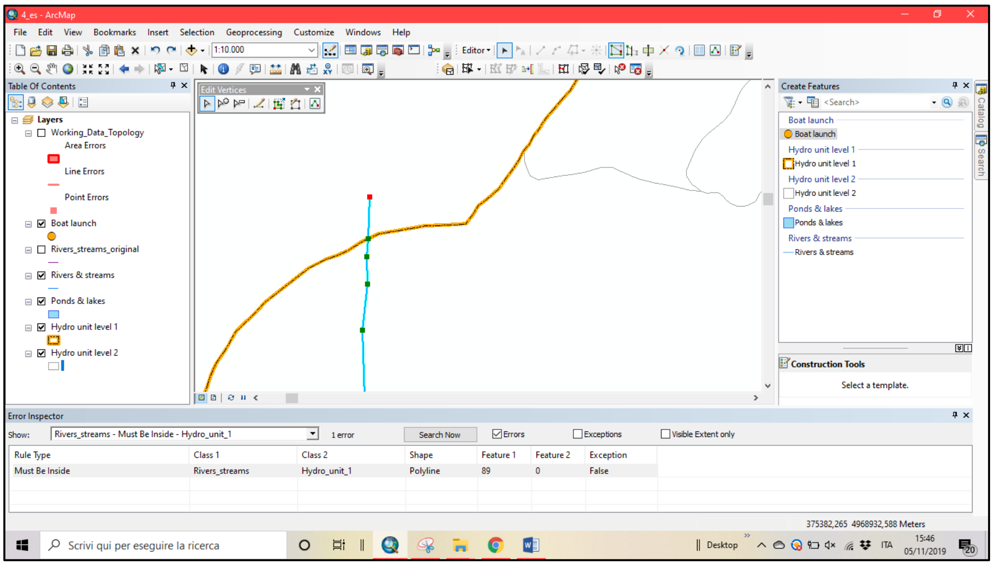

We can do the same for all gaps: errors disappear at the end.

## 15.3 3° RULE: NO OVERLAPPED FEATURES



## 15.4 4° RULE: NO FEATURES OUTSIDE BOUNDARY

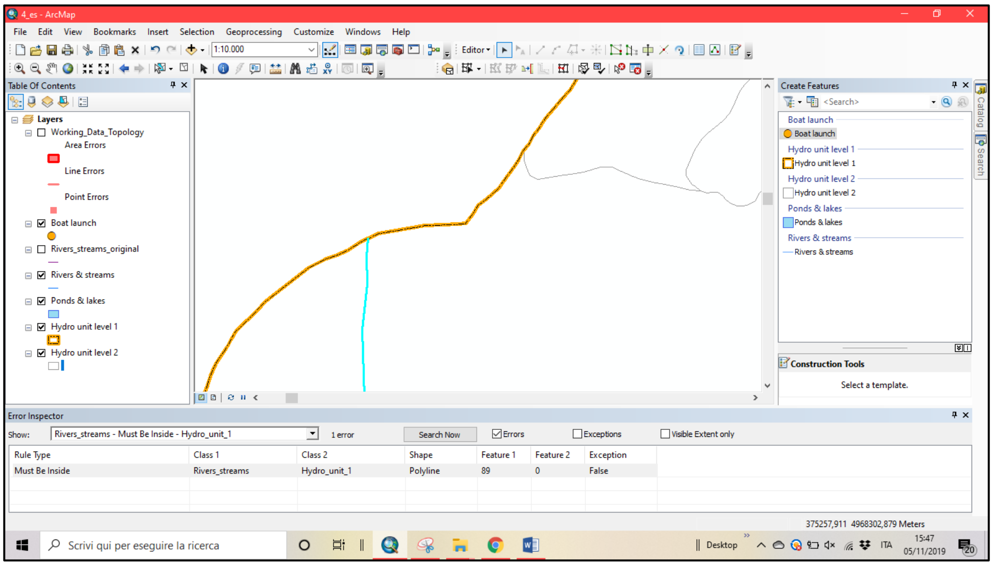


How to correct? Using the Editor toolbar.

Select the river using the tool inside the editor bar: and double click on the river: it shows the different lines and edges.

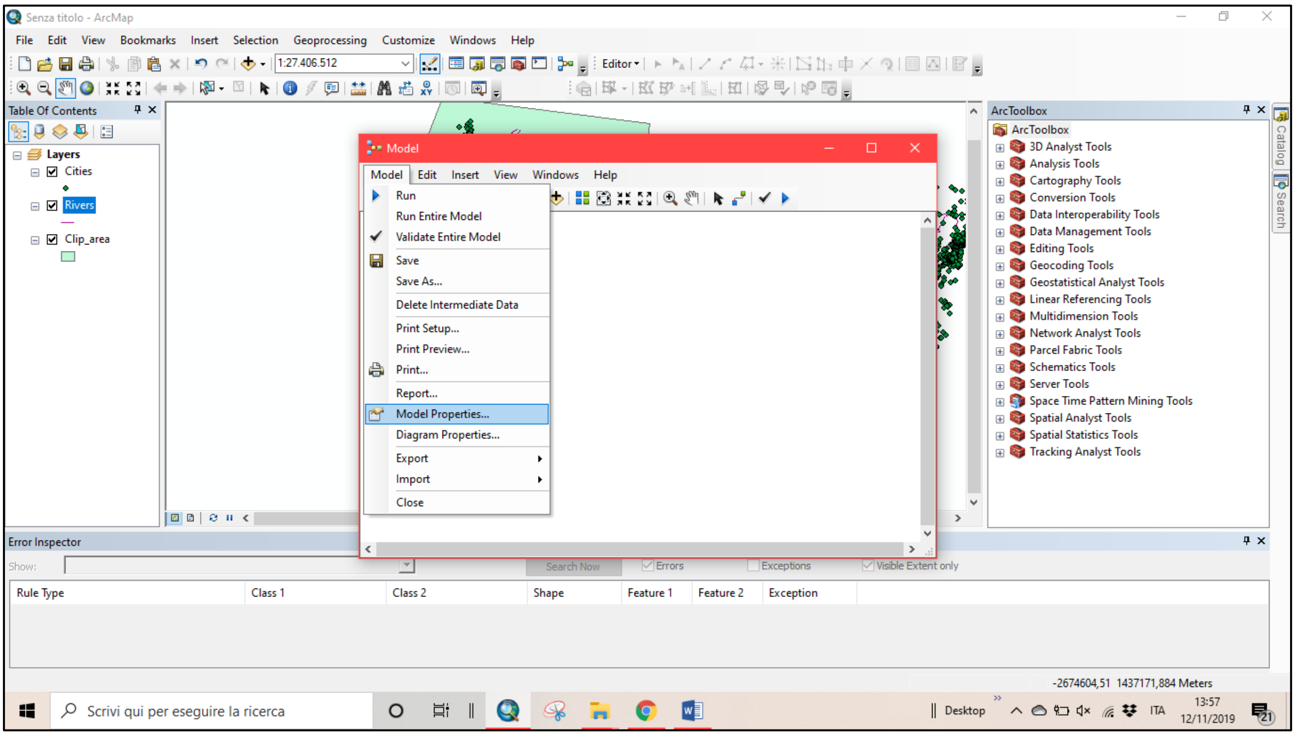
Using the 'delete vertex' tool, select the last node to cancel the last segment.

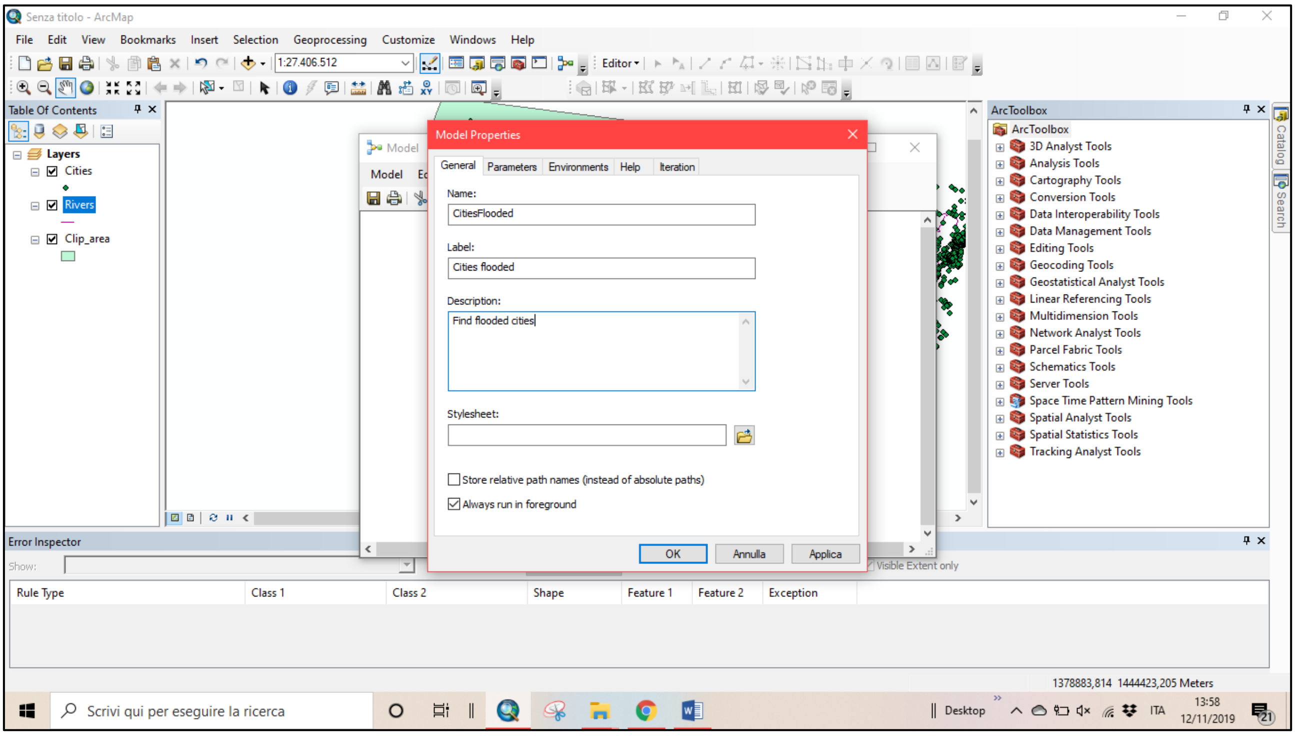
Press F2 (save and stop editing):



Finally, all the errors about the topology have been removed.

We then set up the properties of the model as shown below:




(If we change the name, it will be changed also in the catalogue).

Now we want to impose some operations to accomplish our goal.



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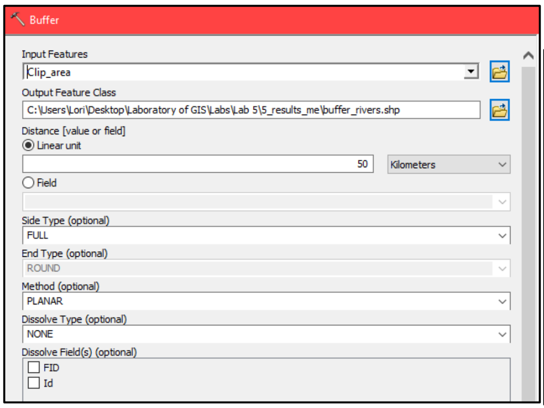
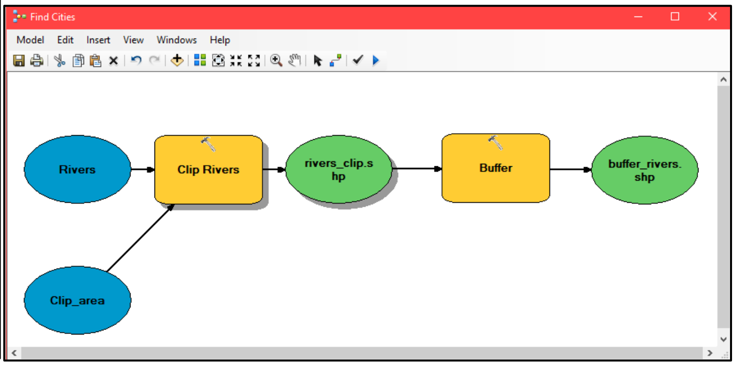
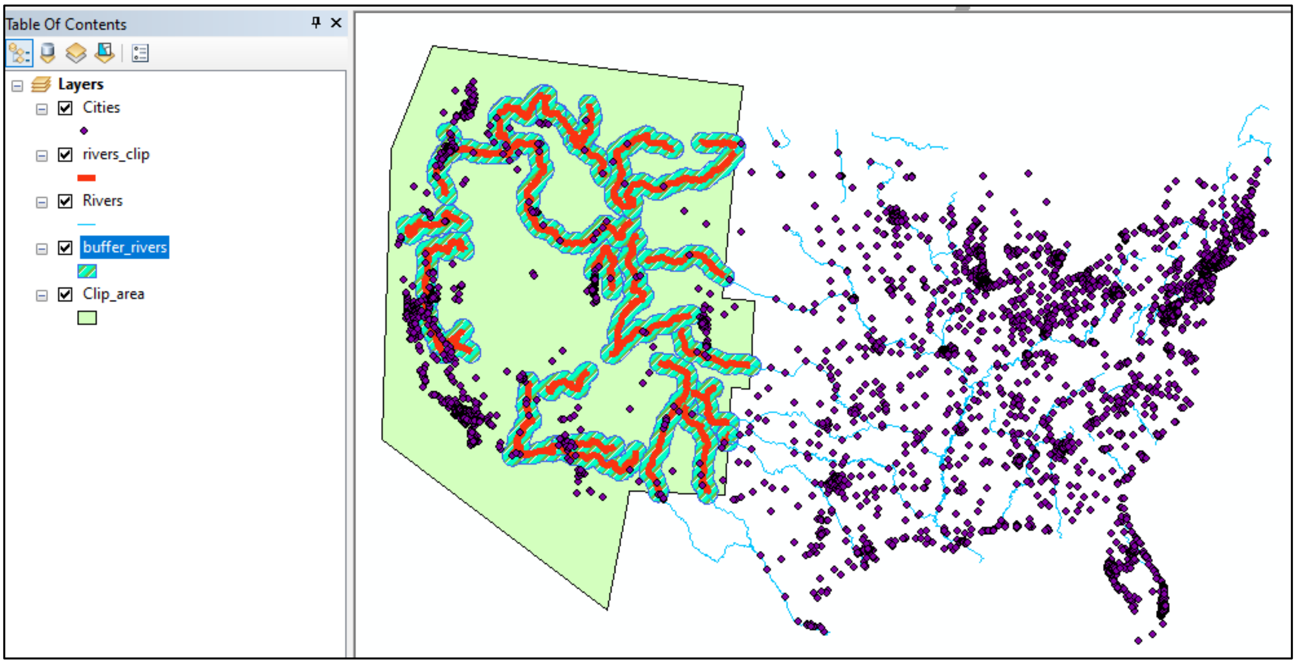
## 16.3 Buffer

We want now to create a buffer (having distance 50 km) around the clipped rivers in order to identify the possible affected areas.



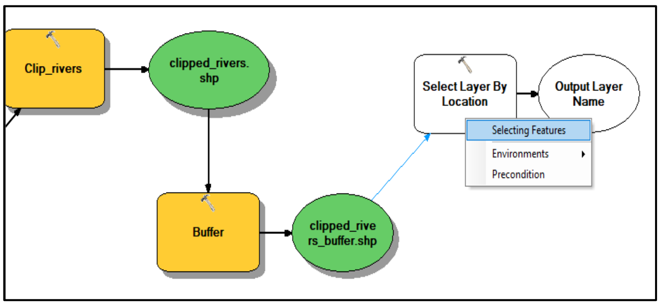



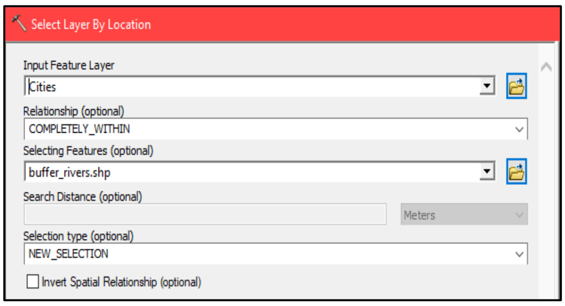




## 16.4 Select only the points inside the buffer – selection by location

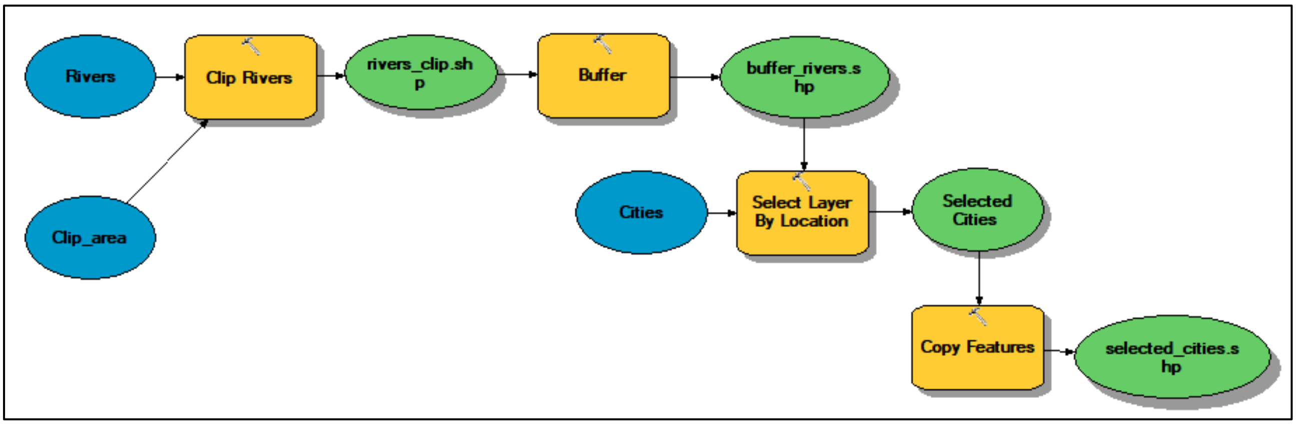
We need to know only the points inside the buffer zones. To do so, we can add the 'Select by Location' tool.

We can add manually the connectors:



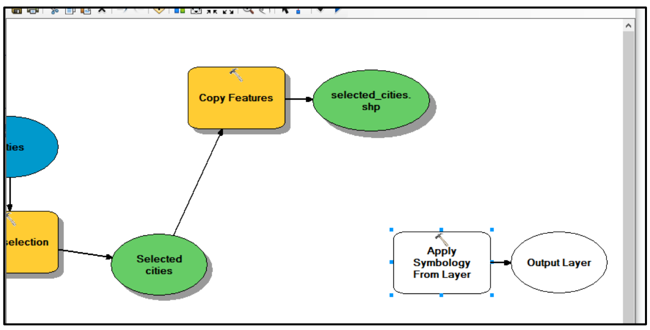



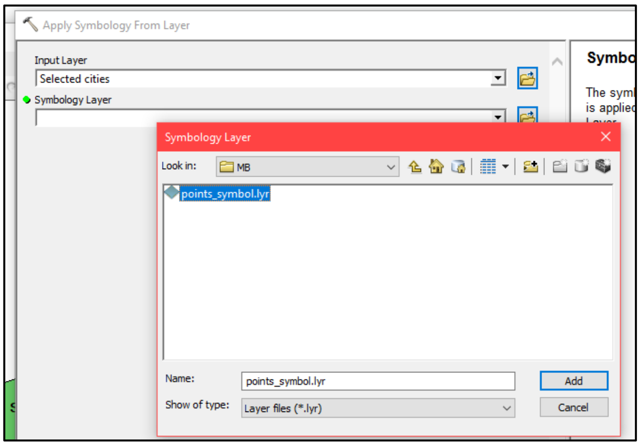
The resulting model is like below:



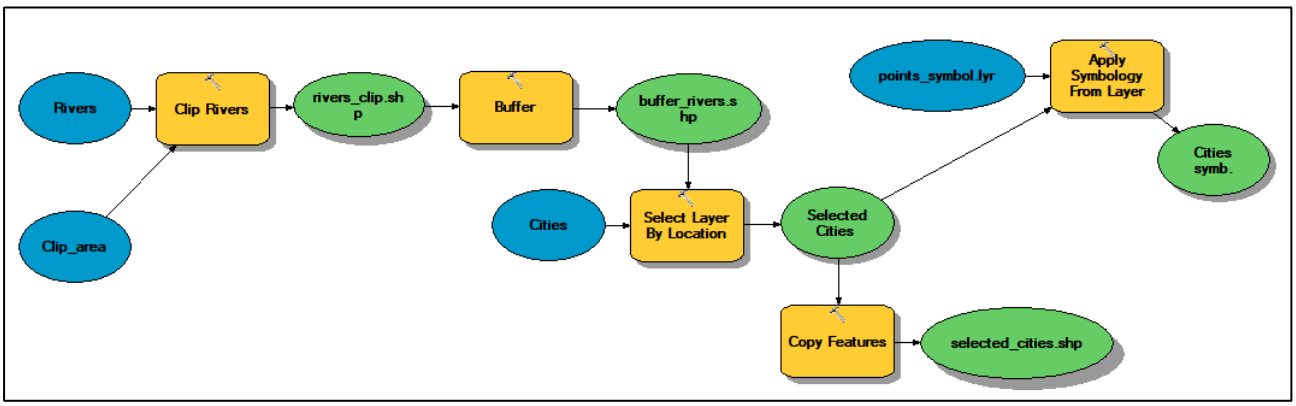

## 16.6 CHANGE SYMBOLOGY OF SELECTED CITIES

To do this operation we add the tool 'Apply Symbology From Layer'. We select the layer whose symbology we want to use. There's no need to add this layer in the current project, we will select it in the options of the tool.



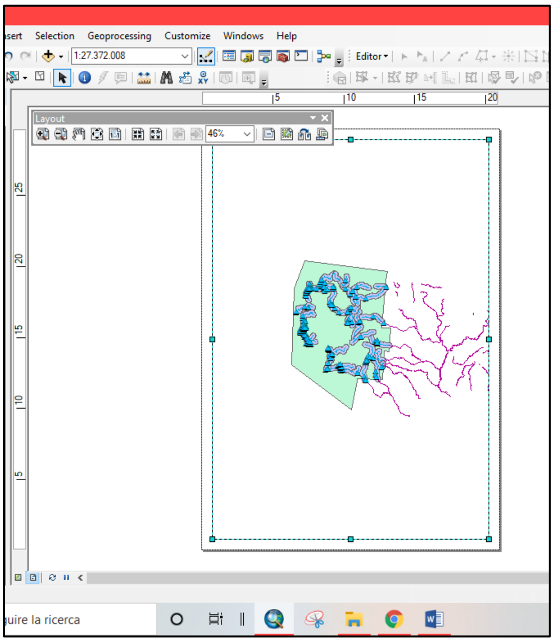




The model will be as shown:

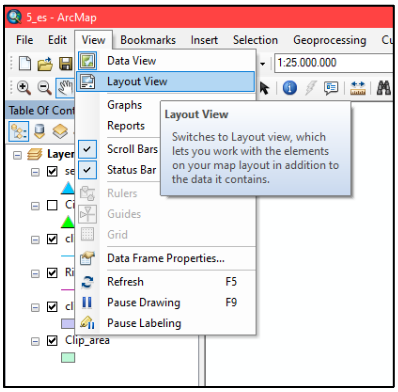


# 17 EX: LAYOUT MAP

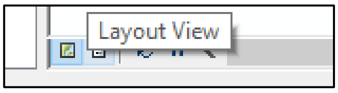
Let's see now how to create a map that can be printed and presented to other professionals.



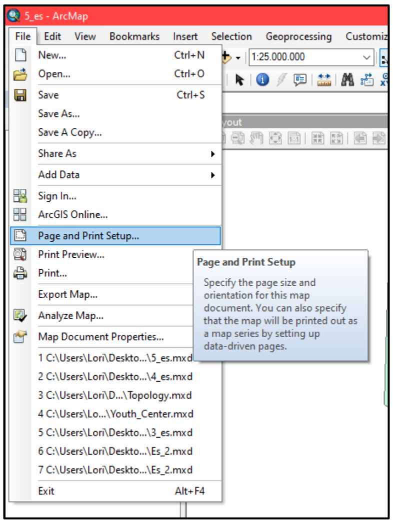
First, we enter the layout view from 'View':

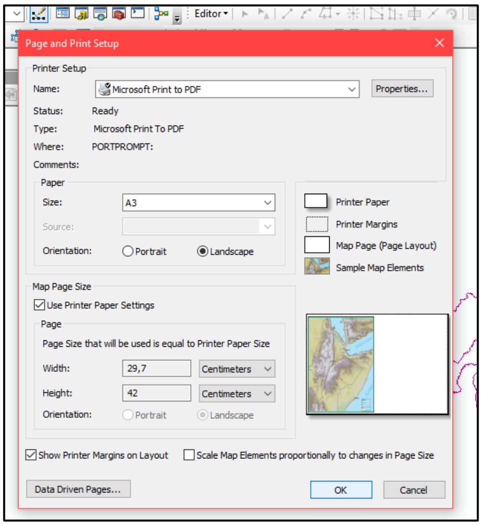



Alternatively, by clicking on the button:

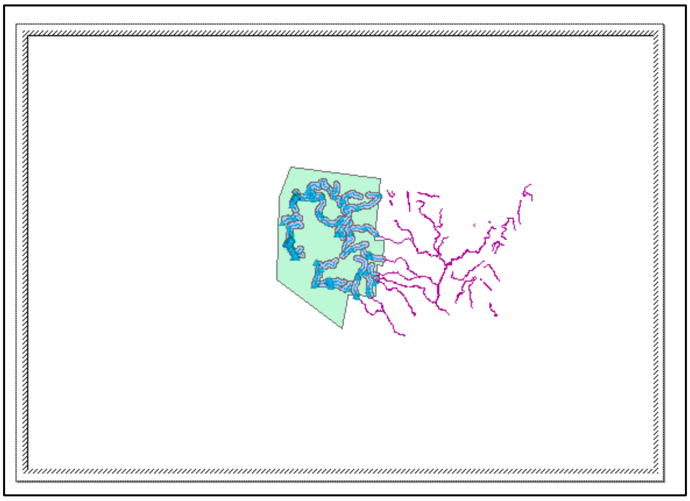



Then we can set up the page:

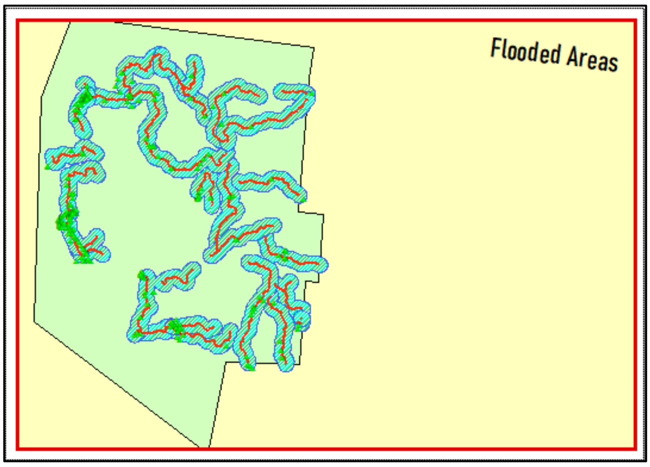



When we are inside the project, dashed lines appear around it

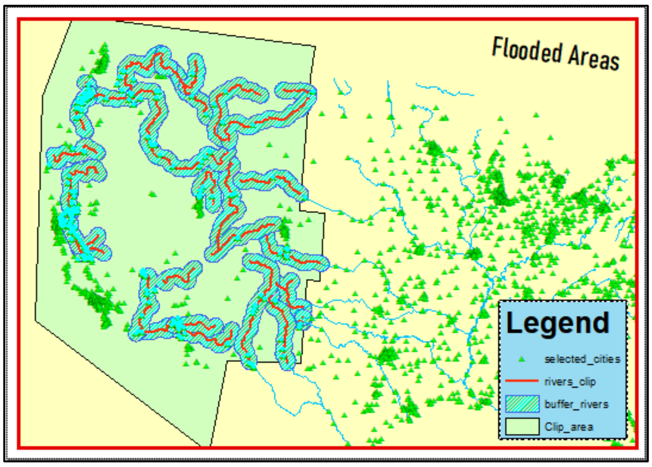


## 17.1 Title

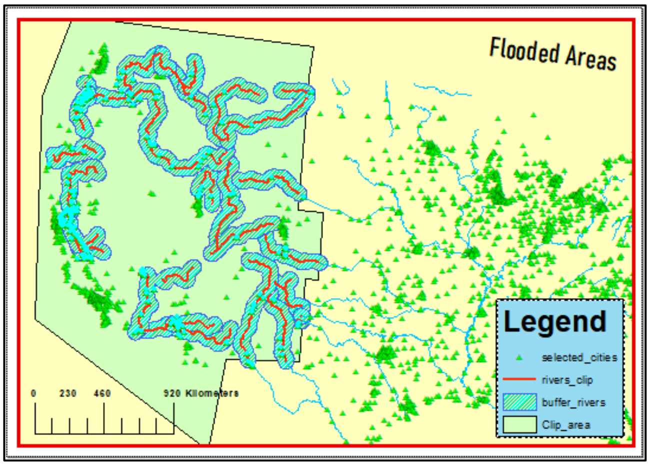



## 17.2 Legend

There is a direct connection to the symbology of the layer.




## 17.3 Scale bar



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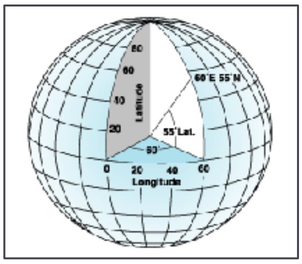
# LAIB 6 – REFERENCE SYSTEMS

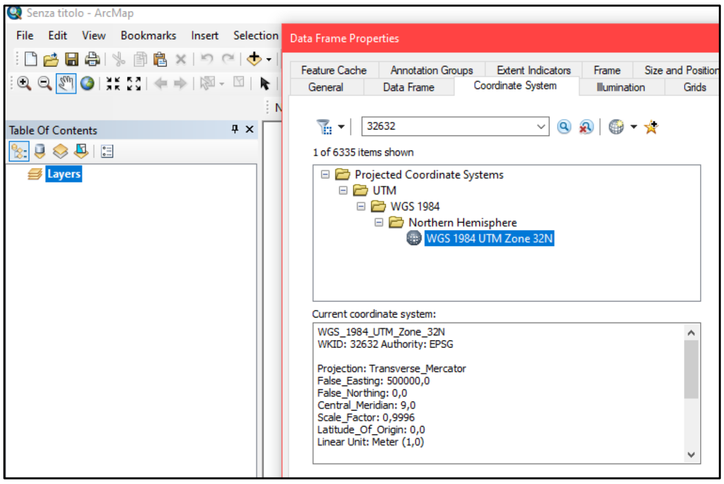


A geographic coordinate system (GCS) uses a three-dimensional spherical surface to define locations on the earth. A point is referenced by its longitude and latitude values. Longitude and latitude are angles measured from the earth's center to a point on the earth's surface. The angles often are measured in degrees (or in grads). The following illustration shows the world as a globe with longitude and latitude values.

A projected coordinate system is defined on a flat, two-dimensional surface. Unlike a geographic coordinate system, a projected coordinate system has constant lengths, angles, and areas across the two dimensions. A projected coordinate system is always based on a geographic coordinate system that is based on a sphere or spheroid. When working with data in a geographic coordinate system, it is sometimes useful to equate the longitude values with the X axis and the latitude values with the Y axis (http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/What_are_geographic_coordinate_systems/003r00000006000000/).

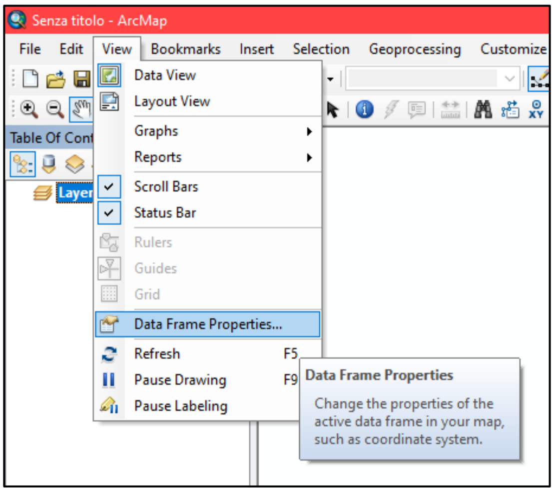
WGS 84 is a geographic coordinate system, and UTM is a projected coordinate system. Geographic coordinate systems are based on a spheroid and utilize angular units (degrees). Projected coordinate systems are based on a plane (the spheroid projected onto a 2D surface) and utilize linear units (feet, meters, etc.).

# 18 EX: VERIFY THE REFERENCE SYSTEM




To verify the reference system of a layer, we can right click on 'Layer' in the Table of contents. We can find our system WGS84 by typing its code 32632:

Or we can click on View → Data Frame Properties:



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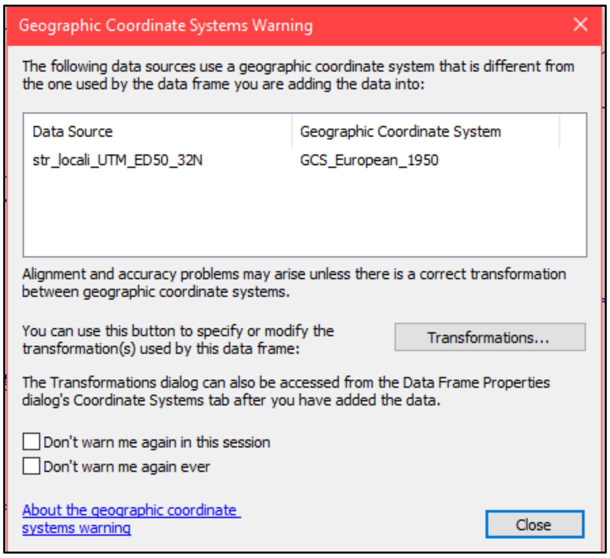
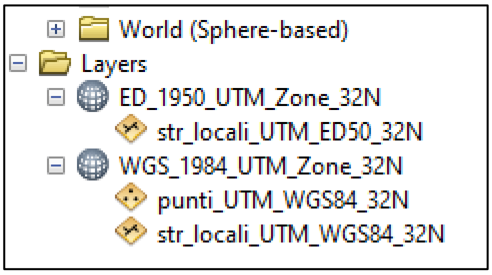
# 20 EX: APPLY AN OTF TRANSFORMATION OF RS

ArcMap allows the user to define custom coordinate reference systems and supports on-the-fly (OTF) projection of vector and raster layers. These features allow the user to display layers with different RSs and have them overlay properly. On-the-fly projection means that individual objects (coverages, grids, images etc) can define their own projection. If they do, they will be reprojected to a common display projection when drawn. Thus, if you have data defined in different coordinate systems (state plane, UTM etc) you can now import that data as is and it will all be drawn in the right place. The only necessity is that a .prj file accompanies the data or that you specify the projection in GMS after importing (https://www.aquaveo.com/blog/2013/02/01/fly-projection).

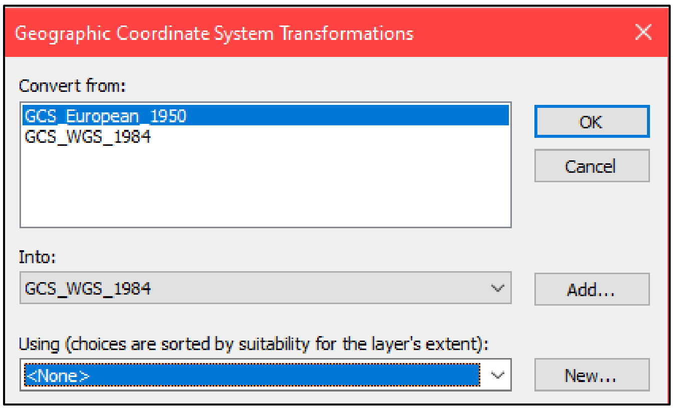
In a new project, load the shape files:

- 'str_locali_UTM_WGS84.shp': no warning showed, because it's in WGS84.
- 'punti_UTM_WGS84_32N: no warning showed, because it's in WGS84.
- 'str_locali_UTM_ED50': a warning is showed, because it's in UTM32N



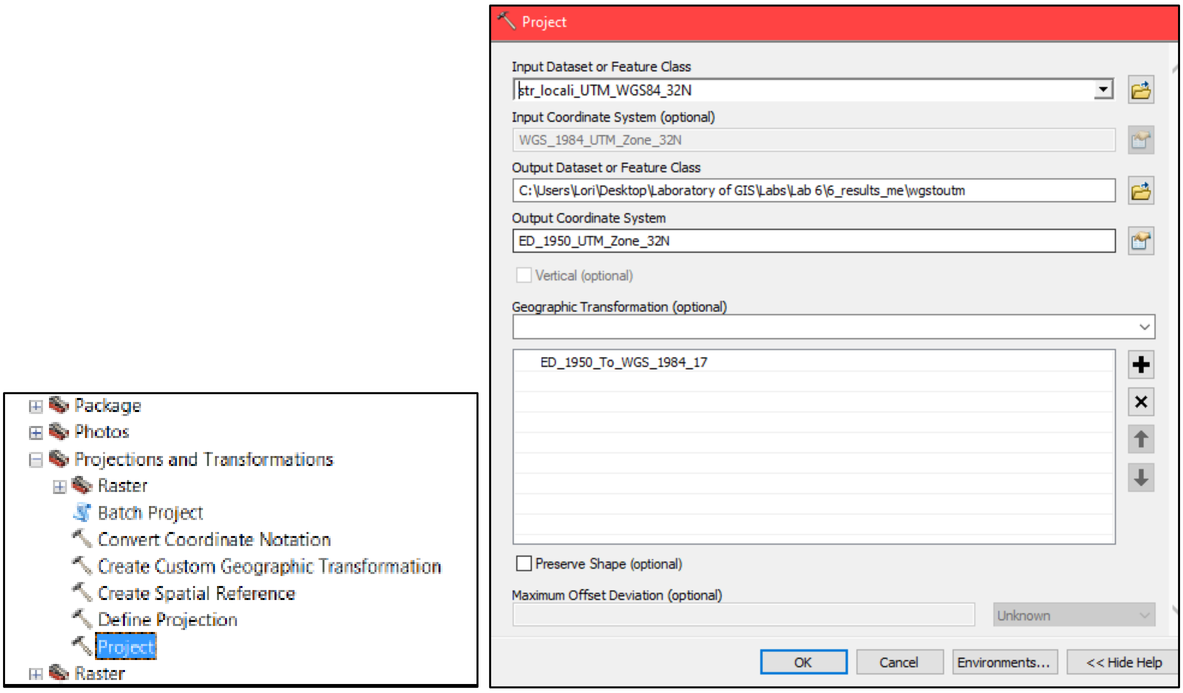




The software identifies that and suggests a transformation of visualization:

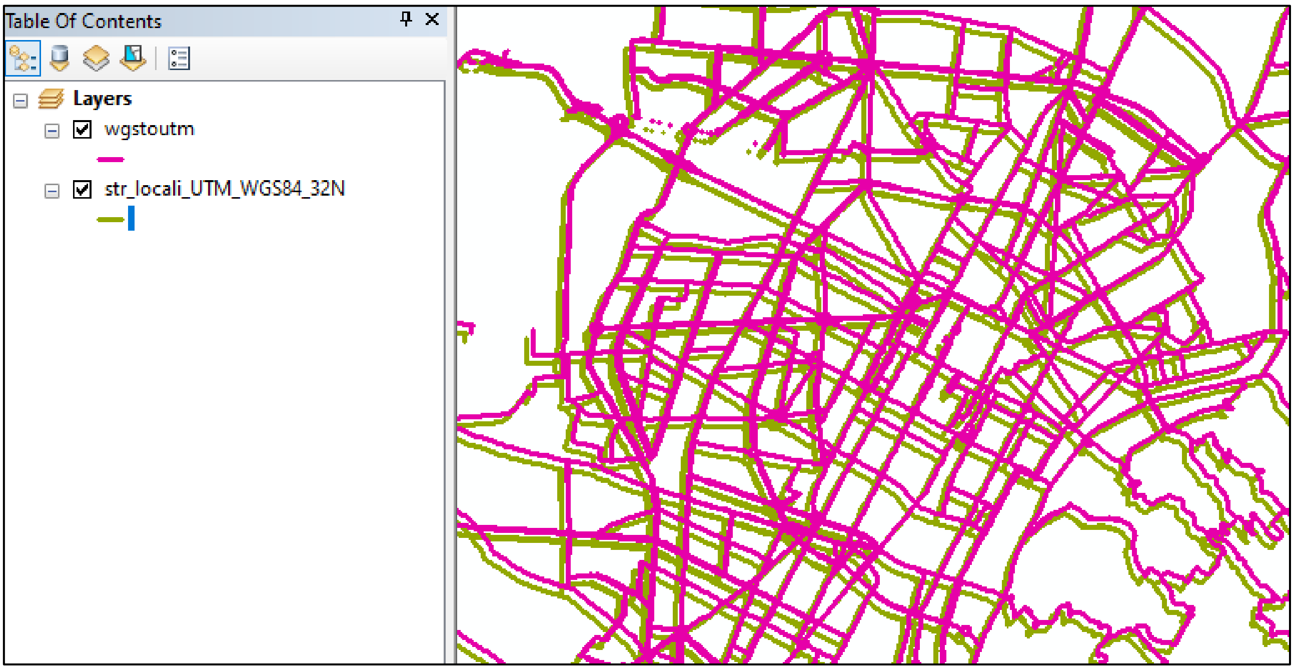


# 21 EX: Apply a permanent transformation of RS

In a new project, load the shape file ‘str_locali_UTM_WGS84.shp’, then with the tool ‘Project’, change its RS, as shown below:




The result is a new layer, with changed RS:

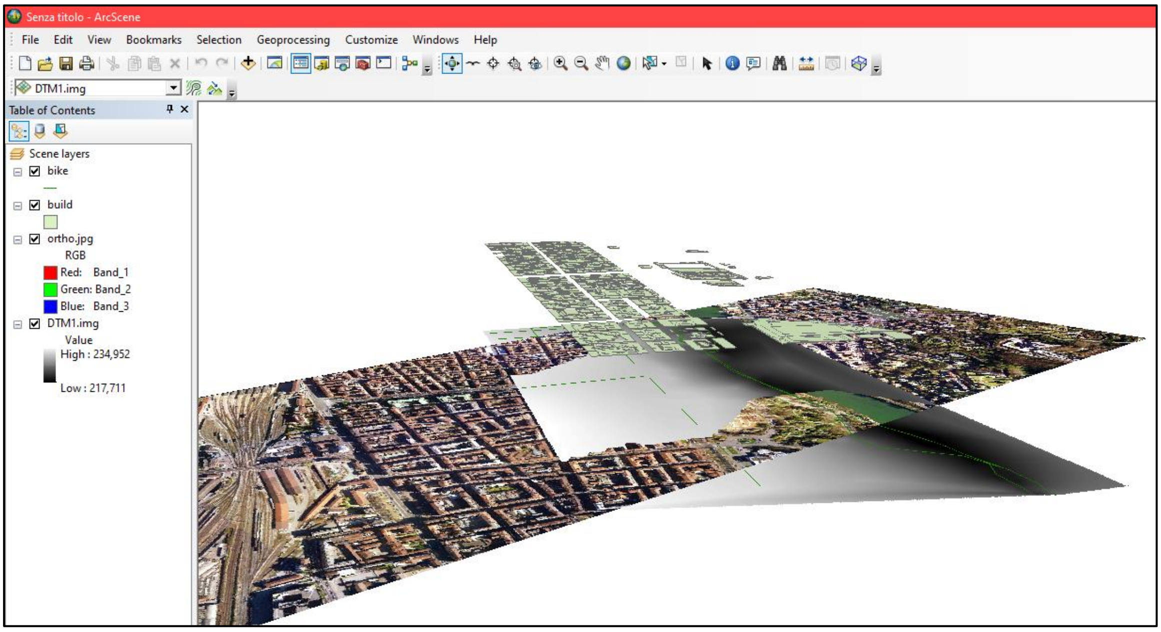



Now we can add the raster file ‘orto_TO_WGS84_UTM_32N.jpg’, which is in the RS WGS84, coincident with the file ‘str_locali_UTM_WGS84_32N’:

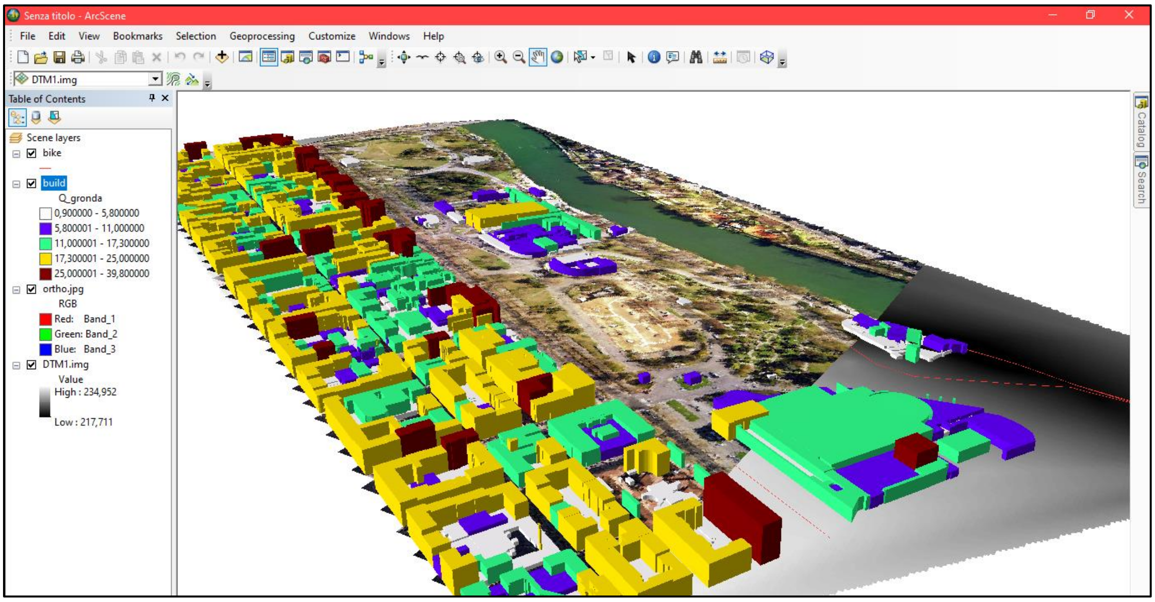
# LAIB 7 - 3D, NETWORK ANALYST, GEOCODING

## 22 EX: 3D MODELLING IN ARCSCENE

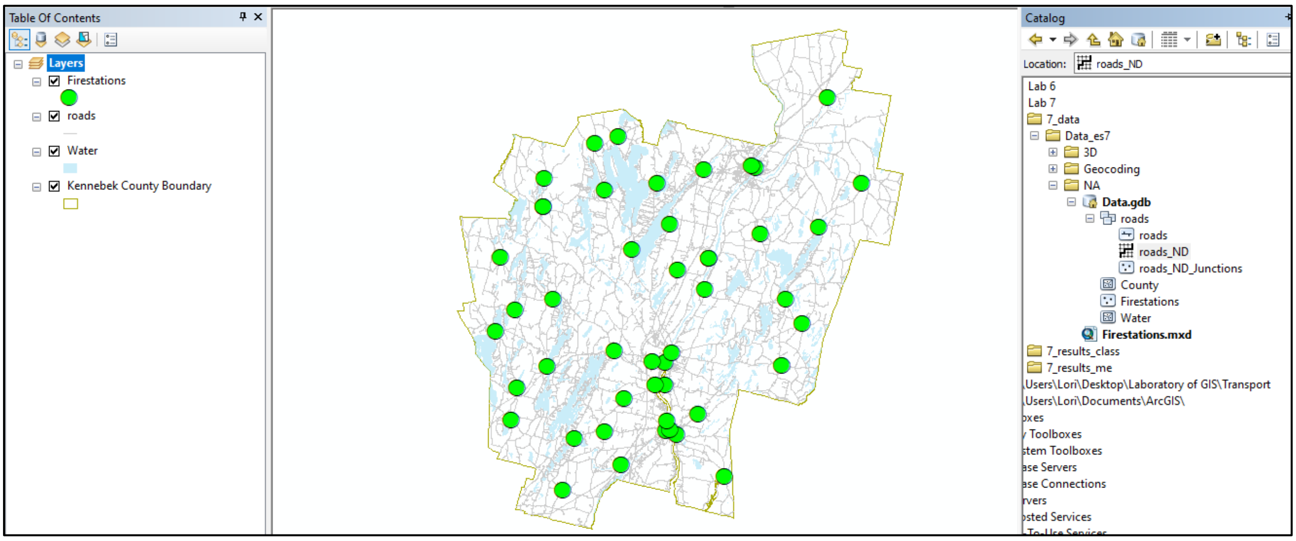
In this exercise, we create a 3D model using ArcScene. We open the program and import all the files from the given folder '3D'. We see several layers, which are not coincident nor co-oriented.




We can arrange the layers and extrude the buildings according to their height.

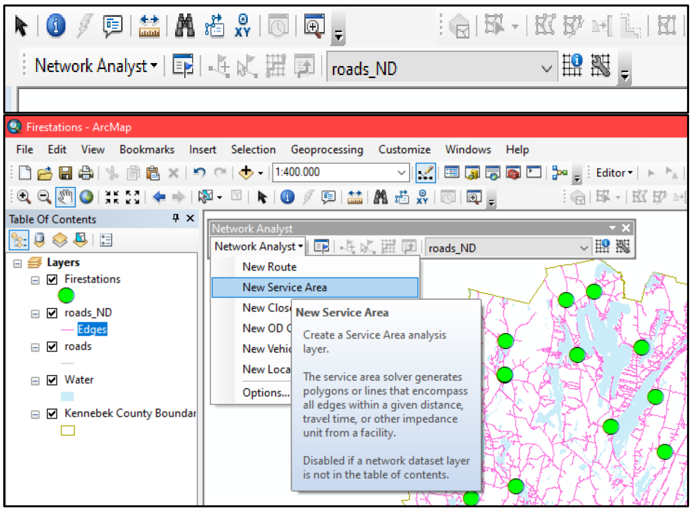



Now, there are available some commands such as 'Fly', 'Navigate', 'Center on Target', that allow to move within the model.

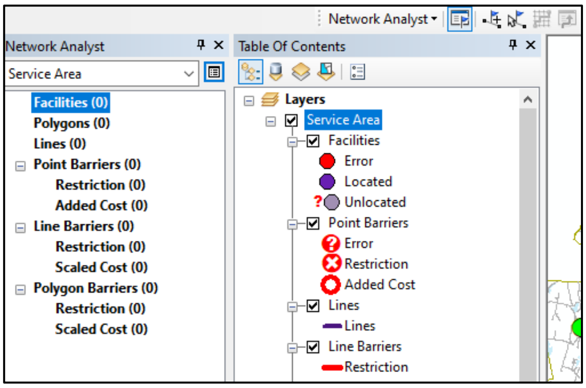



## 23.2 Set up the Network Analysis Environment

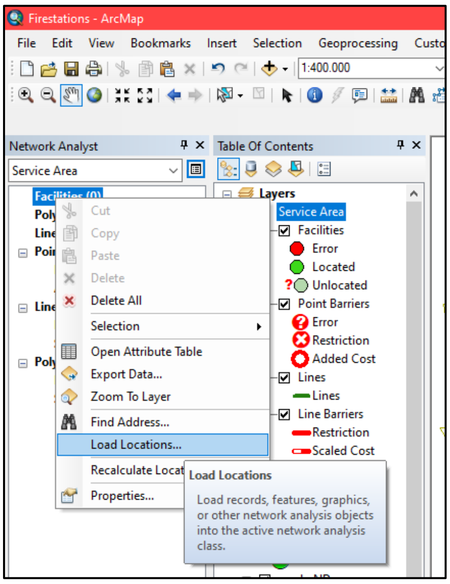
Add the Network Analyst from the 'Customize' tab.

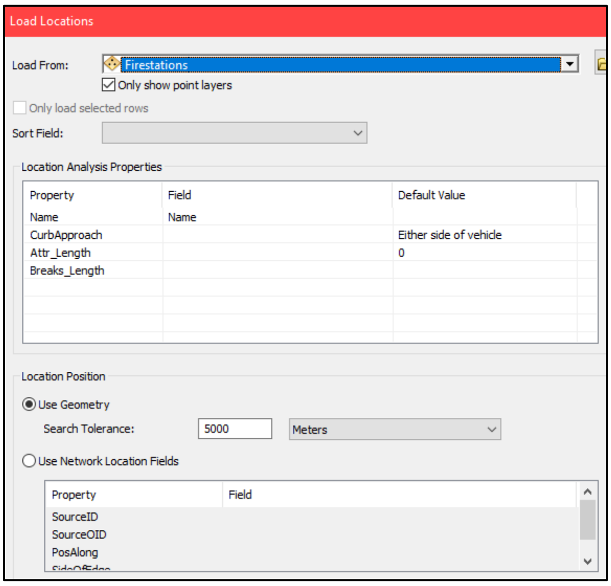



Select 'New Service Area', then open the 'Network Analyst Widow'.



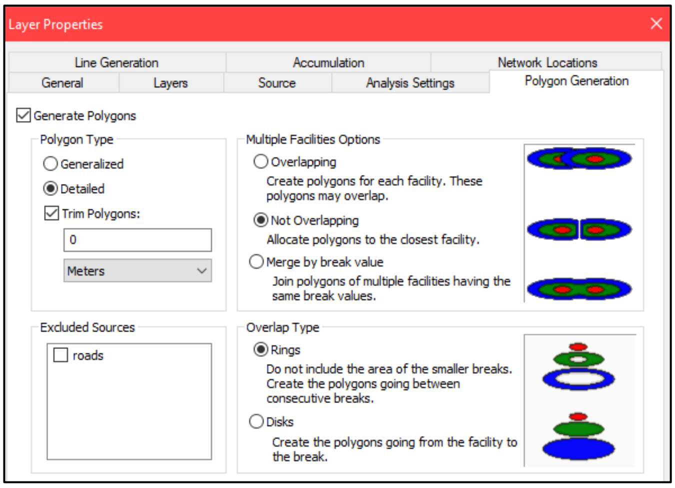

Define the facilities by right clicking on the opened window on 'Load Locations', then select 'Firestations'.




The fire stations are shown on the map.

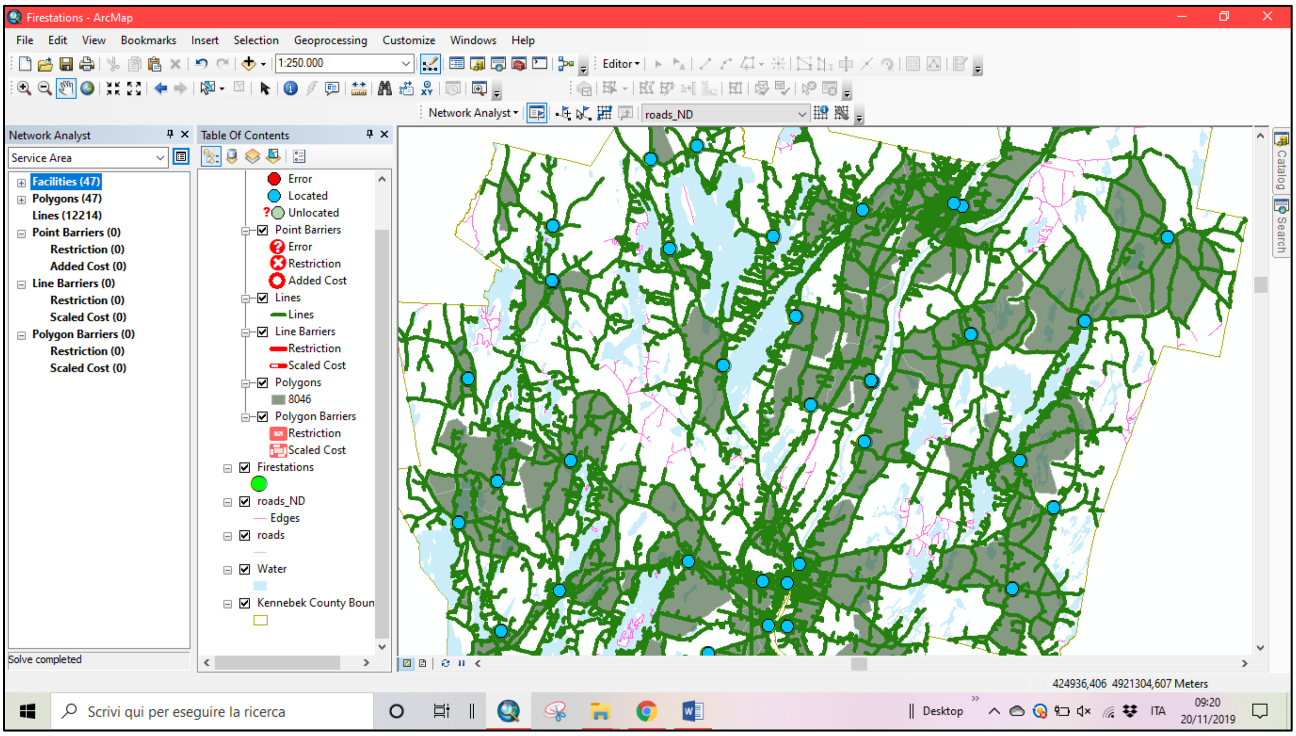
Finally, we click on 'Polygon Generation' tab and impose:




## 23.3 Run and analyse the network analysis

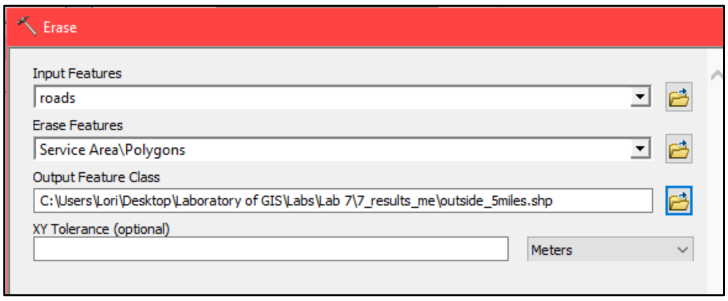
Finally, we can run the analysis by clicking on 'Solve' button.

The result is a network of lines:

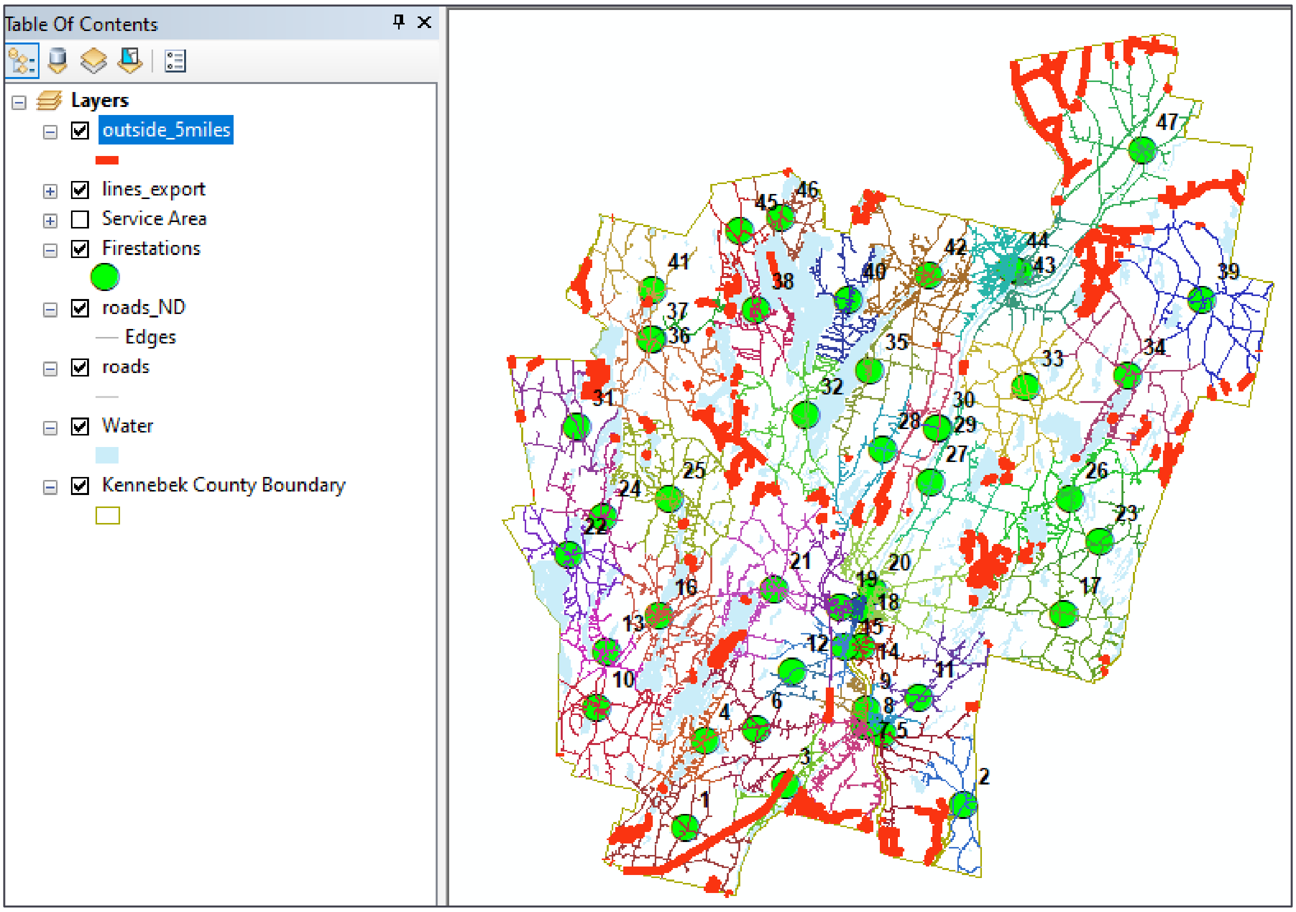


## 23.4 Polyline layer with road segments NOT meeting the 5 mile distance

We generate a new shape file layer, with some not included roads: we use the 'Erase' tool (we don't set the tolerance because we want exactly that roads):




The result is a layer with all the roads which have a distance more than 5 miles from a fire station:

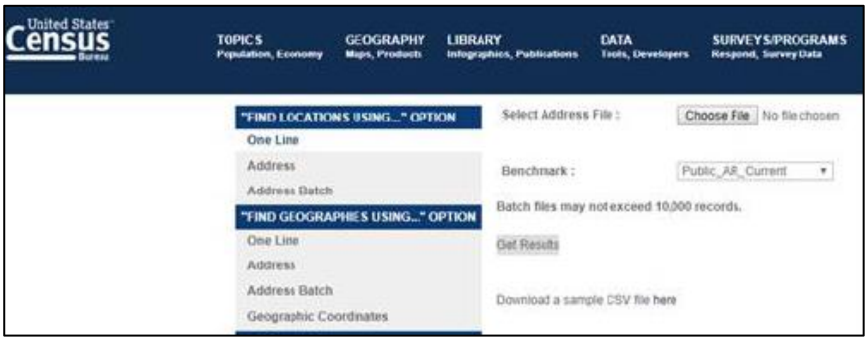



Finally, we have two layers: one containing the roads included in a range distance of 5 miles from a fire station and another one containing the roads that are far away from them.

We can create two maps: one of them showing the critical roads.

## 24.2 Geocoding

We insert the 'Addresses.csv' file on a free website (Census geocoding - https://geocoding.geo.census.gov/geocoder/locations/addressbatch?form) and get the referenced data.




## 24.3 Post-processing

We open 'GeocodeResults.csv' file and insert a header row above the top most record.

We need the data divided in columns:

| | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ID | Address | Outcome | Confidenc | Cens_add | Coord | Tiger | Side | Long | Lat |
| 2 | Colby | 4000 Mayf | Match | Non_Exac | 4000 MAYFLOWER HILL | -69.65724,44. | 75465095 | L | -69,6572 | 44,55706 |
| 3 | Unity | 90 Quaker | Match | Exact | 90 QUAKER HILL RD, UN | -69.33209,44. | 639604865 | R | -69,3321 | 44,6055 |
| 4 | COA | 105 Eden S | Match | Exact | 105 EDEN ST, BAR HAR | -68.228516,44 | 110256258 | R | -68,2285 | 44,39816 |
| 5 | Bowdoin | 250 Maine | Match | Exact | 250 MAINE ST, BRUNSV | -69.96521,43. | 78008087 | L | -69,9652 | 43,90713 |
| 6 | Bates | 2 Andrews | Match | Exact | 2 ANDREWS RD, LEWIS | -70.205284,44 | 616698620 | L | -70,2053 | 44,10716 |

We create two new columns that are called 'Long' and 'Lat'. We select the first cell under the 'Long' column and type the following formula:

```
= LEFT( F2 , FIND( "," , F2)-1 )
```

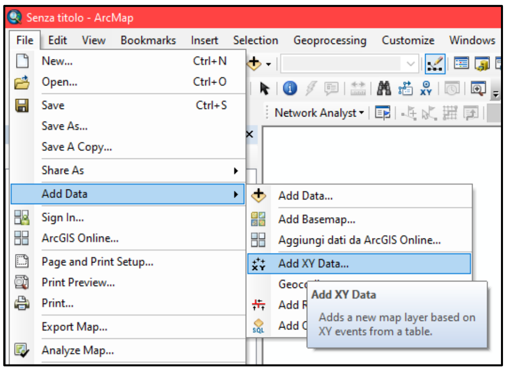
While under the under the 'Lat' column we type the following formula:

```
= MID(F2, FIND( "," , F2) + 1, 14)
```

We save the file as CSV.

## 24.4 Import in ArcMap

Open a new file and add 'XY Data':




Set X field as 'Long' and Y field as 'Lat' and impose the coordinate system as Geographic, WGS 1984.

# 25 Oral Exam Questions

These are question made during the oral exam that may be variable according to the professor's will.

1. Difference between geometry and topology.
2. What is topology and what is it based on?
3. Difference between TIN and raster.
4. Difference between raster and vector and how are they defined.
5. Negative/positive aspects of vector, raster and TIN.
6. What is the network analyst?
7. What is the format of vector and raster?
8. What is a database?
9. What are the spatial models of a database?
10. What are metadata, examples?
11. What is INSPIRE?
12. What are open data?
13. Difference between JOIN and RELATE.
14. Difference between BUFFER and OVERLAY.
15. How can we know coordinates of raster cells?
16. How to model a surface?
17. What is a shape file?
18. What is model builder?
19. What are problems for changing coordinates from (longitude, latitude) to (east, north)?
20. Problems of topology?
21. What is primary key and cardinality?
22. What is a conceptual model?
23. What are XML, SQL, UML languages?
24. What is geocoding?
25. Problems of geocoding, rural areas.
26. Interpolation methods.
27. OTF transformation.
28. Storage modes of databases.
29. Primitives of topology.
30. What are choropleth maps?

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# POLITECNICO DI TORINO

# Master in Civil Engineering

# a.y. 2019/2020

## Laboratory of GIS and Geospatial Service for Engineering Applications to HYDROLOGY

**Professors**
M. Piras
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Loredana Mihaela Chiforeanu

# Contents





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# Part 1 – River Basin

In this exercise we will work on a defined area located in the South-West of Piemonte. The River Basin is called *Stura di Demonte* and it is a tributary of Tanaro River at Cherasco (CN).

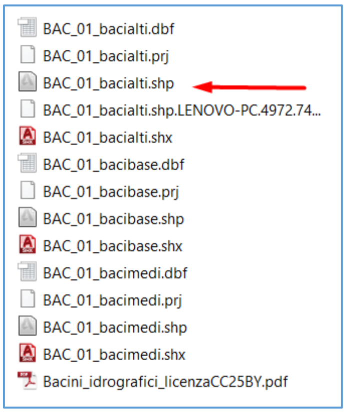
## Prepare a Framework

The procedures of this part can be defined as:

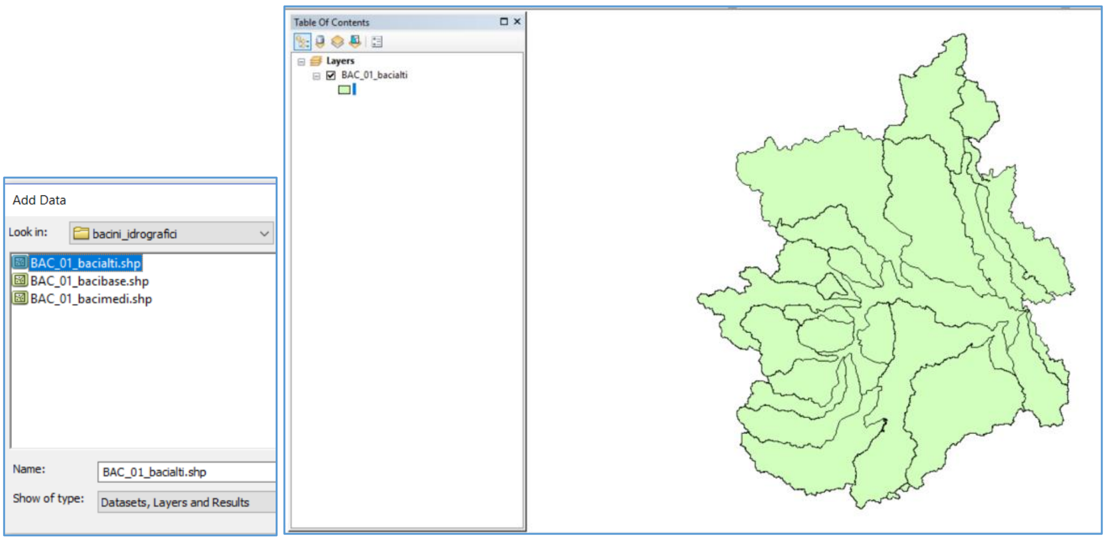
1. Loading catchment map in large size provided by ARPA Piemonte
2. Loading Digital Elevation Models (DEM) provided by NASA
3. Identifying the River Basin of our selected area *Stura di Demonte*
4. Clipping the catchment map with 'Clip' tool of ArcMap
5. Preparing a map of this basin with a legend, indicating the elevation with a color range

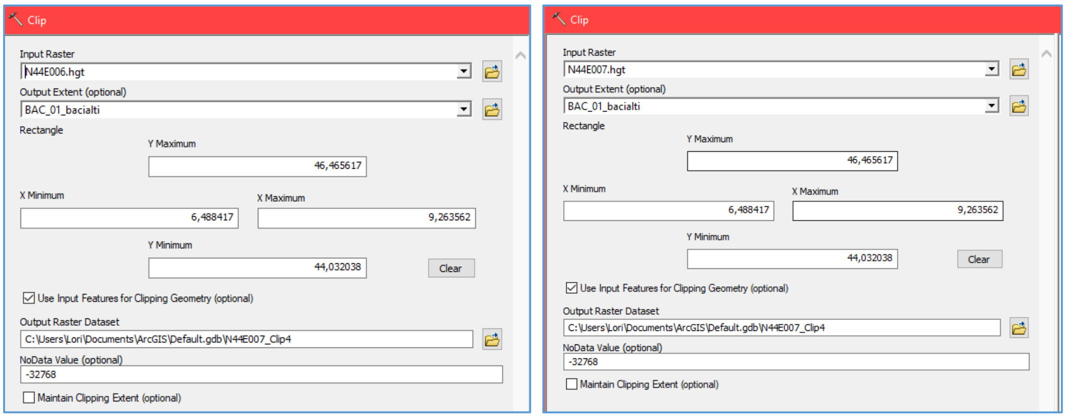
### 1. Catchment Map

First, we download the catchment data file *'bacini_idrografici.zip'* via ARPA Piemonte's website.



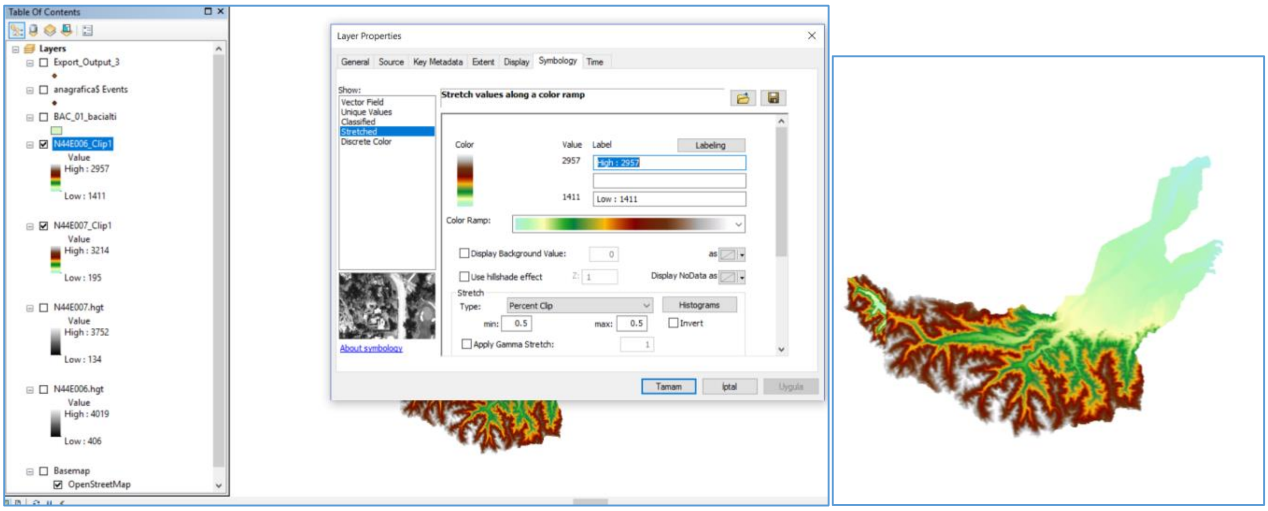

Then, we add the shape file *'BAC_01_bacialti.shp'* in ArcMap project.



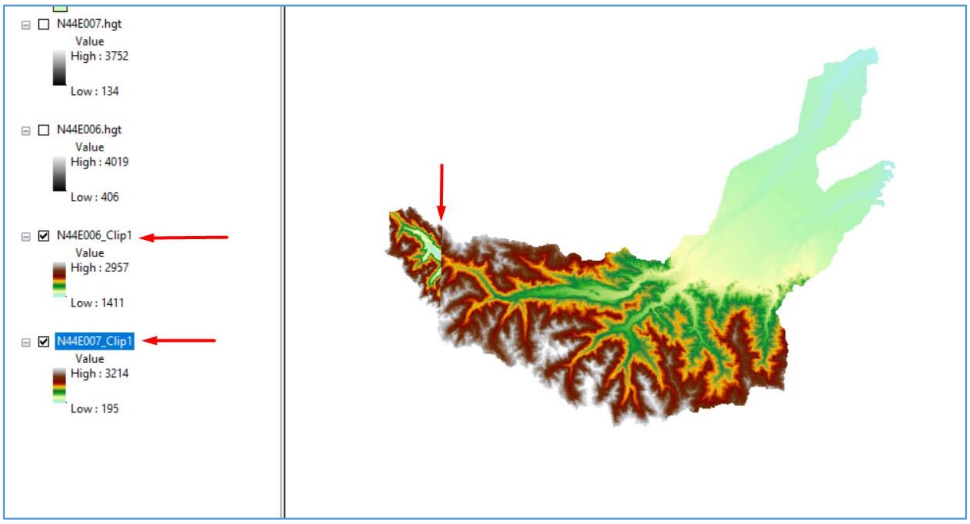


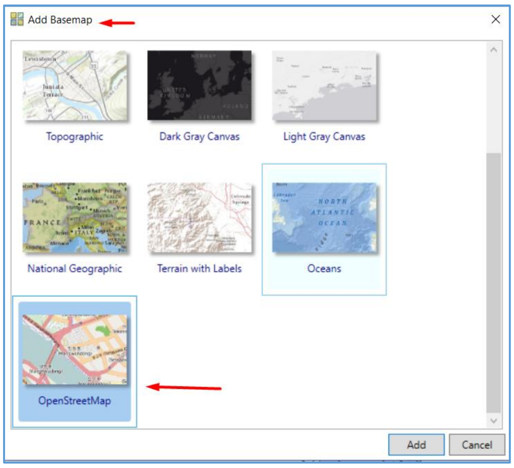

## 5. The framework

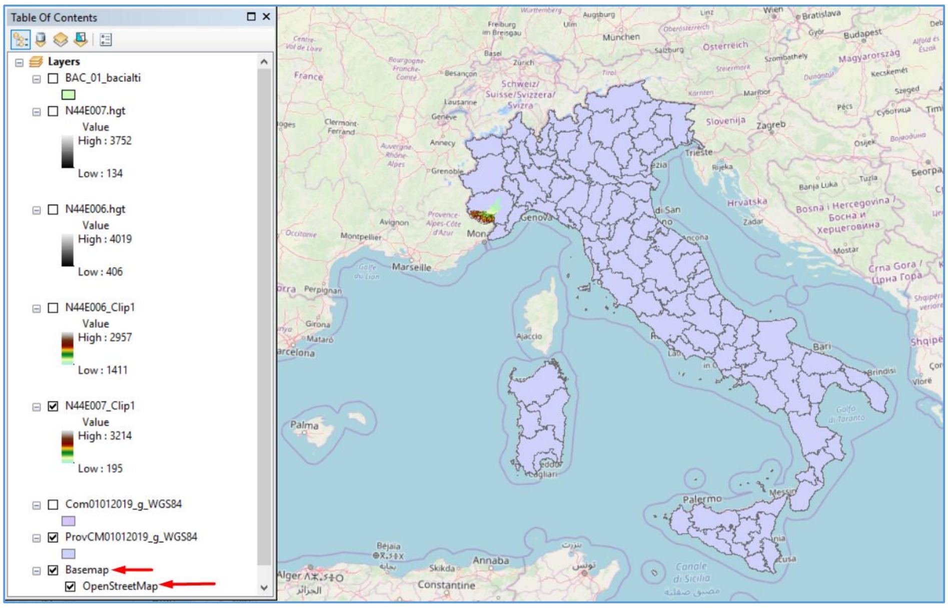
We change the color range of clipped SRTM DEM data files from 'Layer Properties-Symbology' menu.



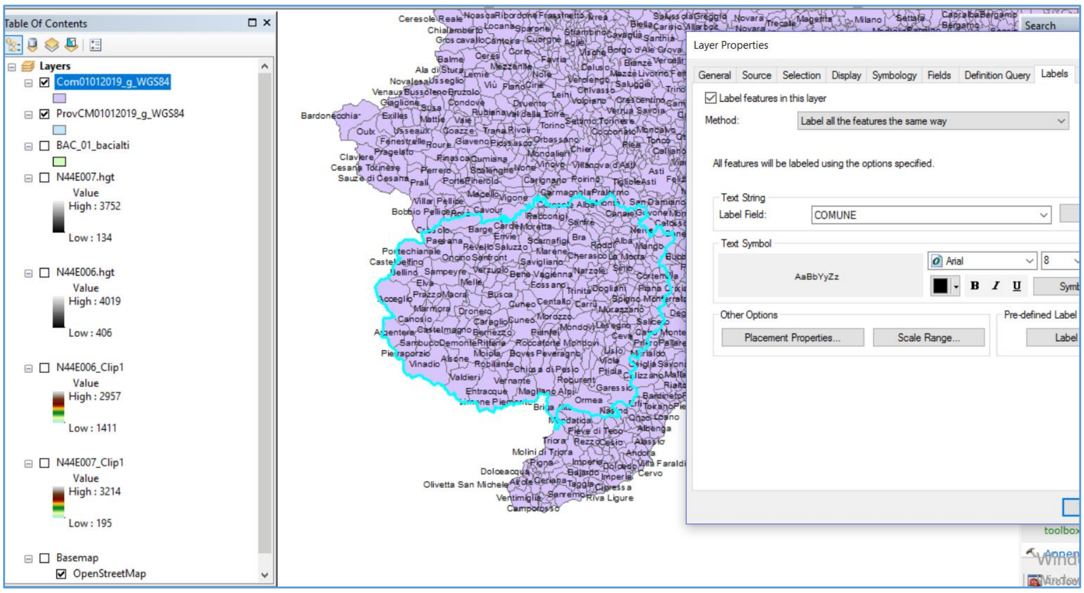

We merge two clipped rasters 'N44E006_Clip1' and 'N44E006_Clip2' in order to get a unique clip and avoid differences of colours:

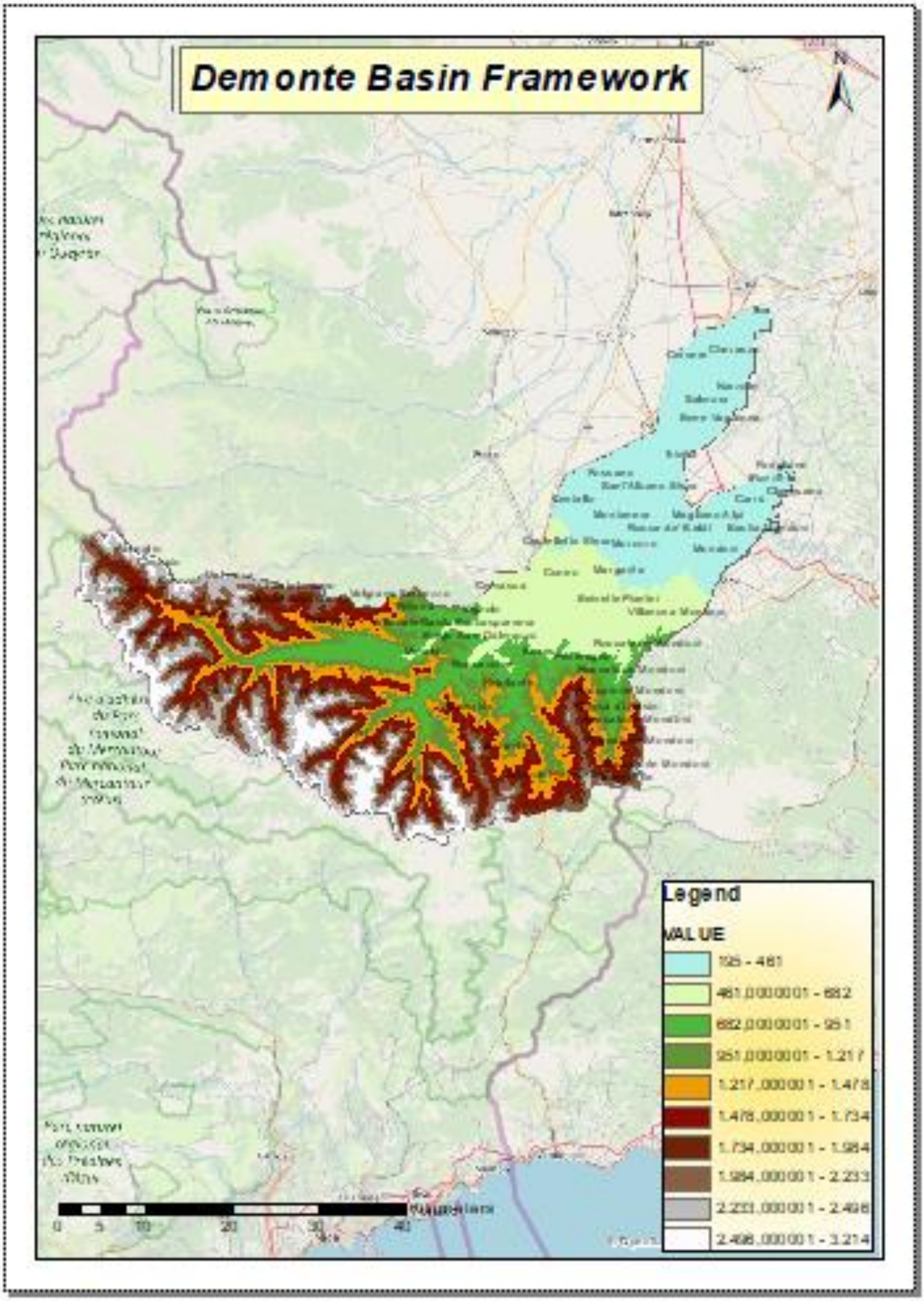




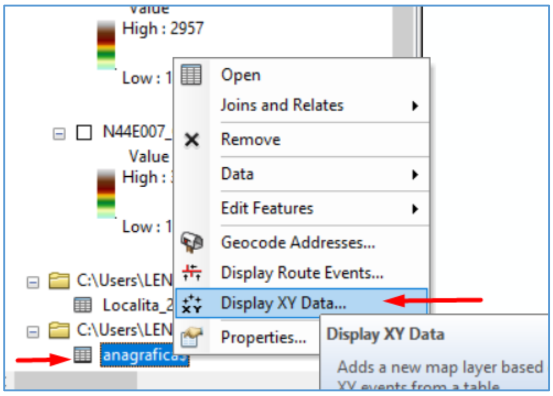



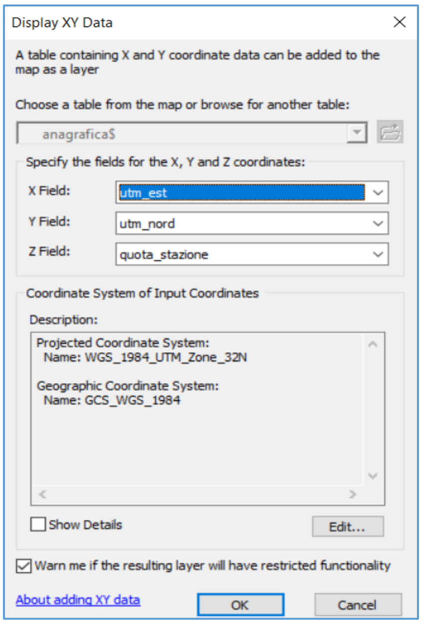

We also load '*point places*' and '*population*' from *istat.it.* We generate '*labels*' with the names of major towns in Cuneo province ('Comune').





Demonte Basin Framework
N
Legend
VALUE
195 - 481
481,0000001 - 682
682,0000001 - 951
951,0000001 - 1.217
1.217,000001 - 1.478
1.478,000001 - 1.734
1.734,000001 - 1.984
1.984,000001 - 2.233
2.233,000001 - 2.498
2.498,000001 - 3.214
0
5
10
20
30
40




So, we get all the gauges of Piemonte.

But we are interested only in those of Stura di Demonte Basin. Using 'Clip' tool we cut the layer in order to create another one containing only the points of interest: