1-Fundamentals of GIS

NOTES AND CONTENTS

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WEEK 2: Exploring Data:

1-18 - using ArcMap to explore data

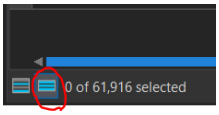
- ArcMap is now integrated into ArcGIS.
- To open .mpk files, go to Insert->import map.

1-19 – viewing and changing layer properties

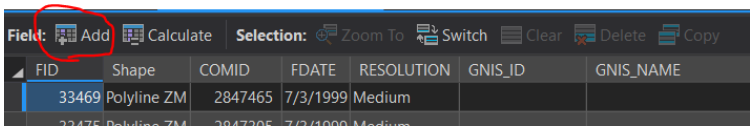
- in properties-> definition query, you can use SQL queries to filter the data displayed.
- Transparency is under the Appearance tap

1-20 – Using feature classes and attribute tables

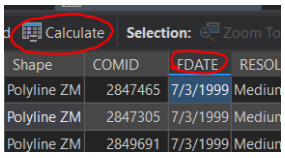
- To only see selected items in the Attribute table, use this sign:



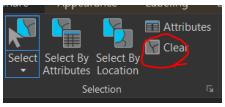
- To create a new layer from select items: select the features you want, then right-click on the layer and select: selection -> make a new layer from selection
- You can add a field(column) to your Attribute table with this sign:



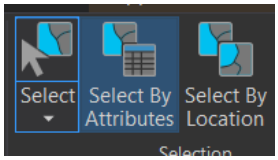
- you can use Python to do calculations on your fields by selecting a field and clicking the calculate sign:



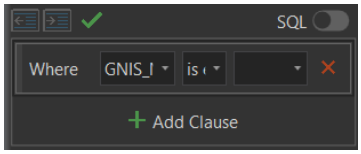
- deselect the selected features:

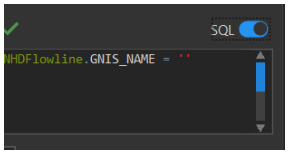


1-21 – select by attribute and calculate Geometry:

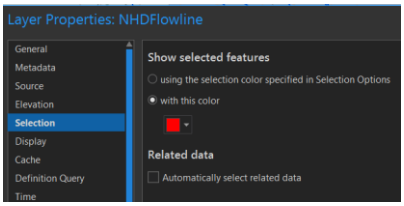


- Where you can use GUI version of SQL
  or the pure SQL code by selecting the SQL option (using the **WHERE** clause)



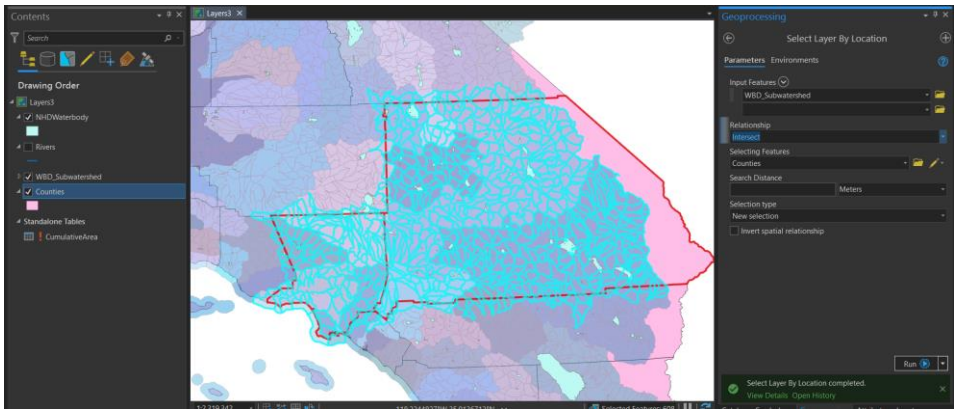


- Changing the selection color: when you select an item, the select item will be shown with this color instead of the default color



1-22 - Select by location (SBL)- Important:

- first, select the area you want using the selection tool or the 'select by attributes'
- then select the 'select by location' to use the previous location as the area you want.
- You can use the **overlay rules** like Intersect to be used in selecting new areas.
- In the blew example, we selected 2 Counties then used SBL to find the watersheds within these two counties.
- The search distance creates a buffer to search for outside the select attributes as well.



Exporting the selected attributes:

- Right-click on the layer you've selected attributes from.
- Data->export

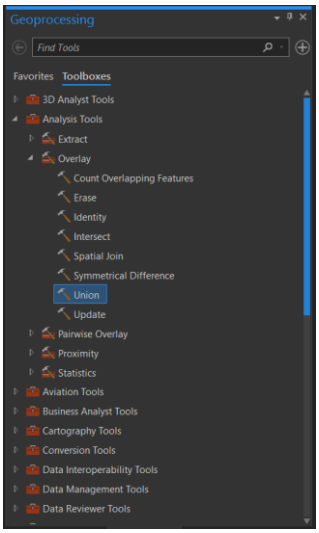
Week 2: Projections and Geoprocessing

1-23 – An introduction to projections:

- **Conformal projection:** preserve the local **shape**.
- **Equal Area projection:** preserve **area** displayed features.
- **Equidistant projection:** preserve **distances** between certain points.

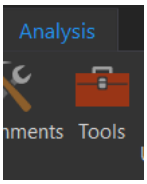
- **Projection Types:**
  You can find what kind the dataset you're working with it is using by going to layer properties
  - Equirectangular
  - Mercator
  - Mollweide
  - Universal Transverse Mercator (UTM) – mostly used.

- You can download data from www.thematicmapping.org



TOOLS:

- You can find tools here:



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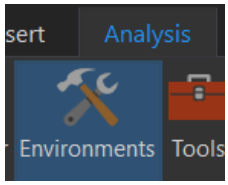
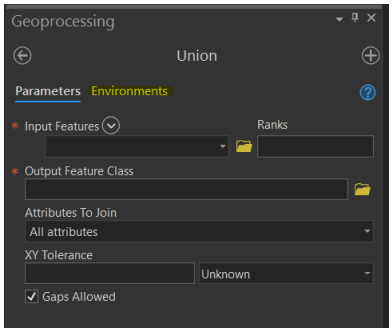
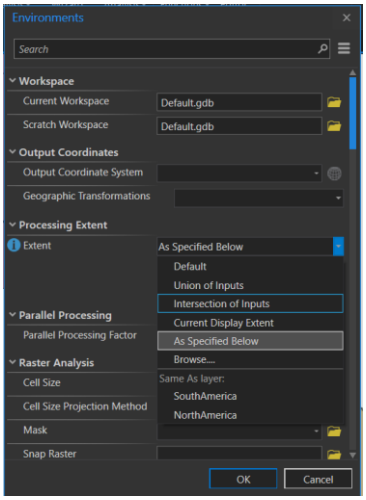
1-25 – Setting Environment Variables:

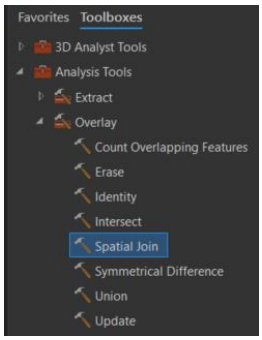


- By the use of the Extent panel, we can select an area Where only in there our operations happen.
- It is also available when using Geoprosecing tools.

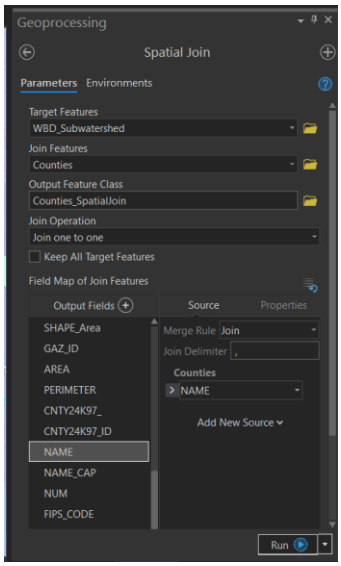




1-26– Assessing Spatial Relationships with the Spatial Join Tool:



- In a regular database, we use a **primary key** to join tables; well, here, we use coordinates as **composite primary keys**.
- In fact spatial join finds attributes within a boundry(check final assignment)
- In this example, we're trying to find the watersheds in our selected counties.
- We set the merge rule for the name to 'join,' adding a new column In the joined table, which shows the states a watershed is in.



- Notice that we changed the max length of this attribute because a watershed can be in many states
- By defining the Delimiter, we decide how we want these names to be separated.
- The "keep all target features" is actually setting the join as 'inner join' or 'outer join' in SQL
- https://www.youtube.com/watch?v=PWUfmCPHSew

join operation - Join one to one: when using this join the Tool adds another column in the table named **Join_count** which counts the amount number of joins happened in each section.

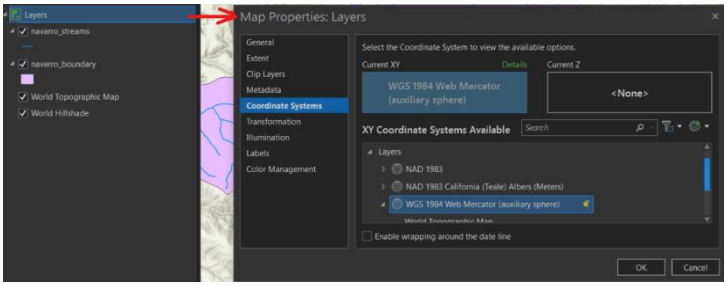
Determines how joins between the target features and join features will be handled in the output feature class if multiple join features are found that have the same spatial relationship with a single target feature.

- Join one to one—If multiple join features are found that have the same spatial relationship with a single target feature, the attributes from the multiple join features will be aggregated using a field map merge rule. For example, if a point target feature is found within two separate polygon join features, the attributes from the two polygons will be aggregated before being transferred to the output point feature class. If one polygon has an attribute value of 3 and the other has a value of 7, and a Sum merge rule is specified, the aggregated value in the output feature class will be 10. This is the default.
- Join one to many—If multiple join features are found that have the same spatial relationship with a single target feature, the output feature class will contain multiple copies (records) of the target feature. For example, if a single point target feature is found within two separate polygon join features, the output feature class will contain two copies of the target feature: one record with the attributes of one polygon, and another record with the attributes of the other polygon.

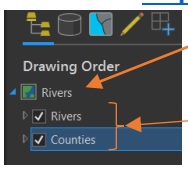
1-27 – Assignment 2:

- **Speeding up the rendering:**

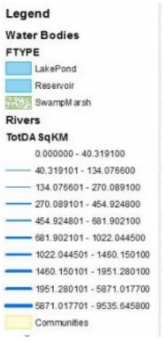
  By selecting WGS1984 in the properties of the layer, you are working on; you can speed up this process.

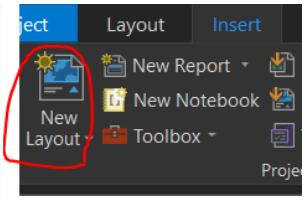


1-31 – Using Layout view to make maps:



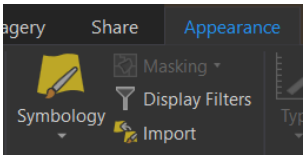
- https://www.youtube.com/watch?v=NZ9ei4-23MM
- **Data frames** are complete maps to themselves, and only one can be displayed at a time In the data view. **Layers** are individual sets of data displayed within a data frame.
- **Bookmarks:** jump back to a specific view and are useful while laying out a map.
- **Legends:** in information in the side of the map(like ***pyplot.legend()***).



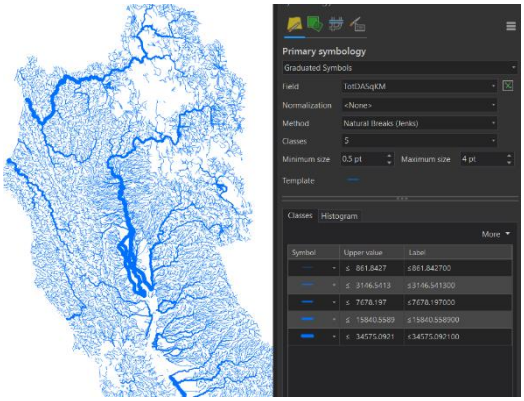


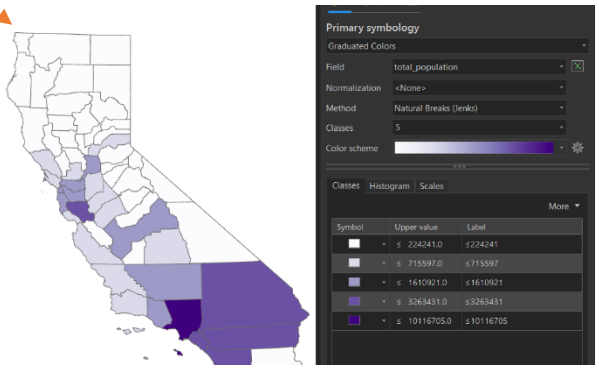
for keeping a standar view

1-35 – setting up symbology



- **Graduated Colors:** dedicating a color proportional to the number, with normalization option, you can normalize your data, for example, rate of people normalized by the total_population. the Asian
- **Graduated Symbols**





1-36 – Labeling map features:

- Righ-click -> Labeling properties: to do specific Labeling
- Righ-click -> Label for auto Labeling

1-37 – making map books

WEEK 4

1-41 – Using Metadata to document data in products

- **37 – making map books**
- Its important and use FGDC format for your meta data (change in ArcGIS setting)

1-42 – 43 - 44 – Sharing Data and using map packages

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1-45 – Choosing Data Format

3 most common formats

- Shapefiles
- Personal geodatabases (not supported in ArcGIS pro)
- File geodatabases

1-46 – Join and relates

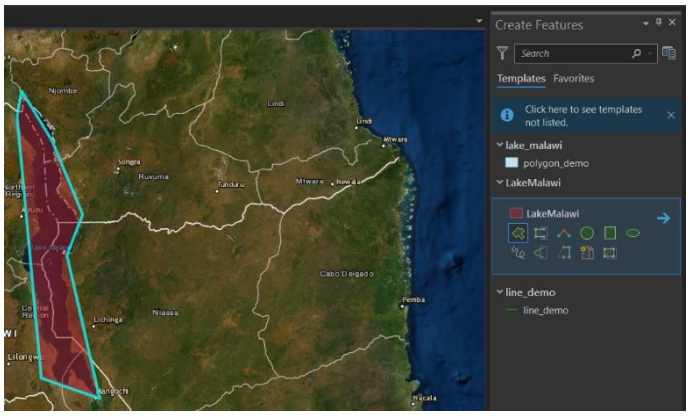
- To join a table to your layer, right-click on your layer and select join
- It is exactly like SQL; you choose a primary key to join tables
- Relate is a one to many join

2 - GIS Data Formats, Design and Quality

NOTES AND CONTENTS

Week 1

2-4 – Vector Data: vector data follows an object model.



- **Objects:** conceptualizations of real items.
- Each record in a feature class is a representation of an object. And a feature class is a collection of many objects.
- Raster is faster, but Vector is correcter.

2-5 – Vector Data in Action:

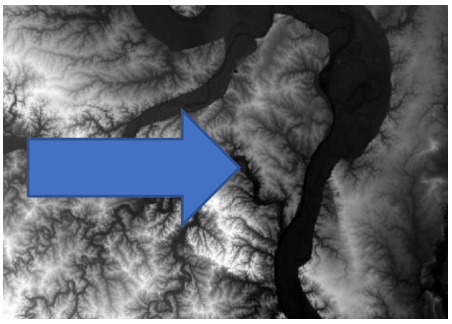
- How to create feature Classes: arcgis.com/create-polygon-features.html

v7 – Raster Data:

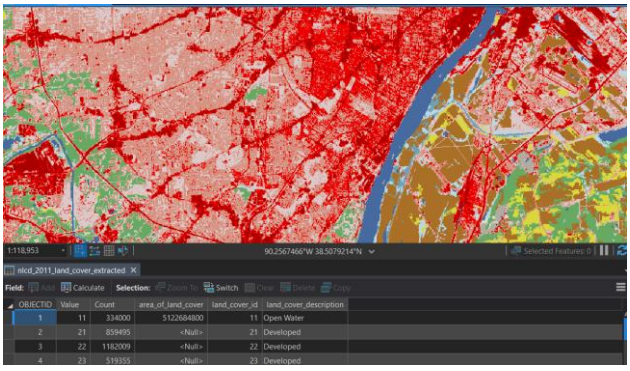
- Vector is for discrete data, and Raster is for continuous data

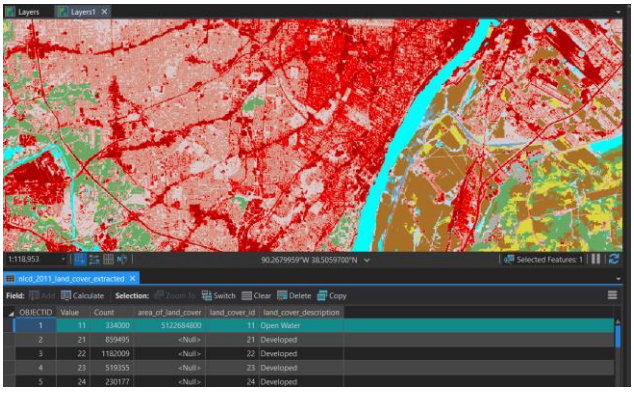
2-7 – Raster Data in Action:

- Pixelated when zoomed in:



- Select attributes in attribute table:





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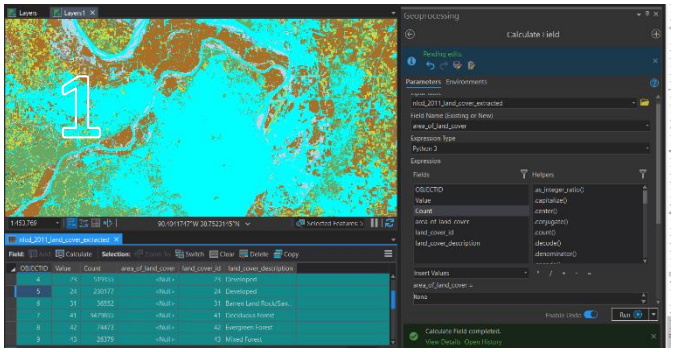
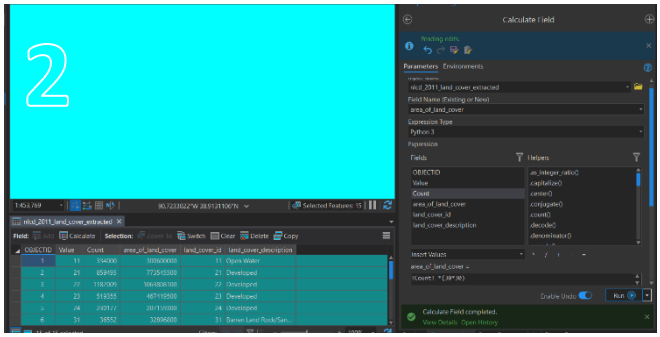
2-7-1 – how to use Calculate field:



[YouTube: Field Calculations in ArcPro (Basic Introduction)]

- In this example, we want to calculate the area of land cover for each row.
- Open calculate and select row or rows you want



- Double click the Field you want (in this case, from properties, we know each pixel is 30mx30m) and do the calculations you want based on the youtube video.

2-8 – Scale and implications:

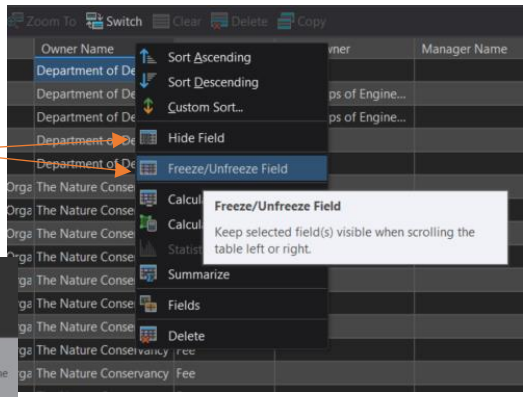
- Remember 1:x is 1/X, so the bigger the X, the smaller the Scale
- You can specify Scale rang(the Scale that the object is shown) in properties.

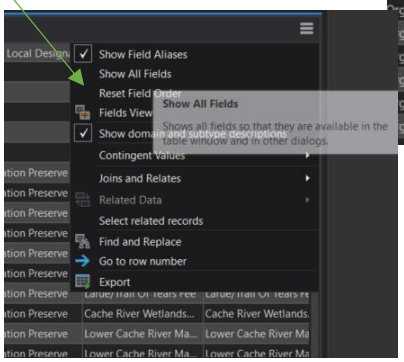
2-10 – Data Design: Attribute Types

- INT: short int, long int
- Floating point: single-precision , Double-precision(Doubles)
- String
- Null -> in Python Null is defined as None
- **Practice files**

2-11- Vector attribute tables:

- You can freeze a field by right-clicking on it, so you always see that specific column when you move through all columns.
- You can also hide a field and unhide it using this menu.





2-12- Data Design: Joins and Relates:

- Exactly like SQL.

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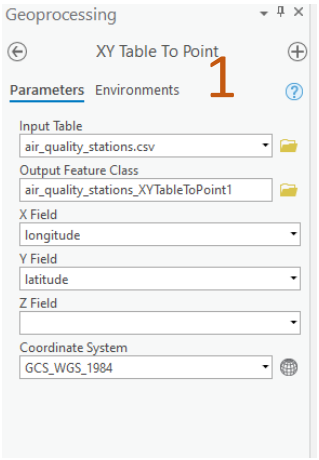
- Primary and foreign key.
- A foreign key is a key that refers to a primary key in another table.

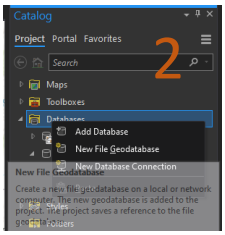
2-13- Data Design:

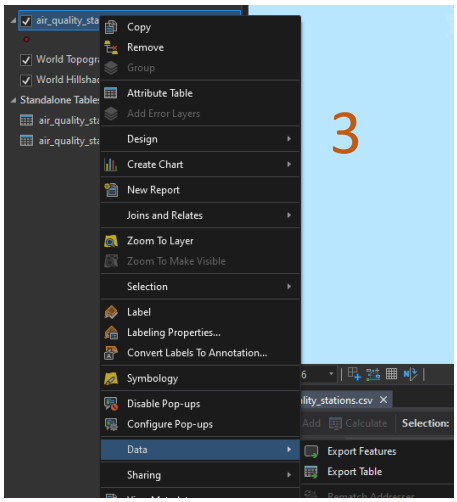
- Watch Mosh SQL course.

Assignment 2-1:

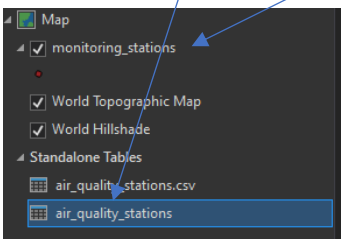
1. Importing a .csv file in ArcGIS: Drag and drop the File in the **Contents** tab on the left.
   The Data is just a table now; to turn it into points in the map, right-click and click on: **Display XY data.**
   X = Longitude & Y = Latitude







2. **Creating a Database:** in ArcGIS pro, you can only create File Geodatabase
   To do so, right-click on "Database" in the Catalog menu.
3. **Import data to your Geodatabase:** right-click on your data, and you can both import it as a Table or Features Class.



4. **Create a Table:** right-click on your Database and select new->table
   Give it and its columns a name.

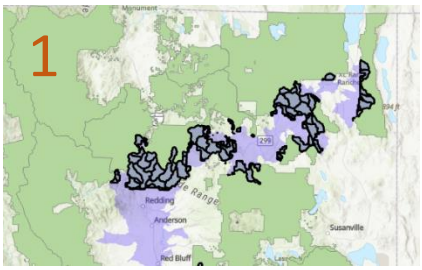
Week 2

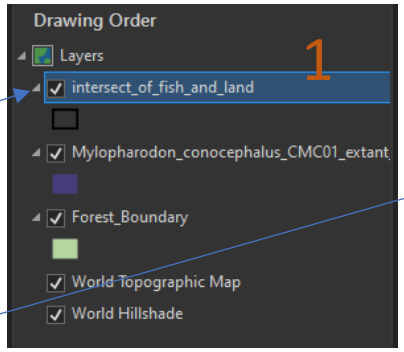
2-17- Geoprocessing Tools:

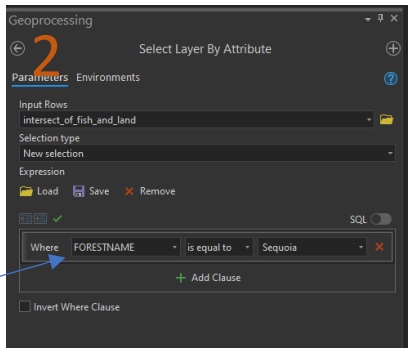
- The projection tool can project the coordination to a new one.

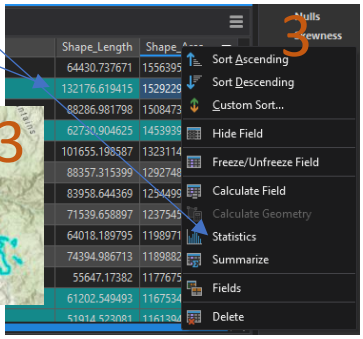
2-18- Intersect Tool:

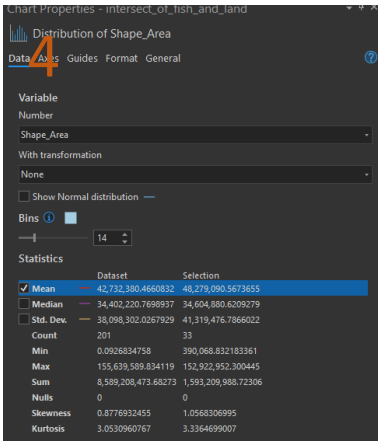
- Select Intersect tool from the toolbox; It is pretty much straightforward. Select your layers and press run:).
- Example: find the area of intersected area: open attribute table of a new feature class and right-click on shape are column and select Statistics.
- You can also use Select by Attributes to select a specific area:





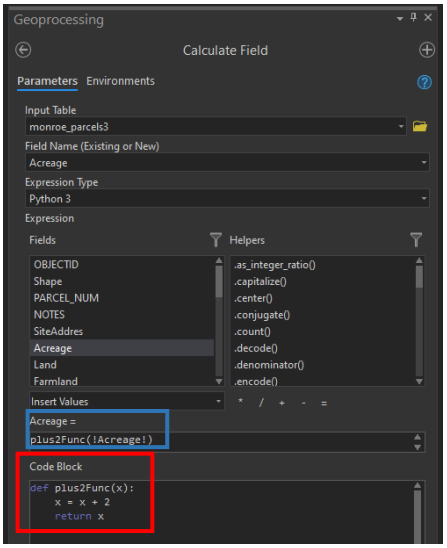






2-19- Intersect Tool: writing query strings

- It's just simple SQL; refer to SQL notebook if needed.



2-21 – adding and calculating data:

- On 2-7-1, I explained how the Calculate field works.
- But what is the Code Block?
- We can write Python functions in this block and use it like this example:

2-22 – interactive selection:

- Use **Shift** when selecting to ADD to your selection.

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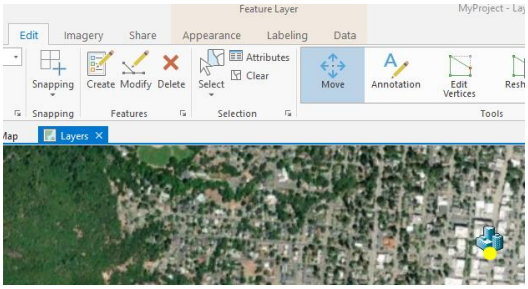
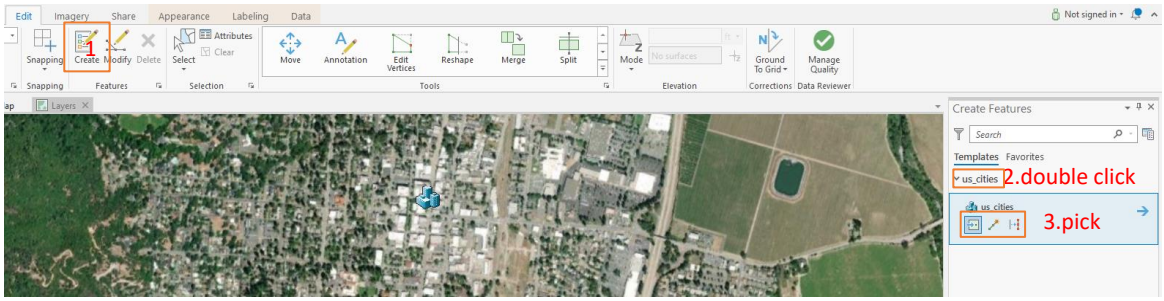
- Use **Cntrl** when selecting to Remove from your selection.

2-23 – a good example that combines all of the selecting tools.

2-24 – editing existing data:

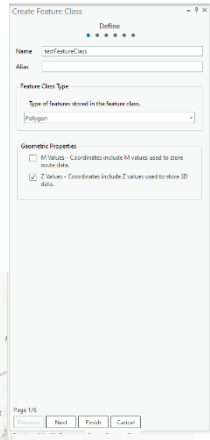


- **Moving features:** to move features on the map, go to the edit->move and move the feature by grabbing the yellow dot.
- Editing attribute tables is a lot easier in ArcGIS pro than it was in ArcMap; you just need to double-click on the attribute you want to change, and there is no such a thing as an **editing session.**
- **Create feature:**

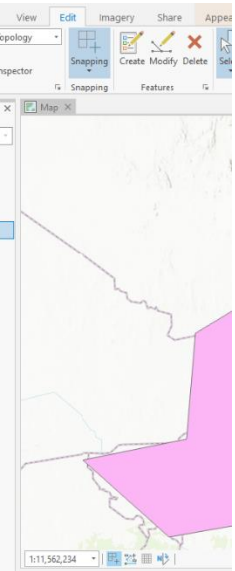


2-25 – Creating new feature classes:

arcgis.com/create-polygon-features.html

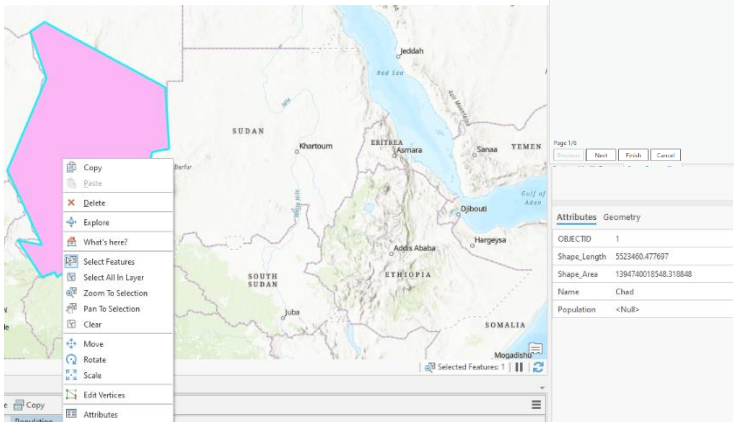


- Right-click on your Database in the Catalog panel, choose "Create feature class" and follow the setups.

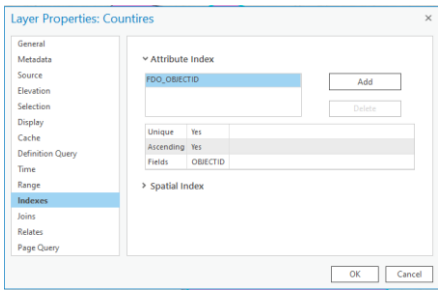


2-26 – basic digitalizing:

- After creating your feature in your feature class, you can change its attributes either by going to the attribute table of the feature class or right-clicking on the feature.
- To enable snapping, click on the snapping option on the Tabs or the sign on the button left.



2-32 – indexing for high performance:



- We had this topic in SQL as well; it makes the search faster.
- To do it in ArcGIS pro: right-click on feature class -> properties and in indexes tap add the attribute you want.

2-35 – percent overlap: $x = \frac{A \cap B}{A \cup B}$

- Use Intersect and Union Tools on your layers and divide the sum of Shape_Area.
- **Dissolve Tool:** removes the inner boundaries in a layer. (you also get the sum of the Shape_area)

What is the difference between a feature class and a feature dataset?

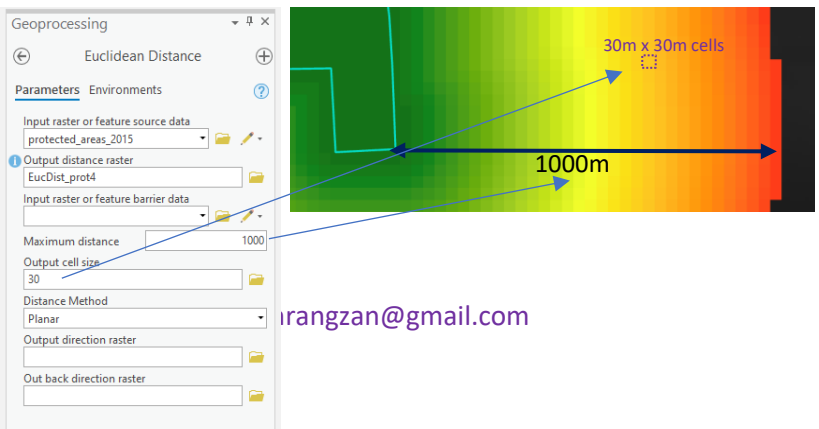
In the Geodatabase, feature classes can be standalone, or they can be organized into larger units called feature datasets. A feature dataset stores feature classes **that have the same coordinate system and the same spatial extent**, meaning they occupy the same

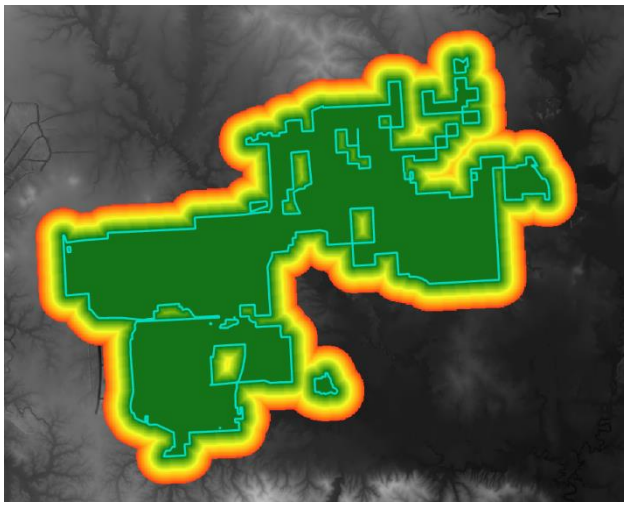
2-37 – Spatial Analyst ToolBox:

- We use this toolbox for raster data; Distance, Buffer, Slope, Interpolation, etc.
- Make a new layer from the selection:
  - Select features for a layer using any selection method and ensure the layer is highlighted in the **Contents** pane.
  - Under the **Feature Layer** tab, on the **Data** tab, in the **Selection** group, click **Layer from Selection**.

But how does the **Euclidean Tool** works?

- The Euclidean Tool **output is a Raster,** but it can be used on both Raster and Vector data.





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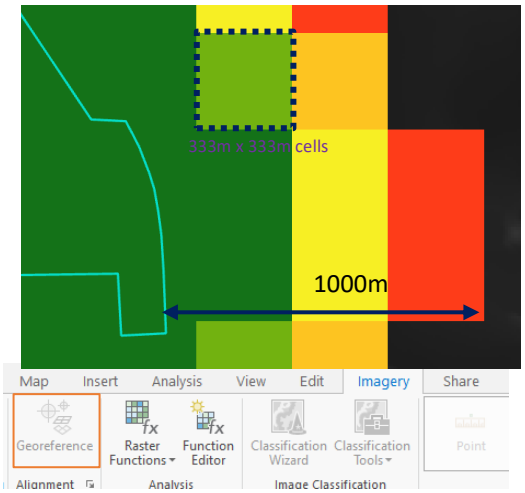
- Now, let's **increase the cell size to 333m**; what will happen?
  - The distance is still 1000m, but instead of 33 cells of 30m, we have around three cells of 333m in each row.

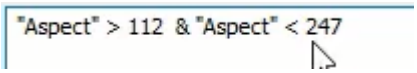


2-38 – Georeferencing Rasters:

- It is used for the images that don't have coordinates or are misaligned
- https://www.youtube.com/watch?v=J-to3kHo1Ug

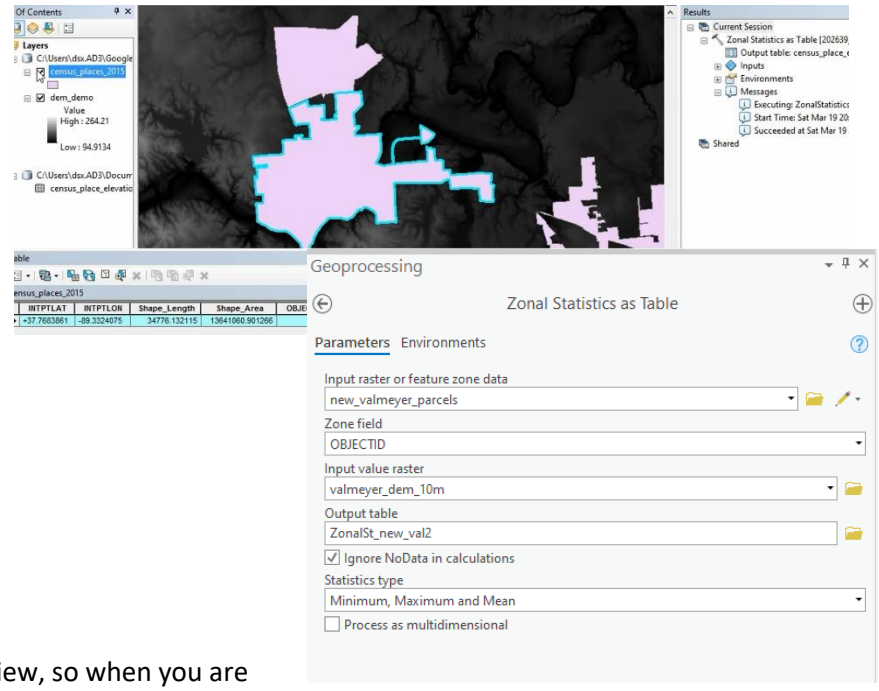
2-39 – Raster Calculator:

- It is used for Algebra Calculations on raster pixels.



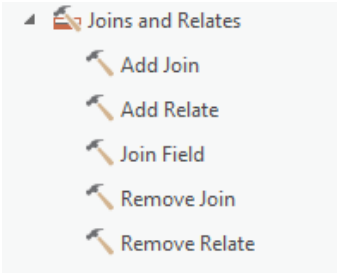
2-40 – Zonal Statistics:

- it is the Spatial join but between a raster and a vector.
- For example, in this case, we have a polygon that we want to find the mean elevation for.



2-41 – Join Feild:

- Add join is not a permanent join; it's a view, so when you are joining a table, you can't change the column names (you don't have access), so if you want to add more than one Zonal statistics table, values(MAX, MIN, etc.) are going to get mixed up.
- To prevent that, we use Join Field, a permanent join, and after joining each table, you can change the column names before going for the next one.



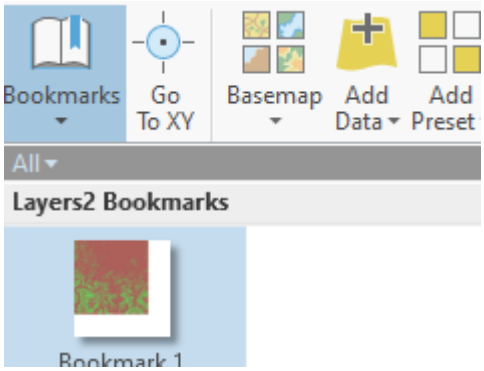
2-42-43 – Uncertainty and error:

- We can't know the exact thing we want; there's always some precision to sacrifice.

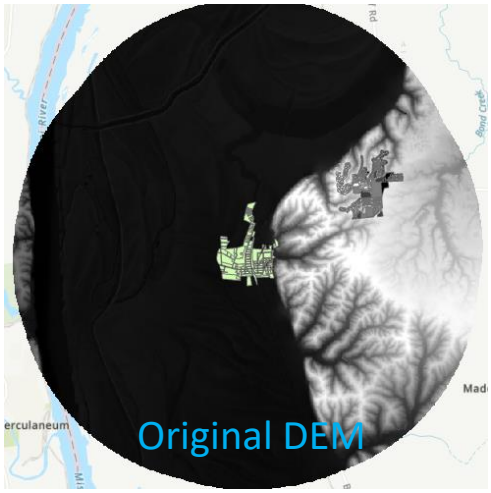
- Uncertainty in measurement, in the way we represent our data(hard, fuzzy, etc.)
- **MAUP: Modifiable Area Unit Problem:** the number, size, and shape of zones can dramatically affect the analysis
- **ecological fallacy:** for example, if we have a mean for a polygon, it doesn't mean that every individual in that polygon has that amount (can have less or more).

2-47 – ArcGIS online:

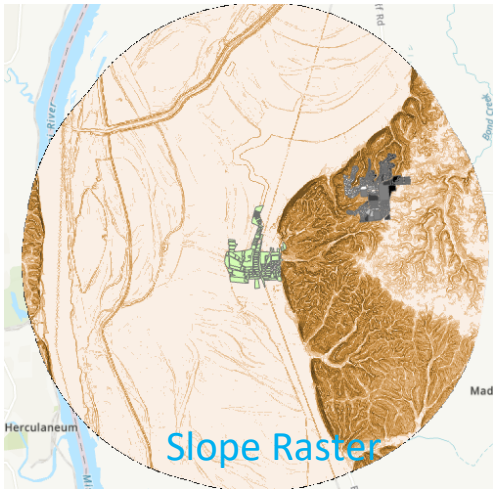
- **Bookmarks:** save the zoom and place it in a layer you are working on so you can always come back to that with convenience.

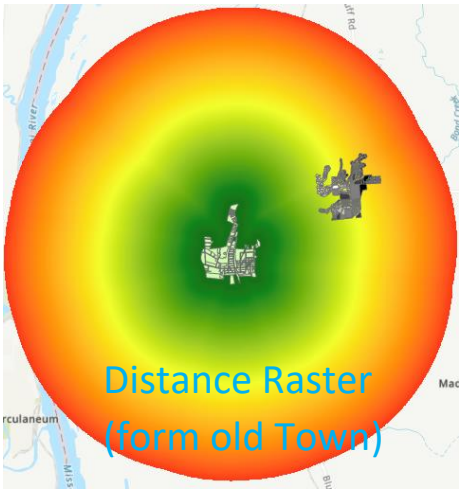


Final Assignment:



- The most used Tool in this assignment is Zonal Statistics, which helps us to get the statistics for an Area[Vector or Raster] on a raster layer.
- In this assignment, we used this Tool 3 times: first we used it on DEM model to get the mean elevation for each parcel of the town.
- Second we used Sapatial analyst tool to create a Slope raster out of our DEM then agiain used zonal satistics to find the mean slope for each parcel
- Third and the most important one was where we used Euclidean Tool to create a Distance raster and then agin we used zonal stats to find the mean distance.
- "*when generating your distance raster, use a maximum distance of 5000, an output cell size of 10m, and set the "Snap Raster" and "Extent" environment variables to the digital elevation model so the cells align."*



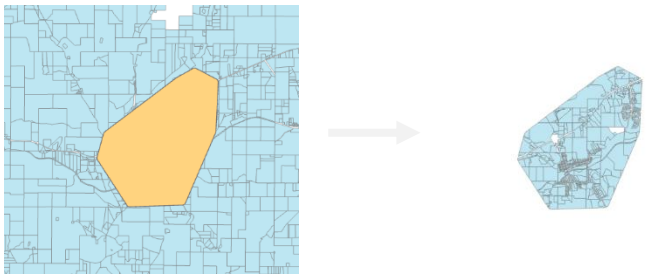


- The snap raster and extent made our distance raster to fully conver our dem.
- For the roads its just as easy as right clicking on you database in Catalog panel and select ->create feature Class.

3 - Geospatial and Environmental Analysis

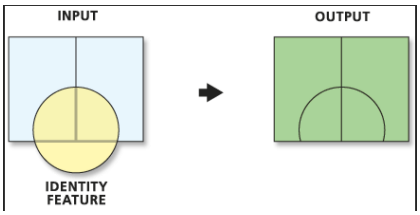
NOTES AND CONTENTS

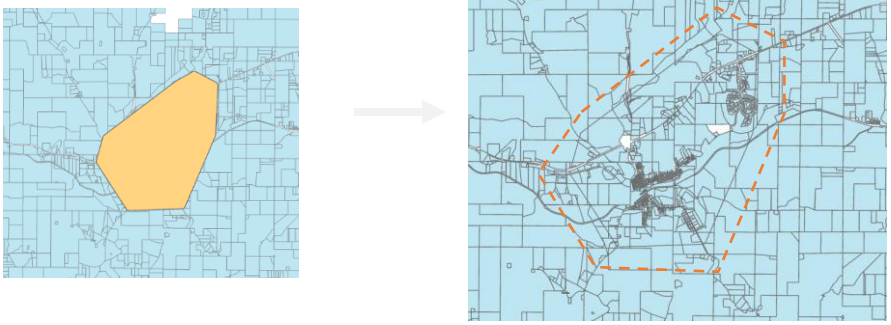
3-4- Clip Tool:



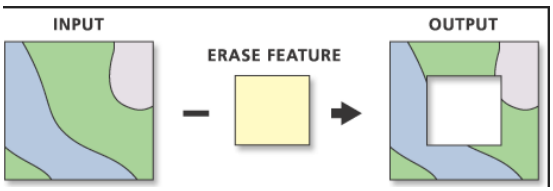
3-5- identity tool:

- notice how the border of the orange vector area is now on the new map. (the orange striped line is there to help you to find the real black borderline





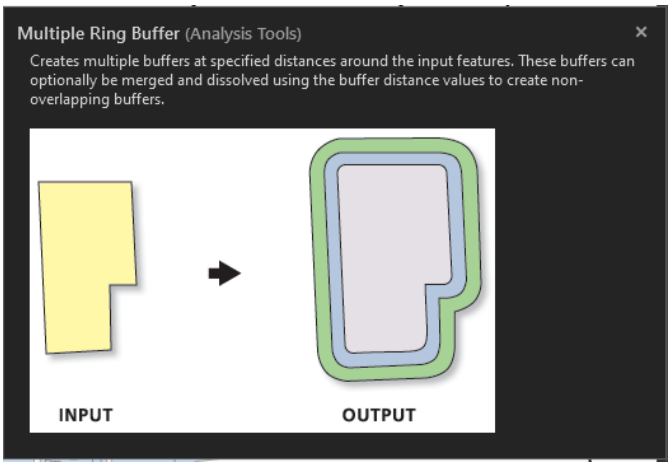
3-5-erase Tool:

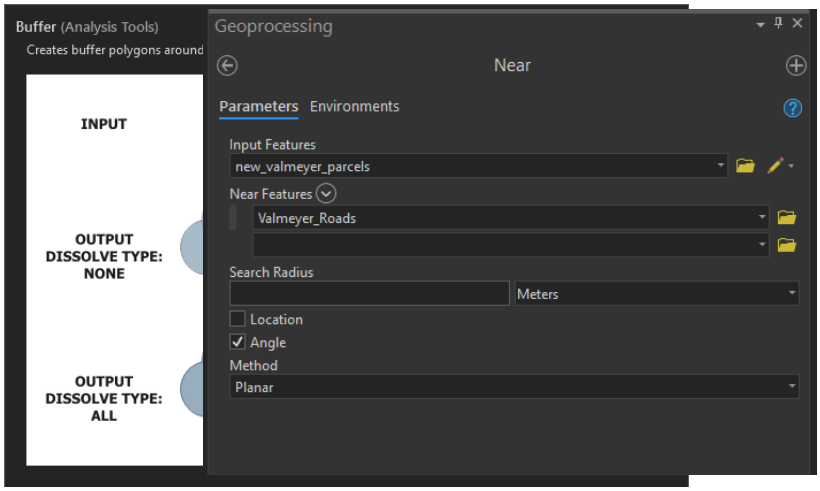


3-6- proximity analysis - buffer:

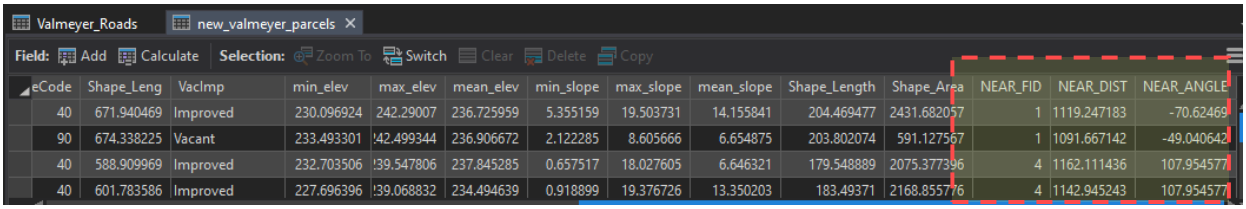
3-7 – Near Tool:

- In this example, we want to find the nearest road to each parcel of our town (new_valmeyer):



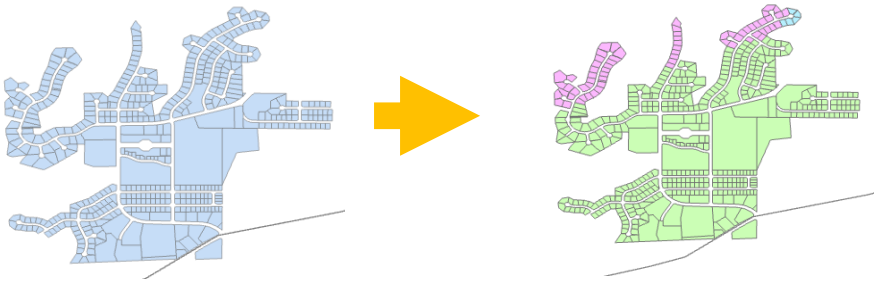


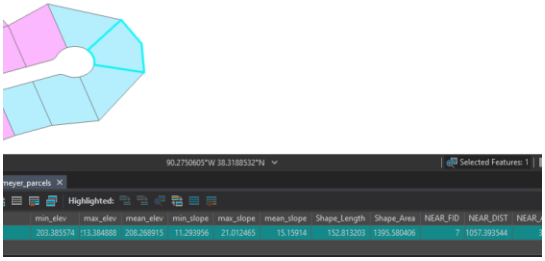
- This function adds the nearest roads to the table of new_valmeyer.
- We can also include the location and the angle of that nearest feature.
- We can see that the near tools added three attributes to our table
  - **Near_FID = near Feature ID = the ObjectID of the nearers Road.**
  - Near_dist
  - Near_angle (optional)



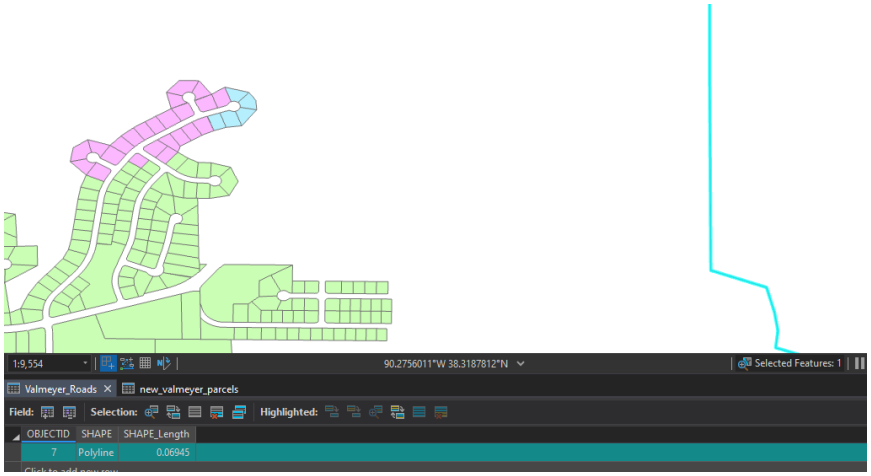
eCode	Shape_Leng	VacImp	min_elev	max_elev	mean_elev	min_slope	max_slope	mean_slope	Shape_Length	Shape_Area	NEAR_FID	NEAR_DIST	NEAR_ANGLE
40	671.940469	Improved	230.096924	242.29007	236.725959	5.355159	19.503731	14.155841	204.469477	2431.682057	1	1119.247183	-70.62469
90	674.338225	Vacant	233.493301	242.499344	236.906672	2.122285	8.605666	6.654875	203.802074	591.127567	1	1091.667142	-49.040642
40	588.909969	Improved	232.703506	239.547806	237.845285	0.657517	18.027605	6.646321	179.548889	2075.377396	4	1162.111436	107.954577
40	601.783586	Improved	227.696396	239.068832	234.494639	0.918899	19.376726	13.350203	183.49371	2168.855776	4	1142.945243	107.954577

- Now based on our Near_FID we use symbology on our town



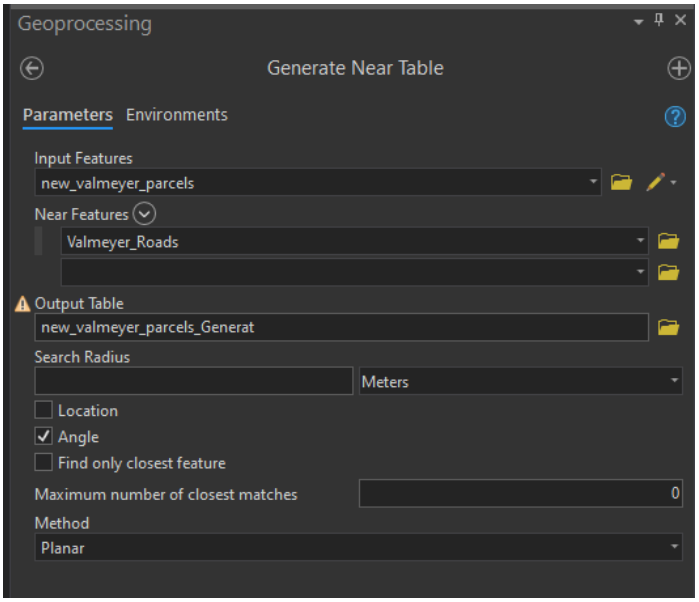


Here you can see that the road objected is seven as it is in Near_FID.



3-7- generate near table:

- Generate new table does not add columns to the input table; it creates a new table, and if you don't check the box "find only closest feature," it will find all the objects (in this case, roads) and ranks them based on their distance unless you declare "max number of closest matches."



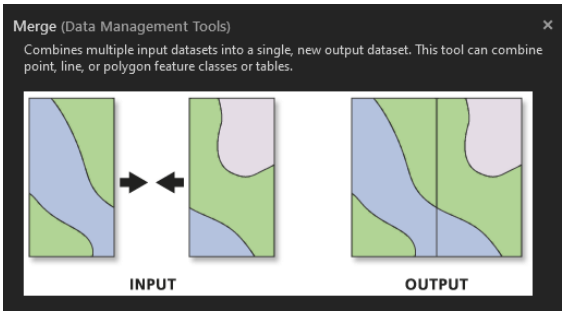
Valmeyer_Roads | new_valmeyer_parcels | new_valmeyer_parcels_Generat

Field: Add Calculate Selection: Zoom To Switch Clear Delete

OBJECTID	IN_FID	NEAR_FID	NEAR_DIST	NEAR_RANK	NEAR_ANGLE
1	1	1	1119.247183	1	-70.62469
2	1	4	1223.011528	2	107.954577
3	1	7	2312.955	3	7.691339
4	1	10	2313.302017	4	-158.172054
5	1	6	2500.158892	5	42.940353
6	1	17	2515.131317	6	86.153496
7	1	2	2636.893524	7	-130.774796
8	1	5	2927.139304	8	71.751214
9	1	18	3423.929724	9	95.558723
10	1	11	3531.911409	10	-172.845081
11	1	9	4150.625623	11	143.092546
12	1	13	4570.400922	12	-100.913077
13	1	15	4795.411572	13	-173.180199
14	1	12	5451.51335	14	-129.208119
15	1	14	6004.556257	15	-99.675722
16	1	3	6174.230465	16	-58.091899
17	1	16	6382.972906	17	-121.361642
18	1	8	6450.194018	18	70.037359
19	1	19	570158.691779	19	97.339999
20	2	1	1091.667142	1	-49.040642
21	2	4	1277.570738	2	107.954577
22	2	7	2213.438112	3	8.596744

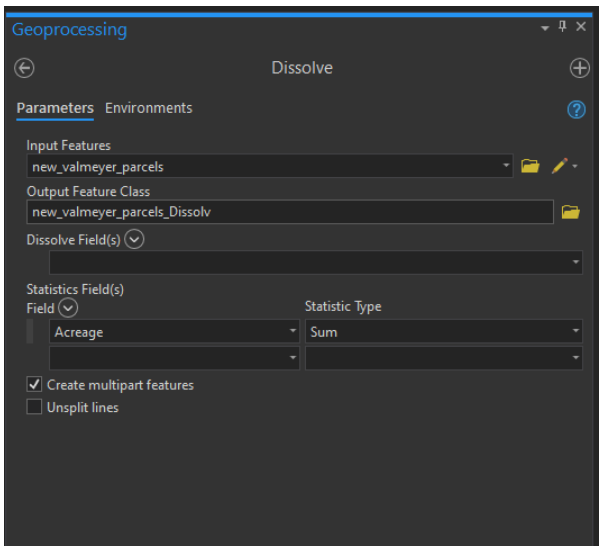
- You can see IN_FID (parcel objectID) and NEAR_FID (road objectID), where the roads are ranked based on their closeness to each parcel.
- You can use Relates to attach this Data to the original table.

3-8 – merge tool:



- When you have two or more sub-data, but you want to work on a larger scale, for example: merging cities when you want to work on a state scale. (tables should be similar/the same)
- Merge tool is for when you have two or more separate feature classes(like old and new Valmeyer), but dissolve for when you have one feature class, but it has boundaries in it you want to remove.

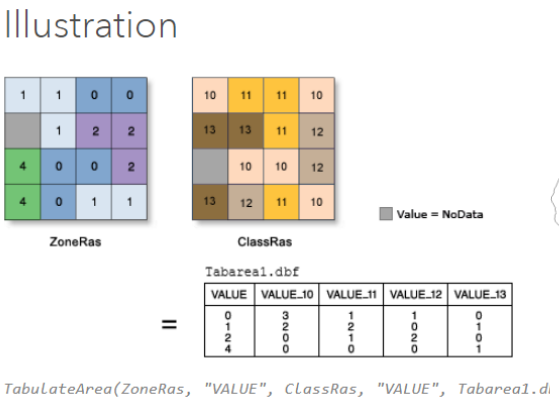
3-9 – Dissolve

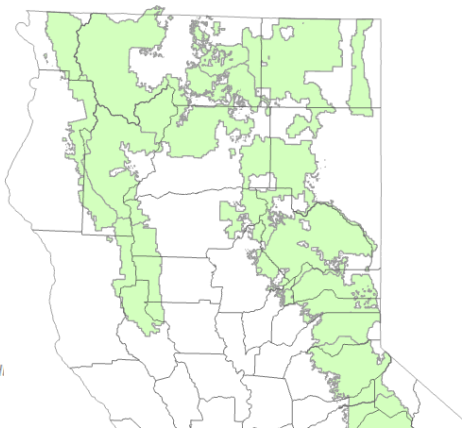


- You can check out 2-37 again.
- Dissolve Field: the Field on which to aggregate feature e.g. State name: dissolves city boundaries but keeps the state boundaries.
- You can also do statistics on fields for example, the area of the state is the sum of areas of cities.

3-11 – Tabulate Area:

- Imagine you have some zones you want a table that tells you which of your features are in each zone; you can do this with a spatial analyst tool, but this kind of output table can sometimes come in handy.
- For example, what forests are in each state.





3-12 conversion tools:

- Vector to Raster
- Raster to Vector
- File conversion and more

3-13 charts and graphs:

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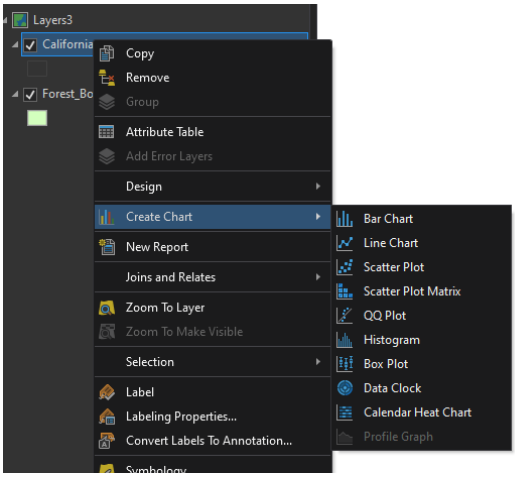
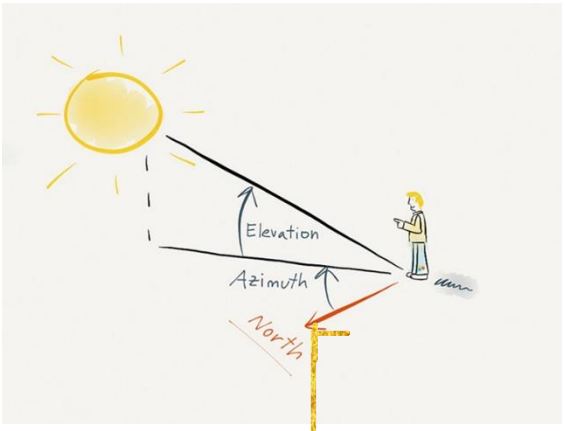


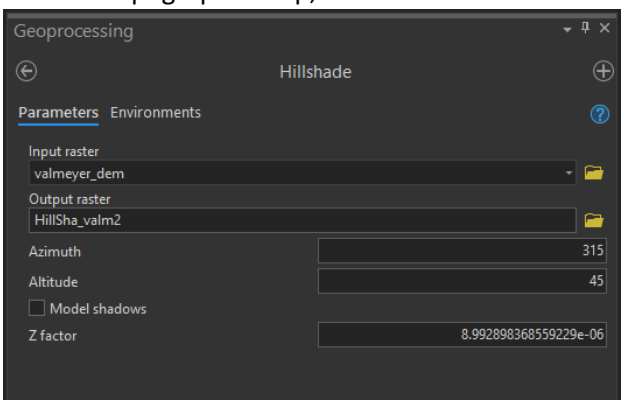
3-19 – Raster Formats:

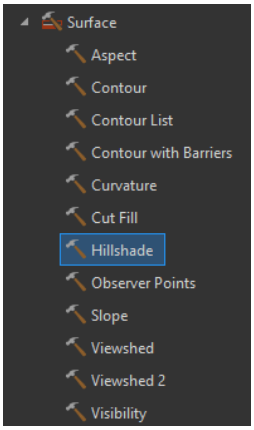
- **.tiff:** Tagged Image File Format – lossless and high quality.
- **.jpg:** lossy compression.

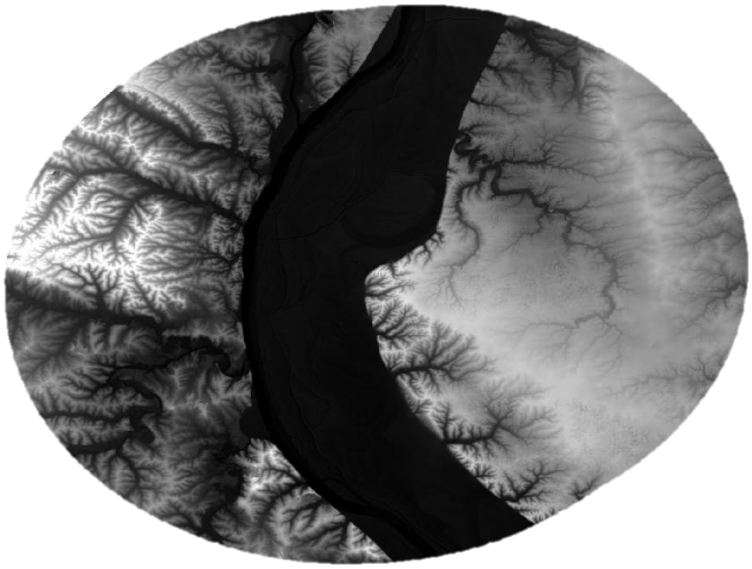
3-20 - Raster Display options:

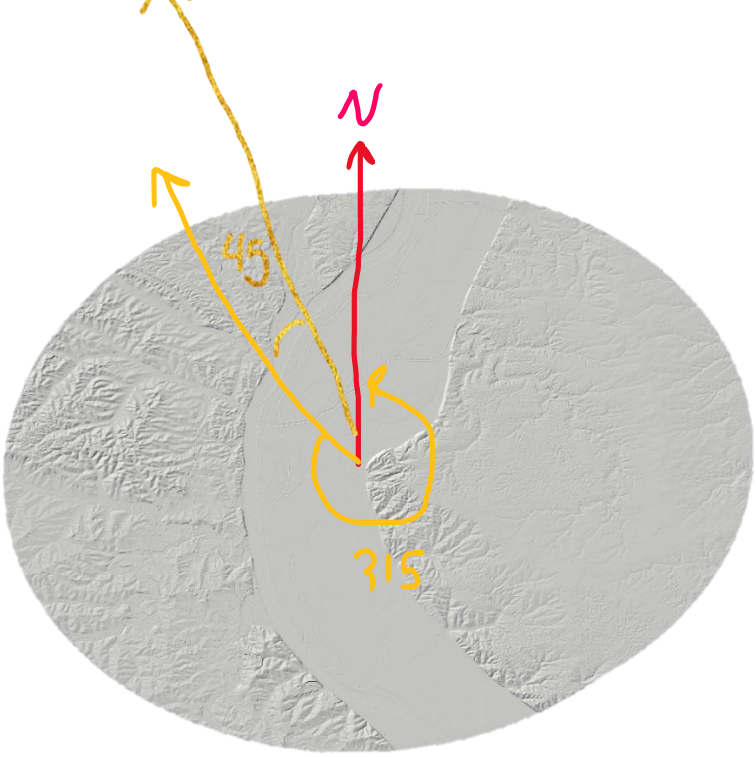
- HillShade: simulating the DEM as if it is an actual topographic map, and there's a sun and actual hills and surfaces:
- Notice that Azimuth and Altitude are for simulation of the sun late.



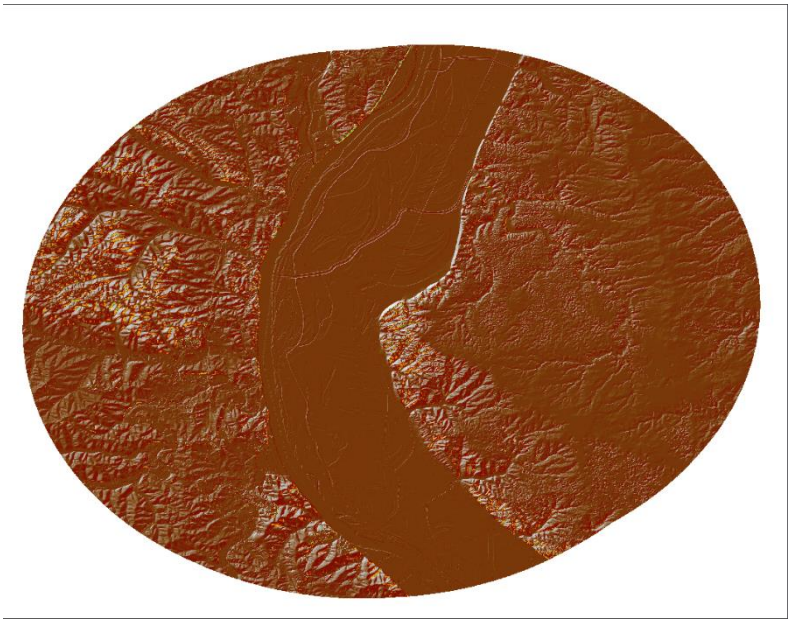


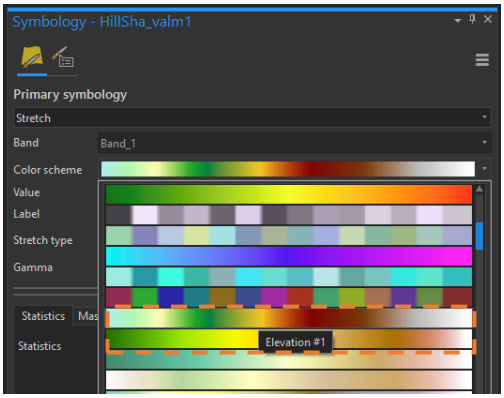




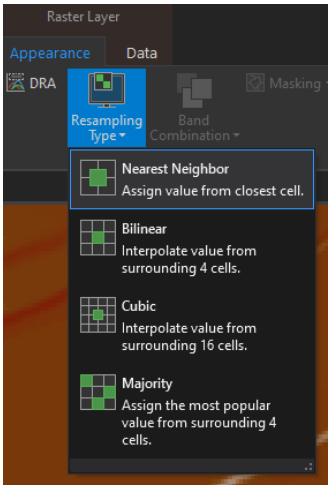


- **Hypsometric effect:** **using colors to create the feeling of depth.**

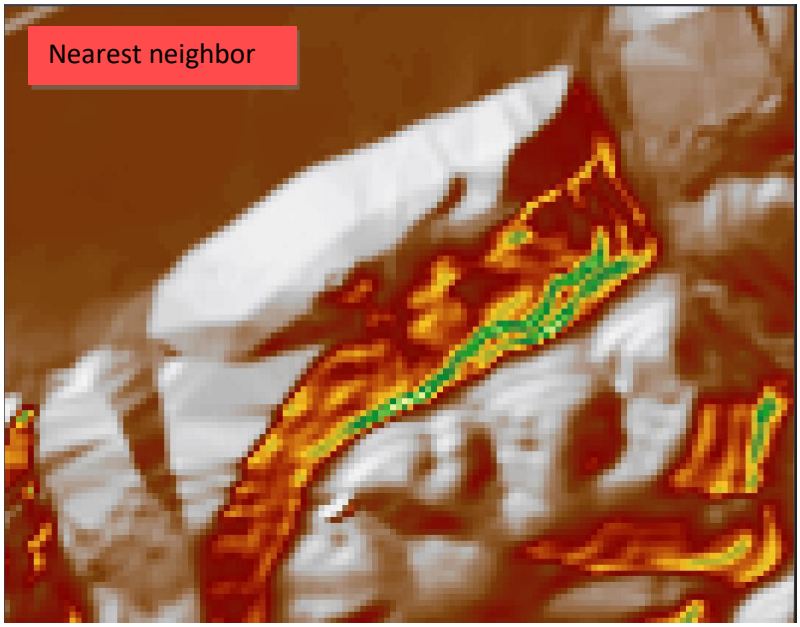


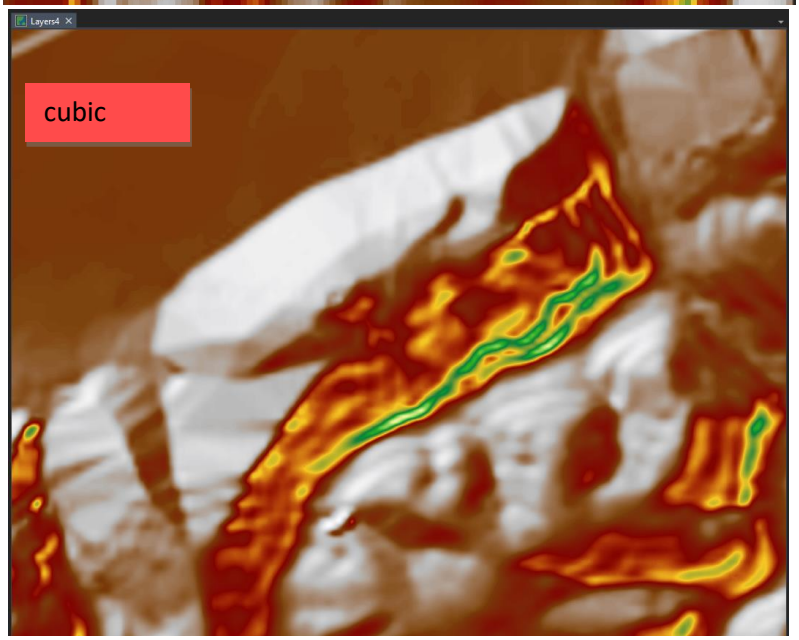


- **Resampling Type:** interpolating the unknown pixels between know pixels when zooming in beyond our Raster resolution.



Cubic is the smoothest, but you need to be careful what you want to do with your data.





Your text here

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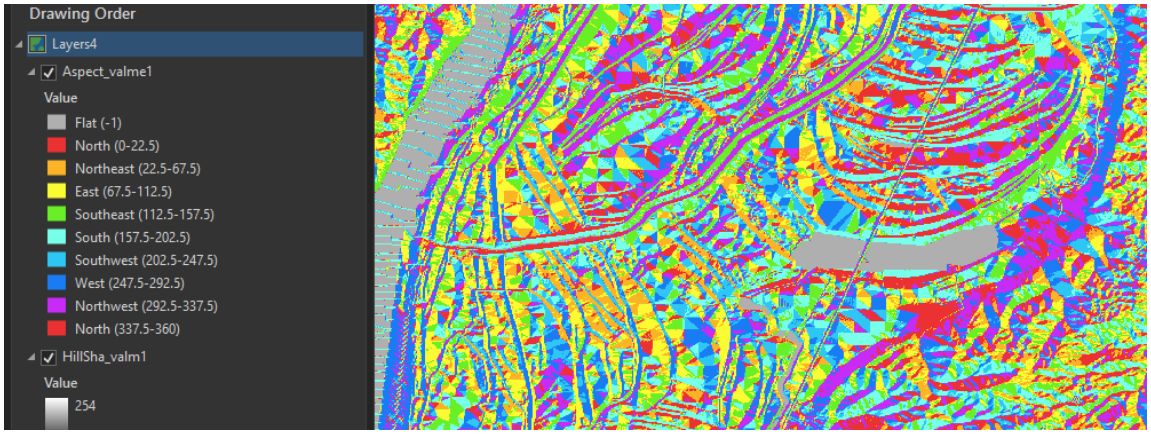
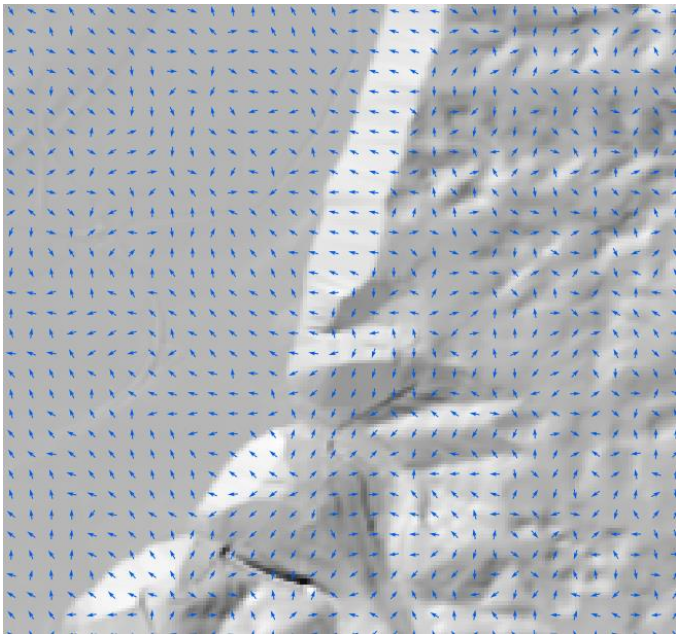
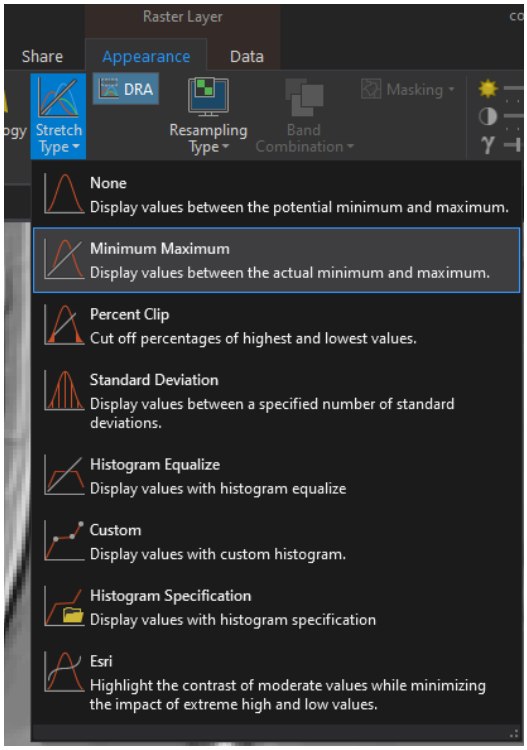
- Aspect: find the Direction of slopes from DEM



- **Vector Field:** we can also use vector field symbology on the aspect layer to show the Direction of slopes in vector shape – it can also be used in wind and water assessment.

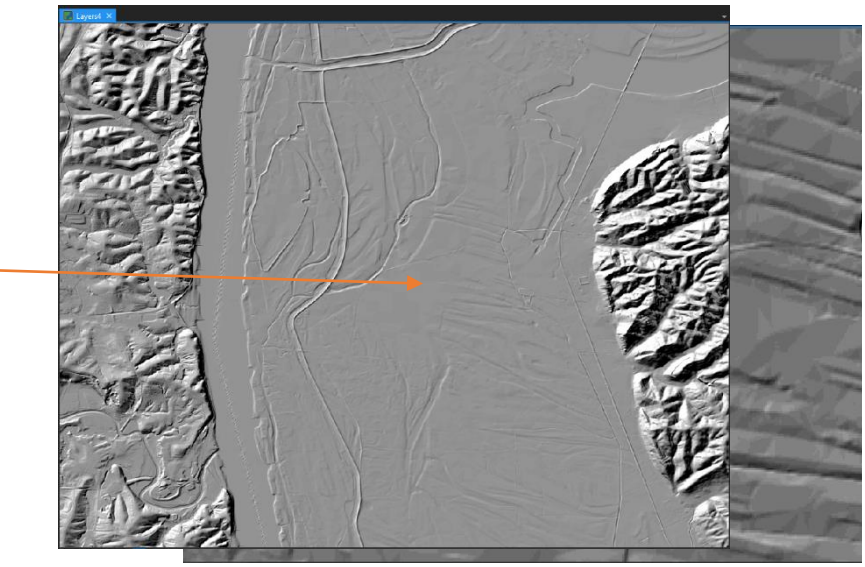


- **Stretch type:** defining the function that we want to stretch our **histogram** with.
-



- **DRA: dynamic range adjustment –** stretches the histogram based on the max and min of the view we have from the Raster.

In the example blew you can see that the contrast increased as we zoomed in.



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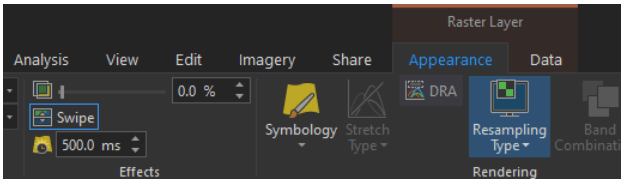
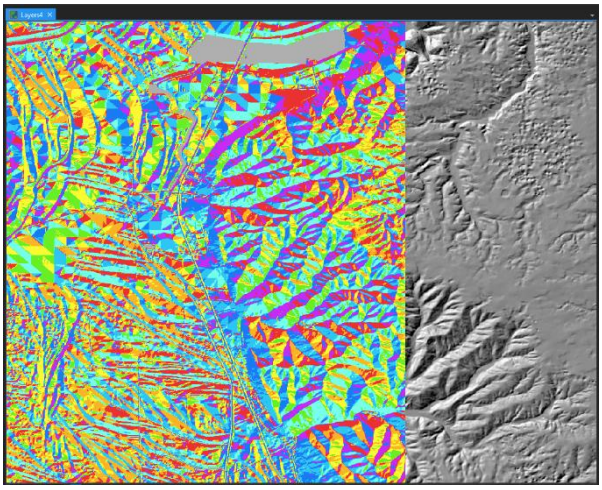
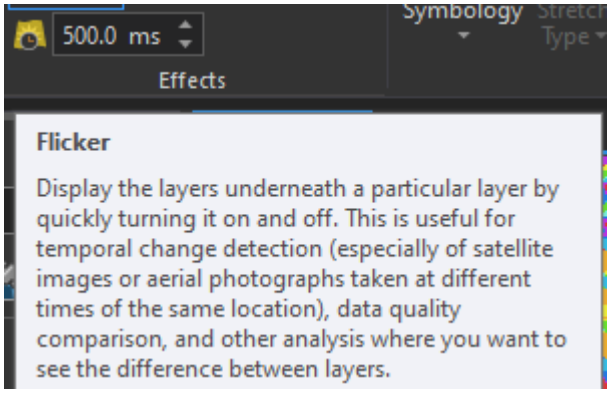
3-21 – comparison swipe tools: youtube.com/swipetool





You can easily swipe through layers and compare them.



3-22 – Resampling and Cell Assignment:

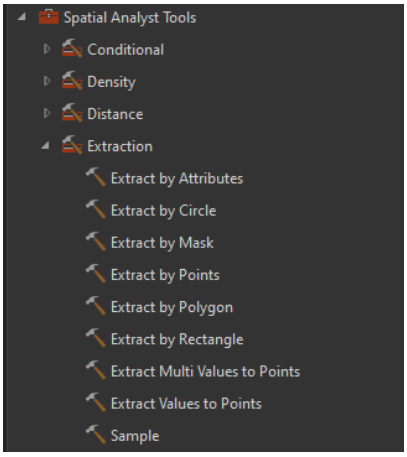
- Changing the resolution of your Raster.
- You can use methods mentioned in 3-20
- **Snap** option in the Environment setting makes your raster snaps and aligns perfectly with your choice's raster layer.

3-23 – Reprojecting rasters:

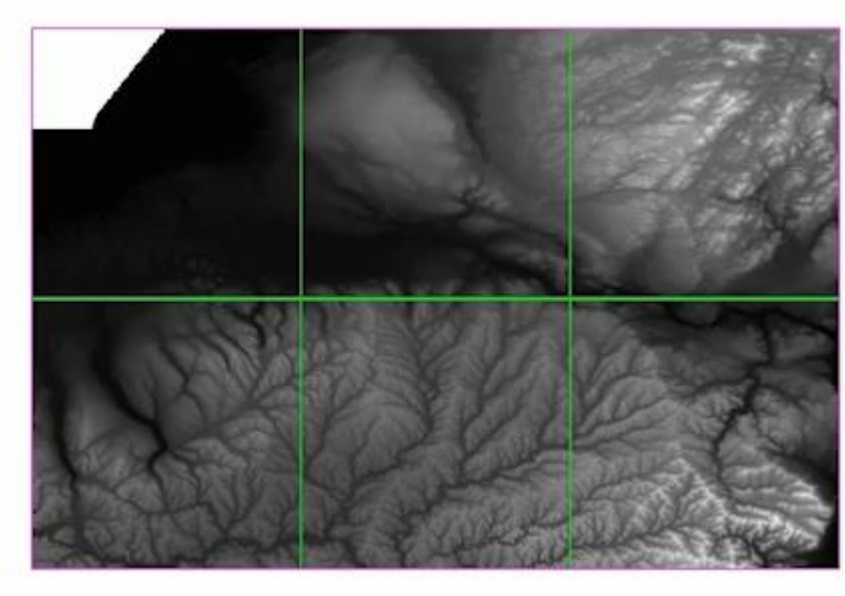
- the help explains what projection is better for each job, for example, nearest neighbor is better for Landused data.
- When you want to move your data to another projection system, always do the projection yourself; otherwise, the ArcGIS will do it for you, and you don't get to validate the Data.

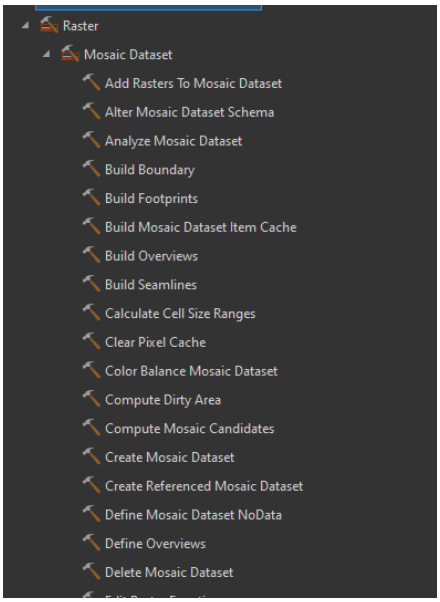
3-24 – Clipping Rasters, extract :

- Extraction in Spatial analyst tool is like vector overlays,
- We can clip data by attribute, point and mask
- Our mask can be both a vector or a raster area.

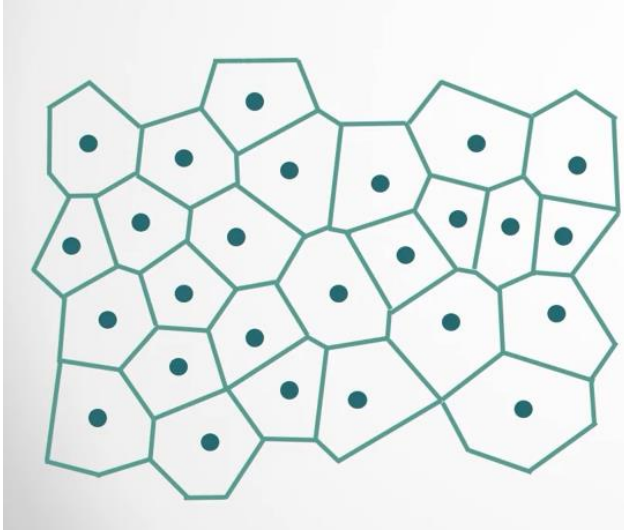


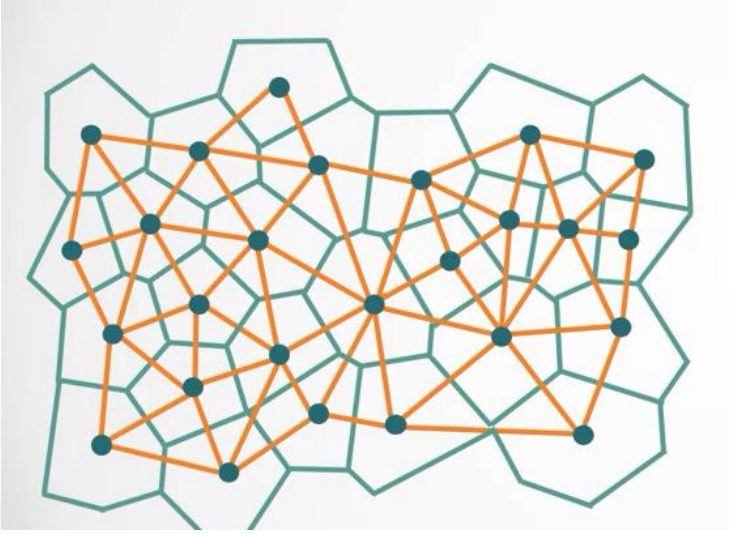
3-25 – Mosaics:

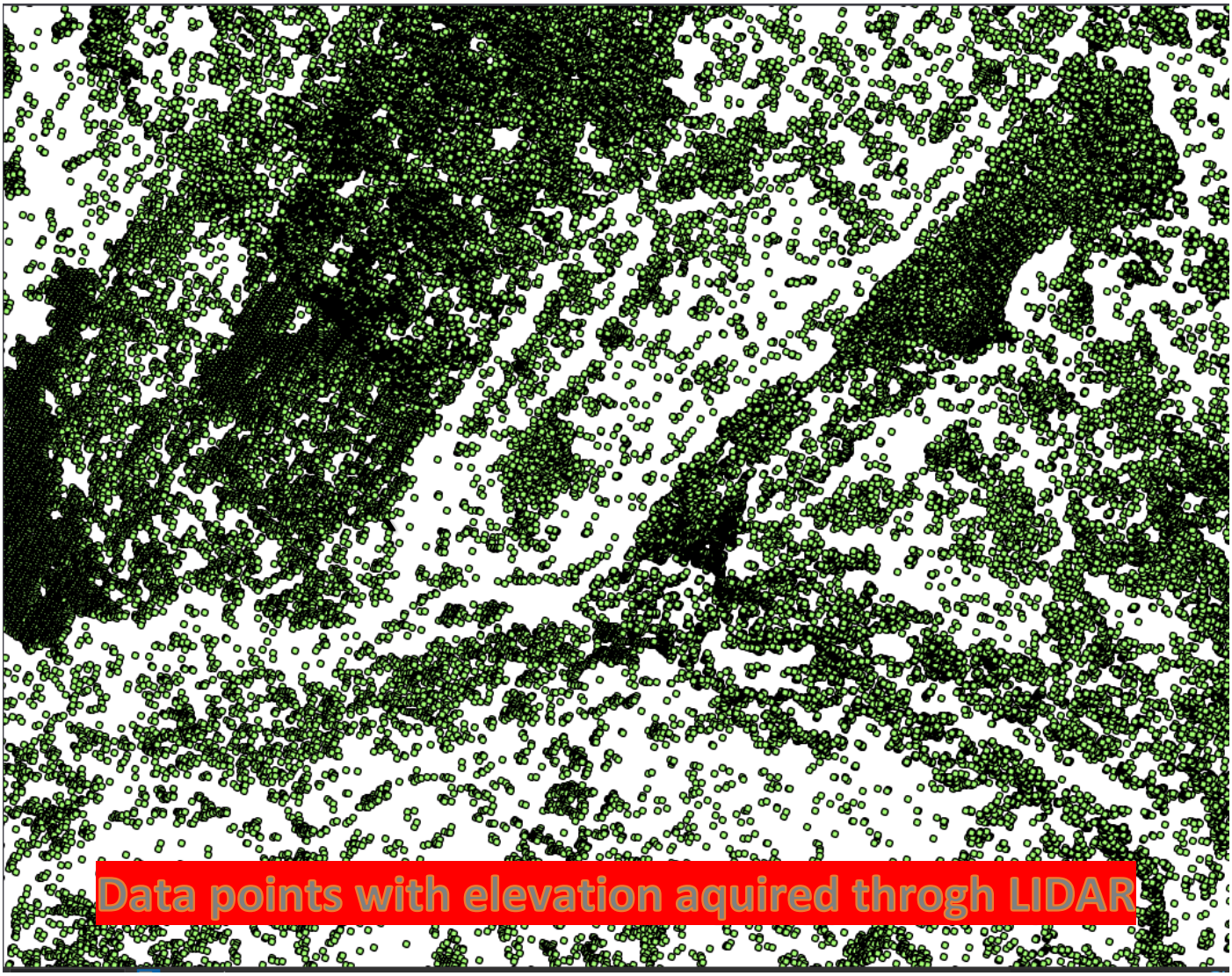




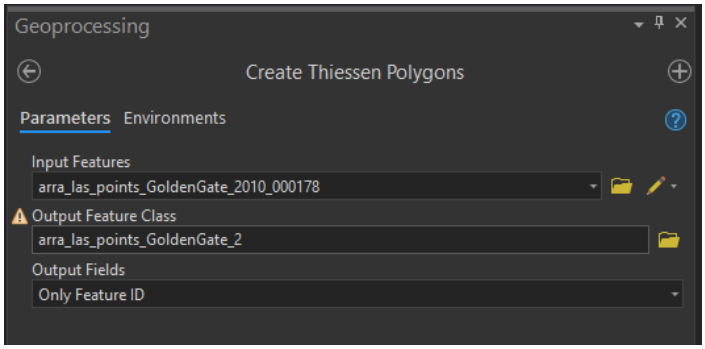
3-28 – TIN (triangular irregular network) and Voronoi (Thiessen) Polygons:

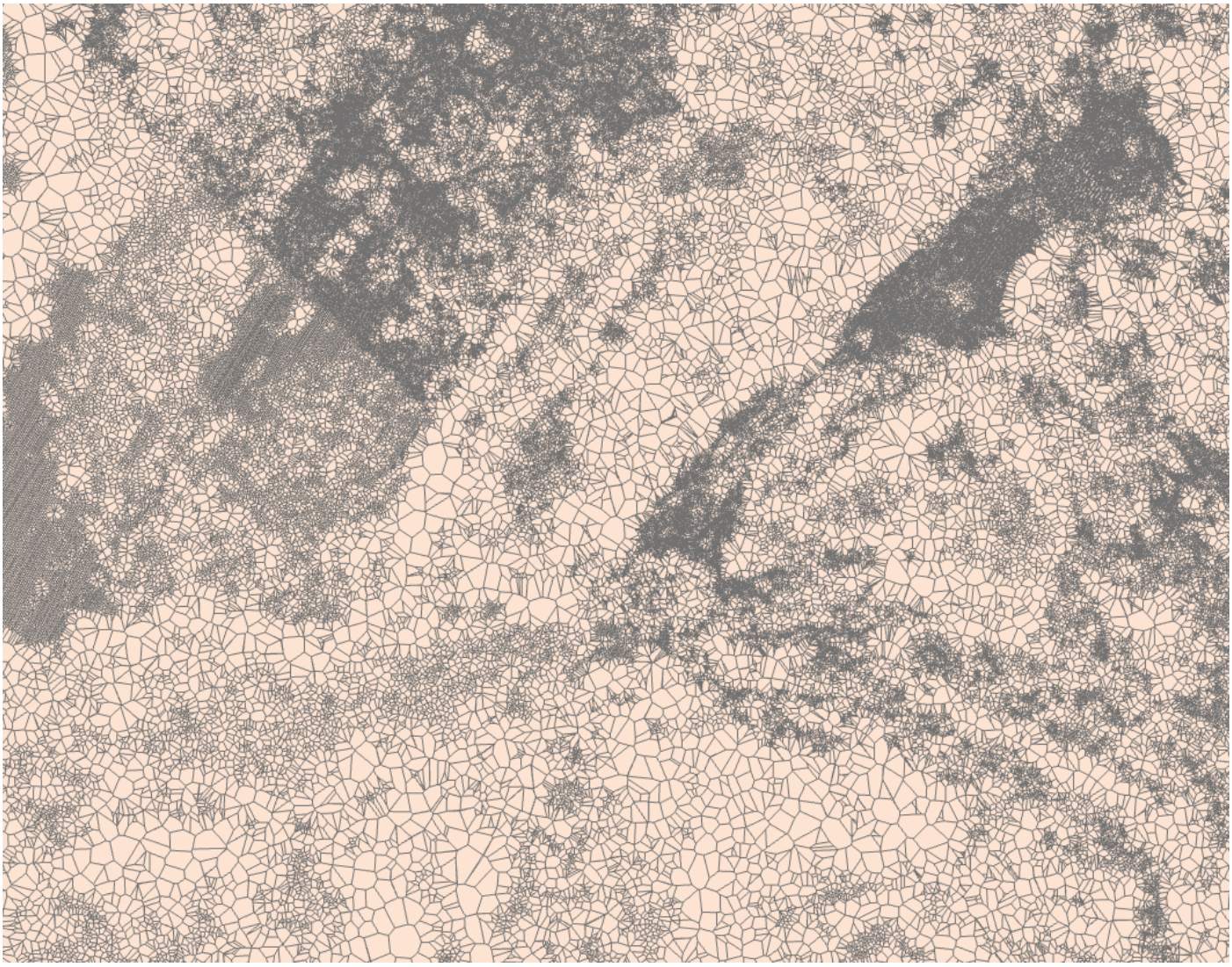






- Creating Voronoi (Thiessen) Polygons:





3-37 – Projections and Coordinate Systems:

- Datum = GIS origin point or points used to reference our data (like 0,0 in math).
- Projections: unwrapping the sphere of earth and showing it on a flat surface.

3-39 – Geographic coordinate systems:

- Meridian(نصف النهار)

3-42 – UTM (Universal Transverse Mercator

- Transverse: Rotated 90 degrees.
- Mercator: Type of Cylindrical projection.
- Universal:
    - 60 projections
    - Each with different standard parallel
    - Each zone covers 6^ of longitude.
- False northing and False easting:

  The origin point of the zone isn't (0,0)

  (0,0) is outside the zone
- Good at Direction but bad at distance and area.

3-42 – Albers projection:

- Preservers the area
- Conical

Project tool: used for reprojection.

Define Projection Tool: when your Data doesn't have a projection defined, we use this Tool to determine the projection.

3-43- environment variables

3-44 – Output Coordinate System environment variable:

- Defines the coordinate system that your analysis is performed in.

3-45 – Extent Variable: **defining an area of interest where only there the processing tool works**

- Tools that honor the Extent environment will only process features or rasters that fall within the extent specified in this setting.
- The Extent environment setting defines the features or rasters that will be processed by a tool. It is useful when you need to process only a portion of a larger dataset. You can think of this setting as a rectangle used to select input features and rasters for processing. Note that the rectangle is used only to select features, not clip them. The extent of the output dataset will typically be larger than the Extent setting to account for features or cells that pass through the extent rectangle.

3-46 – Cell size, snap Raster, mask:

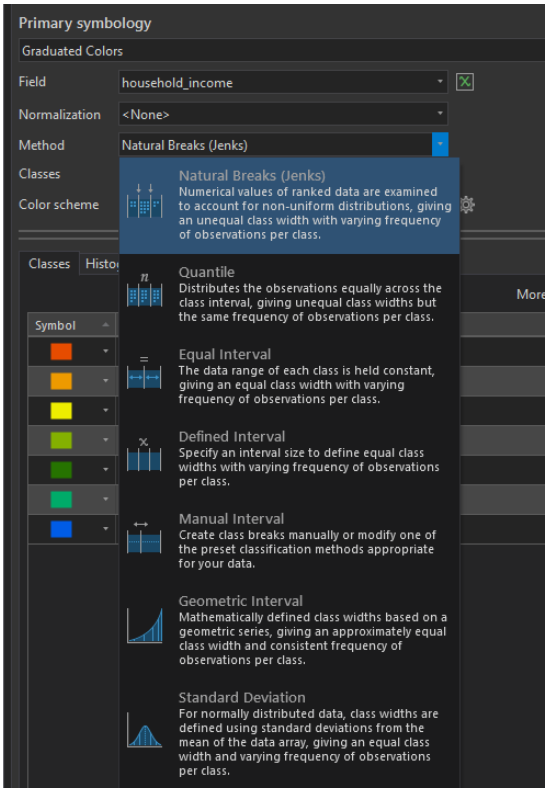
- Cell size: Tools that honor the Cell size environment set the output raster cell size, or resolution, for the operation. The default output resolution is determined by the coarsest of the input raster datasets.
- Mask: Tools that honor the Mask environment will only consider those cells that fall within the analysis mask in the operation.
- Snap Raster: Tools that honor the Snap Raster environment will adjust the extent of output rasters so that they match the cell alignment of the specified snap raster.

3-50 – Color Ramps:

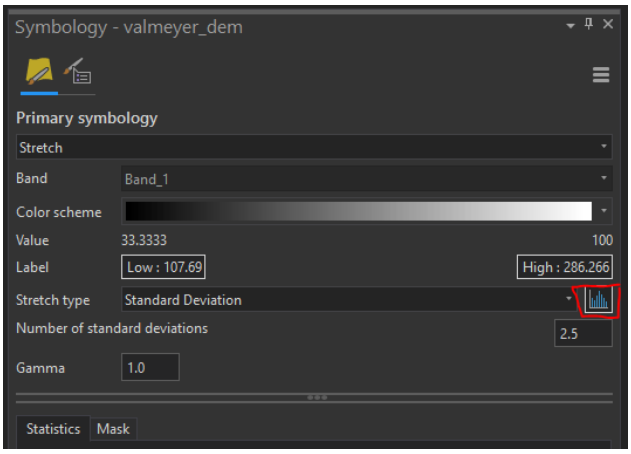
- You can make you customized ramp.

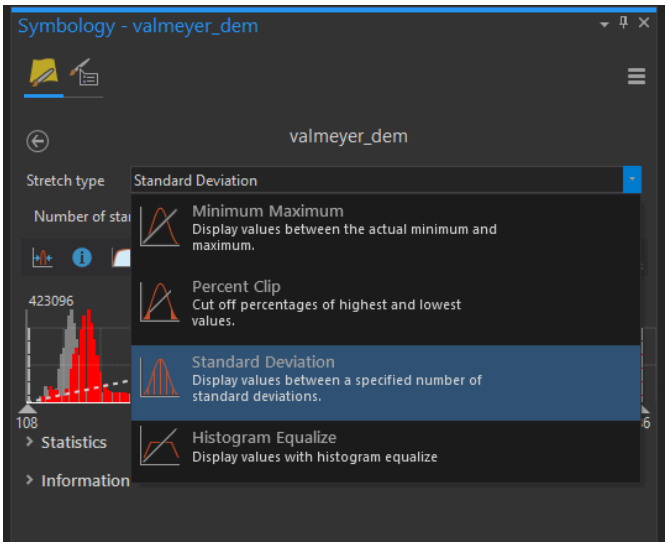
3-51 – Binning and Classifying data (classification method)

- Natural breaks: low variance in each class and high variance between classes.
- Quantiles: the same amount of observation in each class.



3-52 – stretching rasters (histograms):



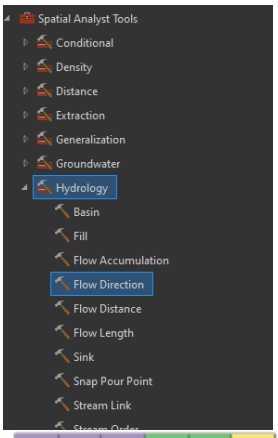


Histogram Equalize
fits a curve on the color ramp such that in areas with a large number of values the color changes rapidly, and in areas with a small number of values the change is more gradual.

3-53 – saving and copying symbology

3- assignment 1 - Generating Streamlines from Digital Elevation Models

- Flow direction: uses DEM to find the Direction in which the water will flow on a hill (it is the same as the aspect tool) but generates numbers instead of directions (NSEW)

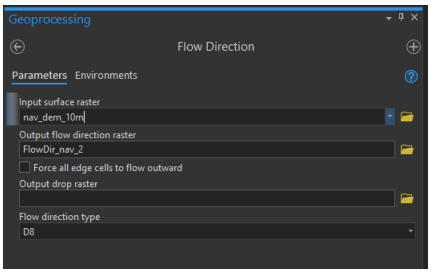


D8 method

The D8 flow option models flow direction from each pixel to its steepest downslope neighbor. All of the flow is directed to this steepest neighbor. The output of the **D8** direction type is an integer raster whose values range from 1 to 255. The values for each direction from the center are shown in the following image:

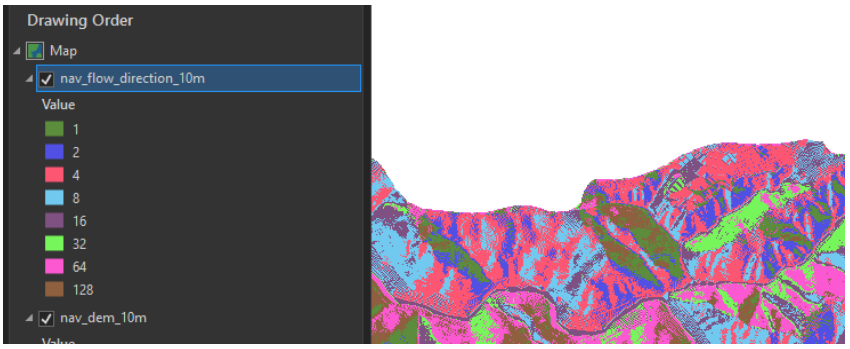
32	64	128
16		1
8	4	2

For example, if the direction of steepest drop was to the left of the current processing pixel, its flow direction would be coded as 16. The example below shows how elevation values are converted to flow direction codes.



Elevation values converted to flow direction codes.

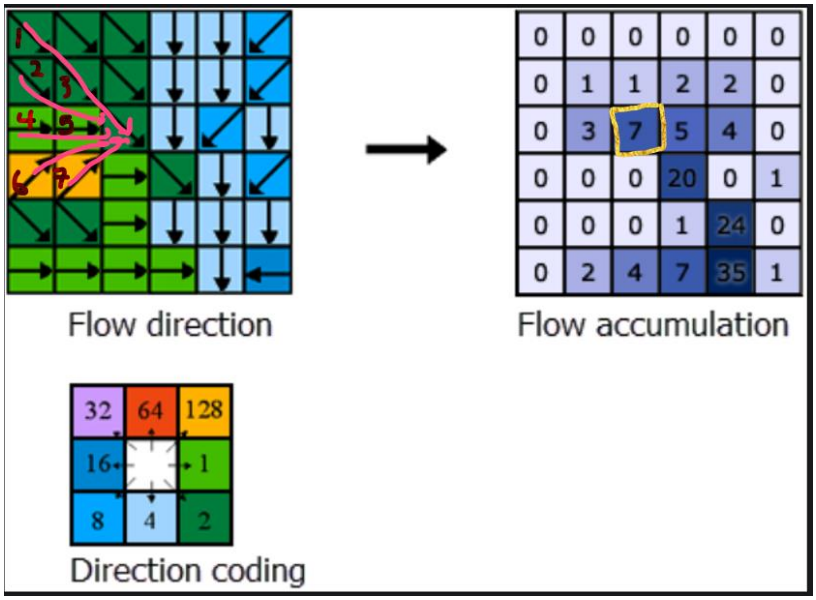
Elev_Ras Flow_Dir



- Flow accumulation: uses a **flow direction layer** to find the number of cells fllowing into a cell

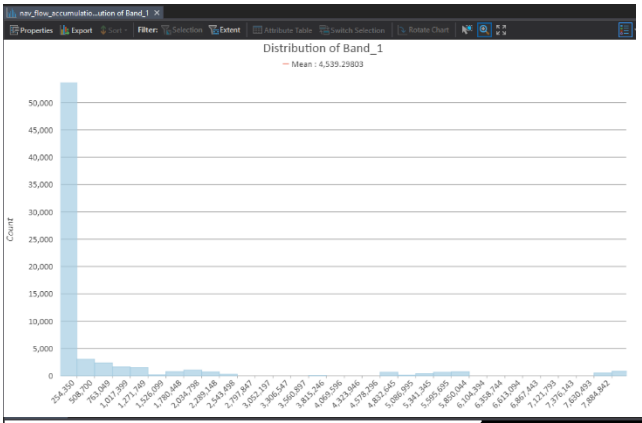
- The Flow Accumulation tool calculates accumulated flow as the accumulated weight of all cells flowing into each downslope cell in the output raster. If no weight raster is provided, a weight of 1 is applied to each cell, and the value of cells in the output raster is the number of cells that flow into each cell.

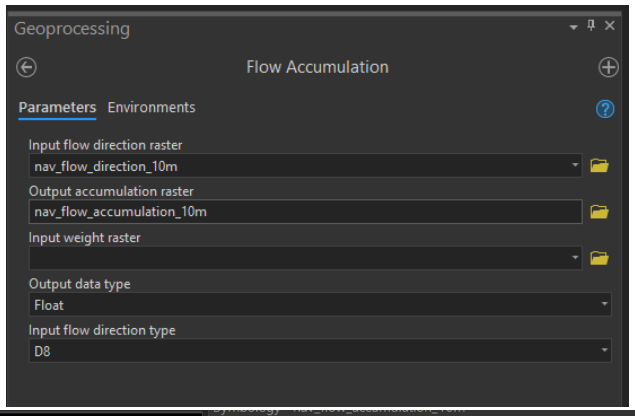
- In the graphic below, the top left image shows the direction of travel from each cell and the top right the number of cells that flow into each cell.

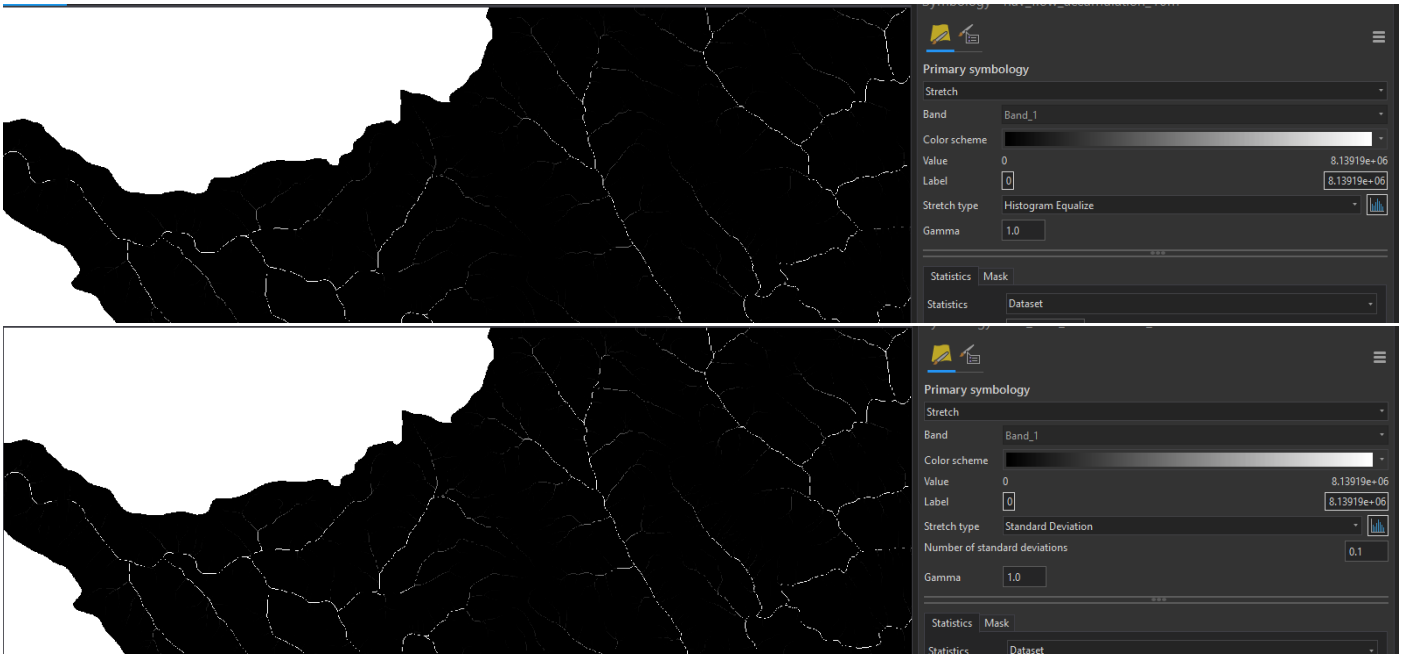


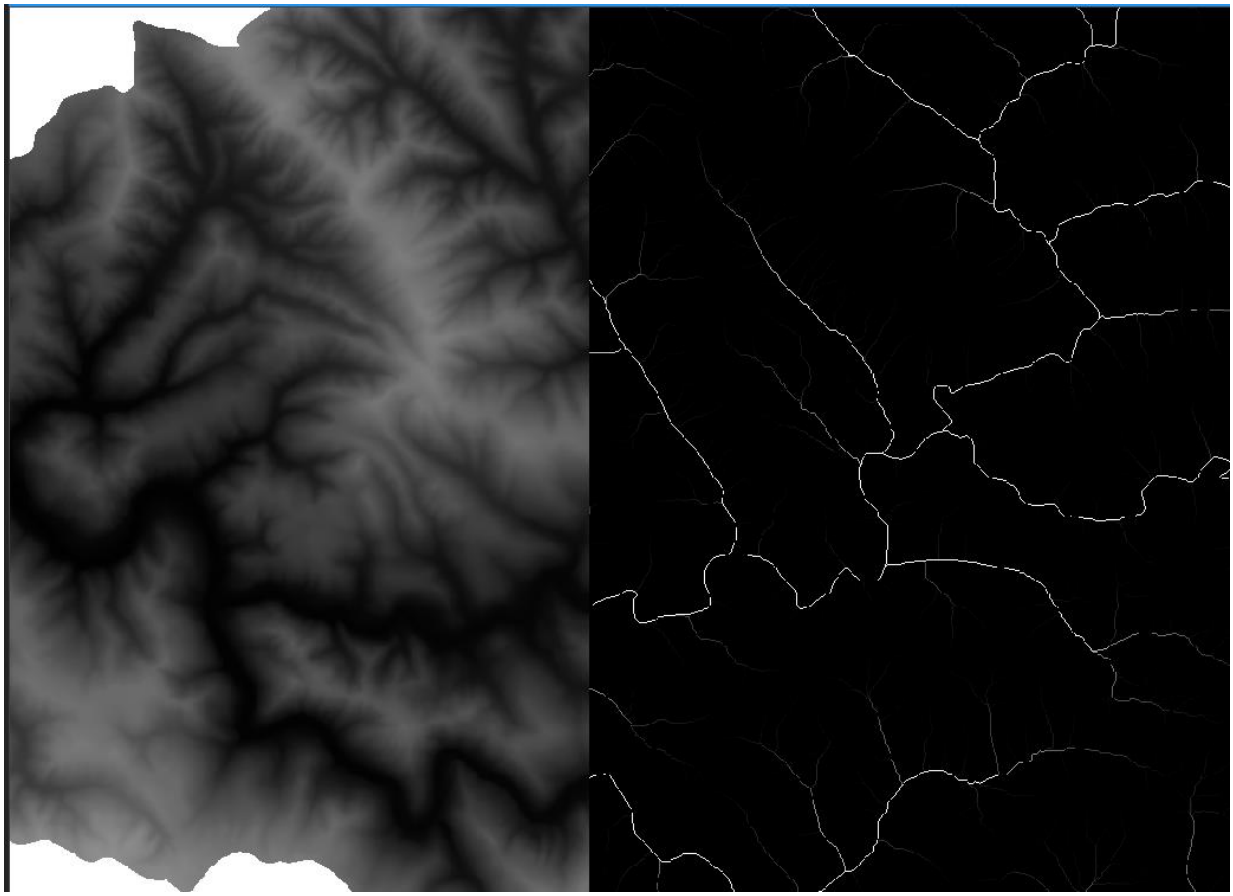
You can see that most values are the ones with low accumulations (black points) which means they are not the place that water accumulates.

On the first map, you can see that rivers are not all visible, and that's because of the histogram; when we use Equalized or standard deviation(with a low portion of deviations), the histogram focuses on showing all observations that's why more rivers are visible.



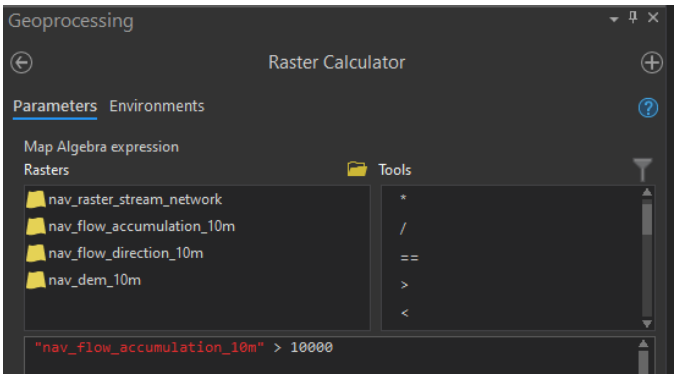






Finding the upstream area:

In this case, let's define a stream as any place that has an upstream area of 1 square kilometer. If our DEM has 10m cell sides, then each cell has an area of 100 m2 , so we need 10,000 cells in order to get 1,000,000 m2 , or 1 square kilometer. So, in raster calculator, this equates to: "nav_flow_accumulation_10m" > 10000



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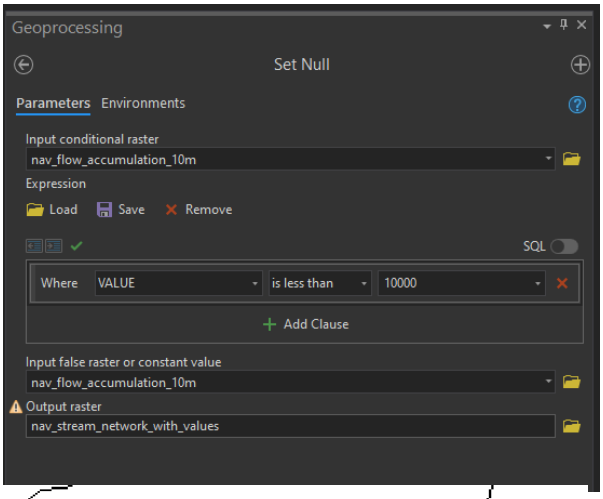
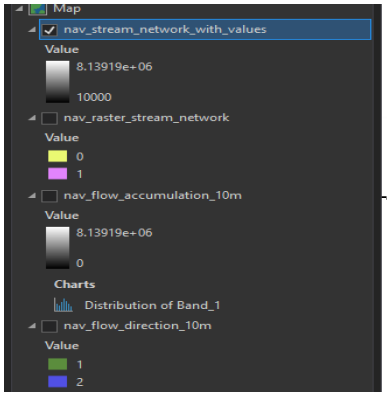
Set Null Tool:

Now we want to remove the non-stream areas; how do we do that?

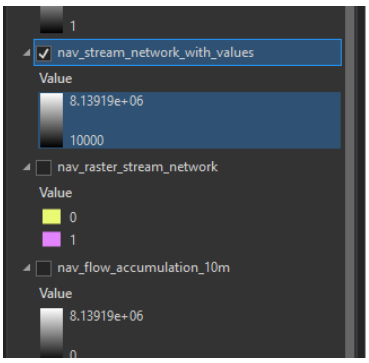
This time we want the pixels with values less than 10000 to be null, so we use this Tool

The True values for the condition will be null, and the False values will be the value that we provide in "input false…", notice that if you choose the same layer as the input, the false pixels won't change and will be the same as the input feature.





Min max histogram



none histogram

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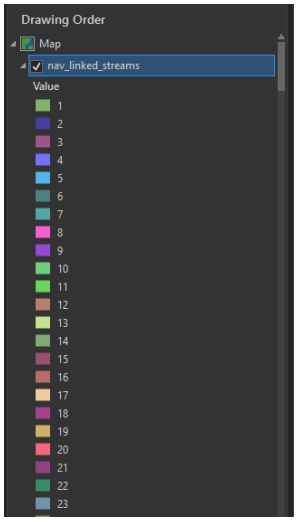
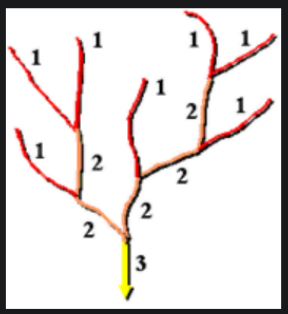
Stream link tool: (we set the symbology to "unique values" manually.)

Assigns unique values to the pixels of each part of rivers - assigns unique segments of stream between confluences (merging) of rivers all the same ID, so each unique raster value is a different stream segment.

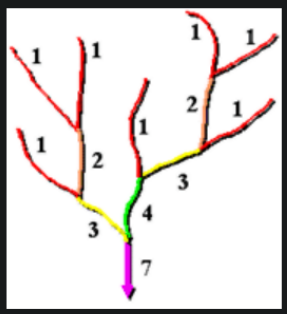


Stream Order tool: Assigns a numeric order to segments of a raster representing branches of a linear network.

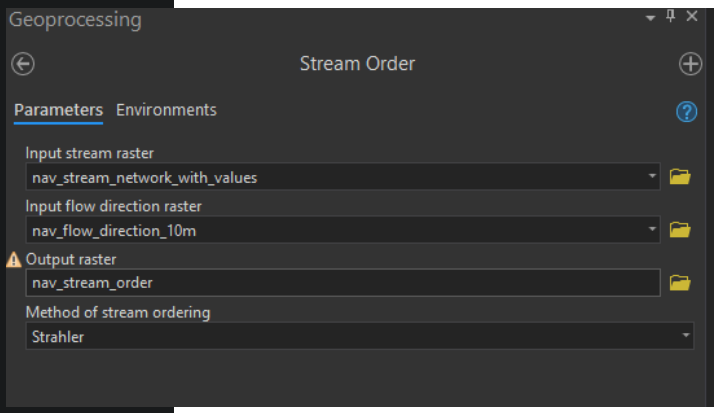
The Stream Order tool has two methods you can use to assign orders. These are the methods proposed by Strahler (1957) and Shreve (1966).



Strahler stream ordering method



Shreve stream ordering method



Converting to Vector:

Once we used **"Raster to Polyline**" and then used **"Stream to Feature"** they both do the same job, turning Raster to vector, but stream to feature treats it as an actual water stream which you can see works a lot

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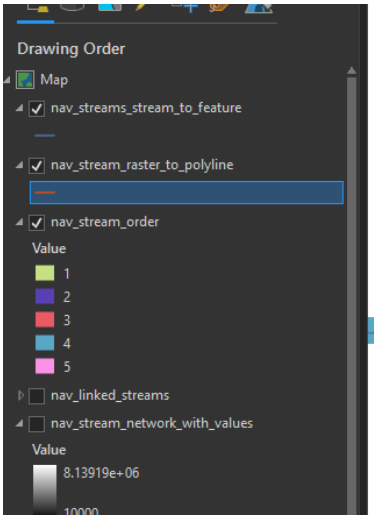
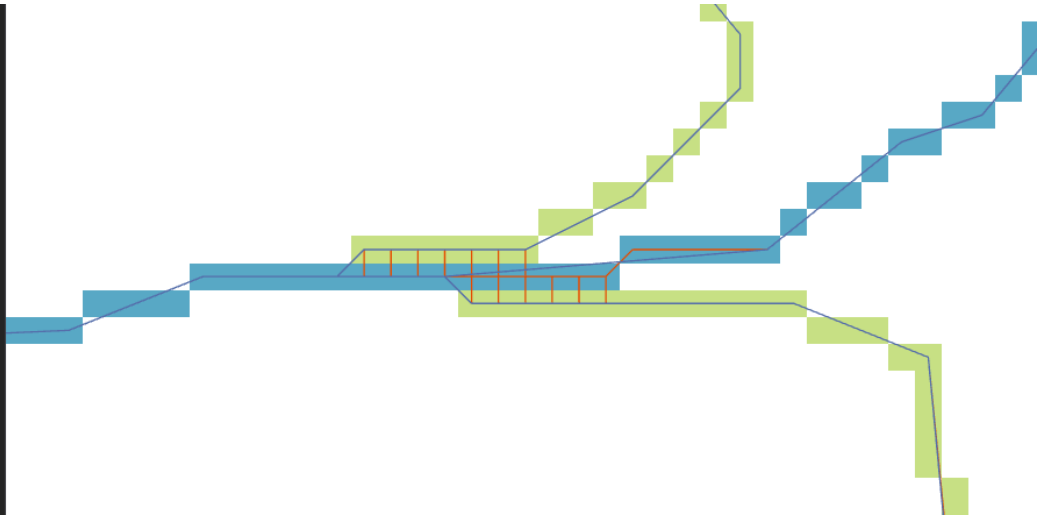
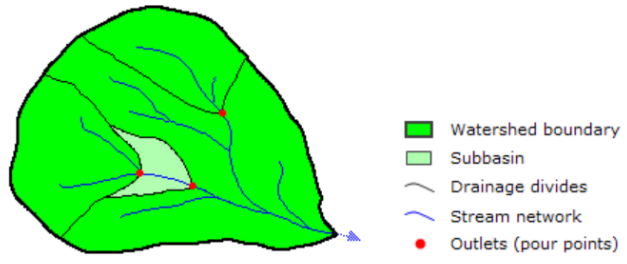
better in our case. (we provided the flow direction raster to Stream to Feature, but not to Raster to Polyline)



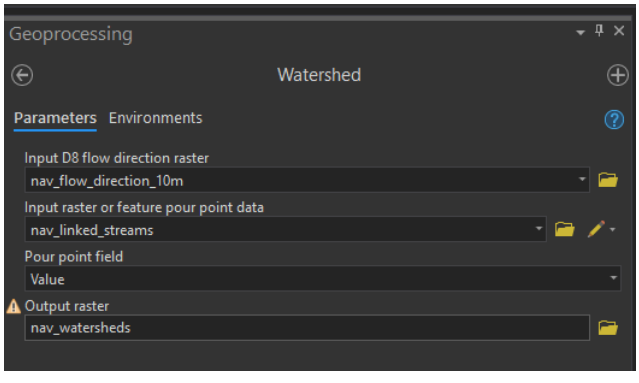


Assignment 3-2:

Watershed Tool:



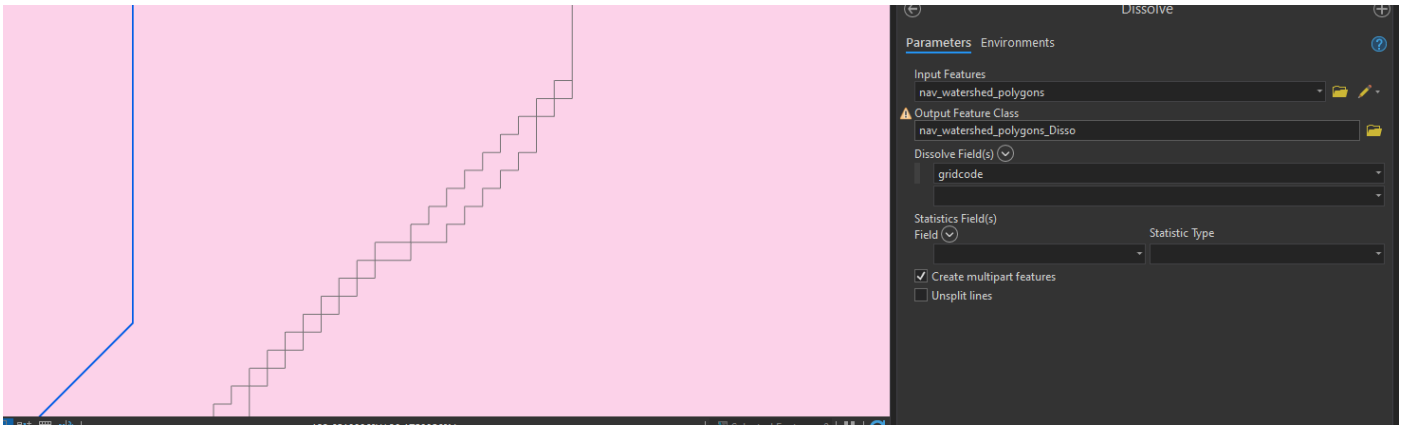
Watershed components



data derived from a GPS is almost always in the WGS 1984 spatial reference.

Raster to polygon Tool – Slivers: **when converting Raster to poly gone slivers might occur, we get more rows in our attribute table than the raster areas. In order to solve that, we use the Dissolve tool and using a common key.**

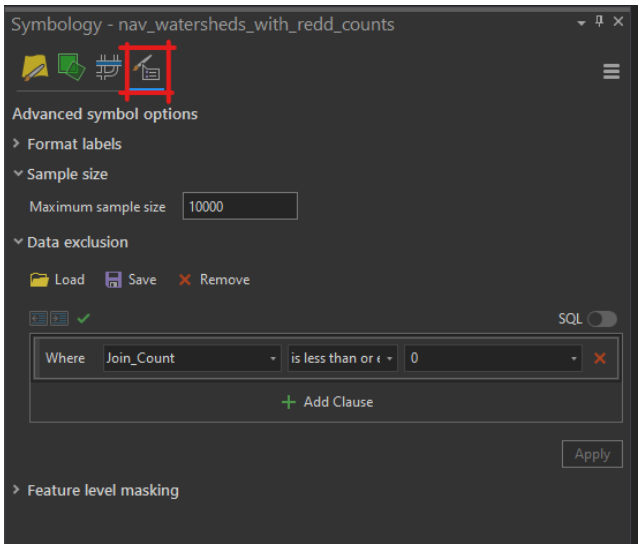
Make sure to mark multipart features.



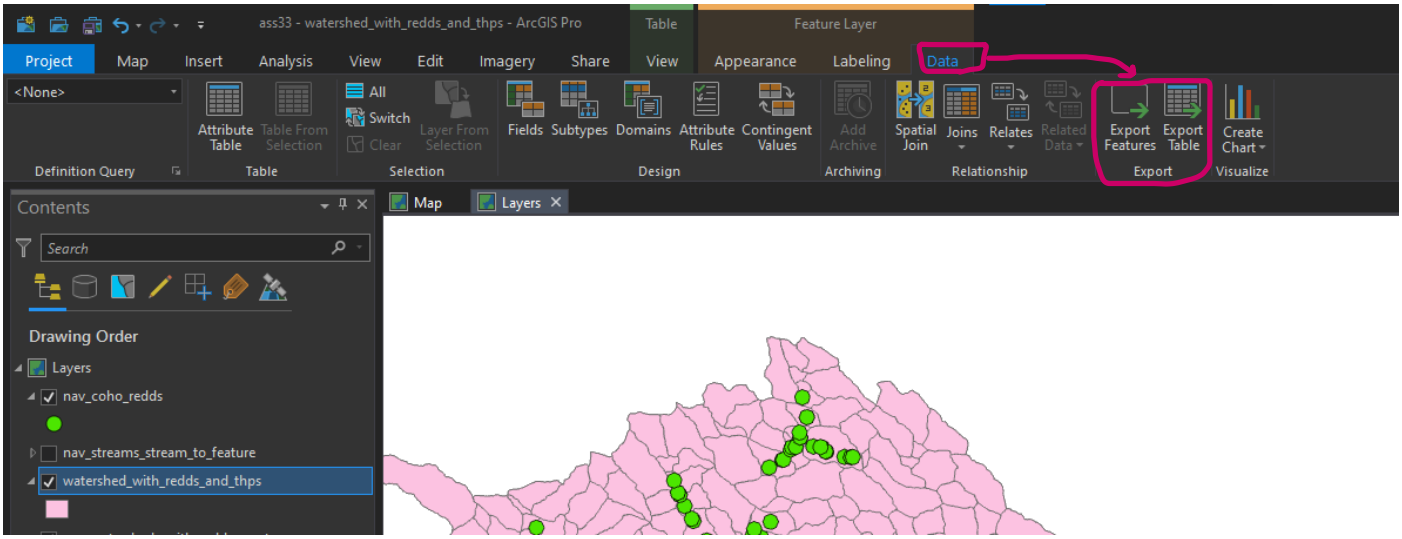
Data exclusion and Sampling in Symology:

You can find these setting in the marked tab.

Sampling comes handy when you're classifying big data; the algorithm uses smaple data to do classification, but keep in mind that small sample data can introduce error.



JOINs: it's important to remember that joins are not permanent; you can always remove joins; in order to save them permanently, you need to export the feature class.



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Final Assignment walkthrough:

- After adding the data.gdb, the first thing I did was join the *ozone_averages* to *air_quality_locations* and then export it to consolidate the Joins.
- Then used dissolve tool on the census_tracks with the block_id as the key but in order to find the new average income, what I did was to find the *total_households = households_per_sq_km * area_sq_km*
  Then found the *total_income = total_households * household_income* by using the *calculate_field Tool*
- I used the dissolve tool and set the dissolve rule to SUM up the total income and total_households then found the *household_income_mean = total_income_SUM / total_households_SUM.*
- Then used the symbology tool to classify the new layer based on ozone.

- Extract MultiValues to Points tool was used to extract elevation data onto air_quality table.

- Used the Create TIN on the air_quality data then with TIN to Raster turned it into raster and used elevation symbology.

- For the gr
- aphs I desided to used scatter plot cause that's the only graph in ArcGIS pro which has Trend Line.

4 - Imagery, Automation, and Applications

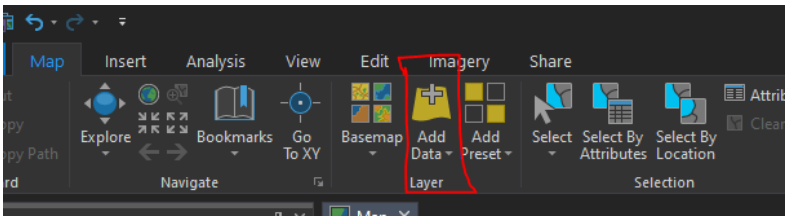
4-7 -Download Satelite Images:

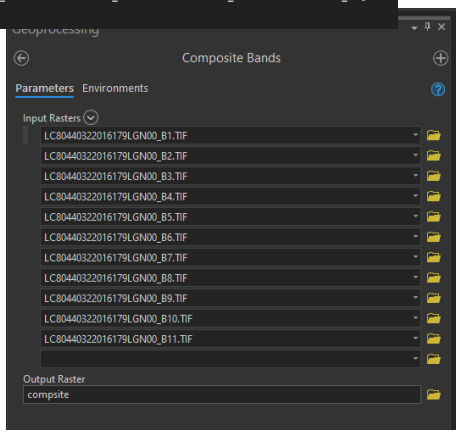
https://earthexplorer.usgs.gov/

Landsat files come in .tar.gz format.

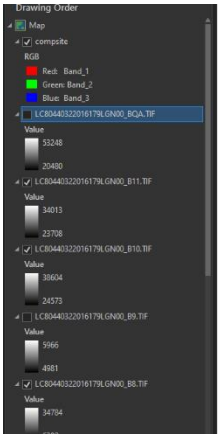
4-8 – working with Imagary:

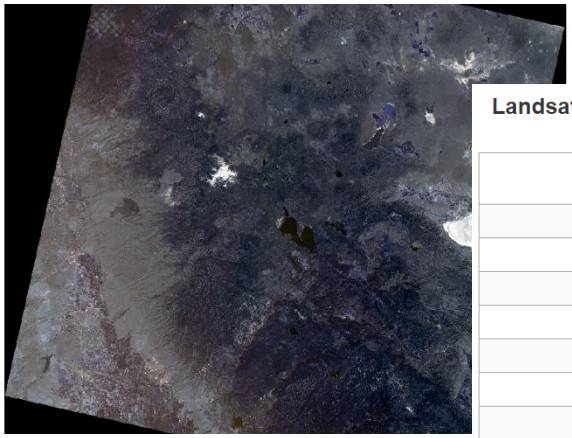
You can import .tif data using add data:





- each band raster is black and white (each pixel has one value) and picture software show them as a black and white picture.
- With the use of **Composite Tool** we can add this bands together.

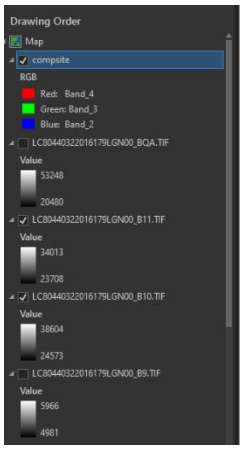




Landsat 8-9 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)

Bands	Wavelength (micrometers)	Resolution (meters)
Band 1 - Coastal aerosol	0.43-0.45	30
Band 2 - Blue	0.45-0.51	30
Band 3 - Green	0.53-0.59	30
Band 4 - Red	0.64-0.67	30
Band 5 - Near Infrared (NIR)	0.85-0.88	30
Band 6 - SWIR 1	1.57-1.65	30
Band 7 - SWIR 2	2.11-2.29	30
Band 8 - Panchromatic	0.50-0.68	15
Band 9 - Cirrus	1.36-1.38	30
Band 10 - Thermal Infrared (TIRS) 1	10.6-11.19	100
Band 11 - Thermal Infrared (TIRS) 2	11.50-12.51	100

- This is a Landsat 8 Image, but we can see that the assigned bands are wrong because band 1 is Aerosol, and we don't want that.
- To see the image with the normal color, we need to use bands 2, 3, and 4. We do the change in Symbology tab
- And now we have the normal color image.



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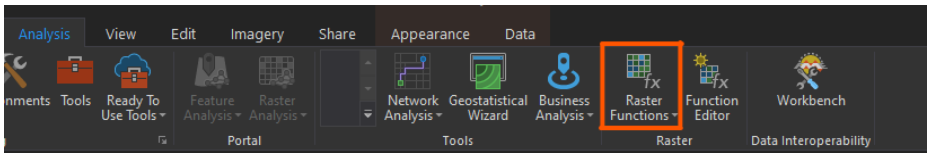
4-9 – Normalized difference vegetation index (NDVI):



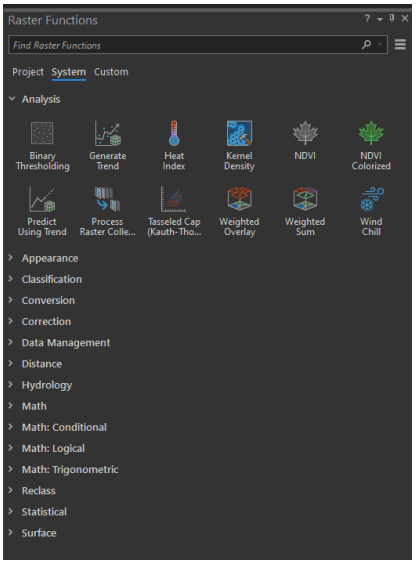
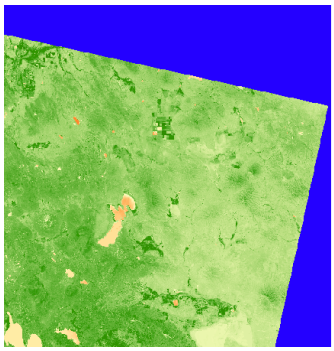
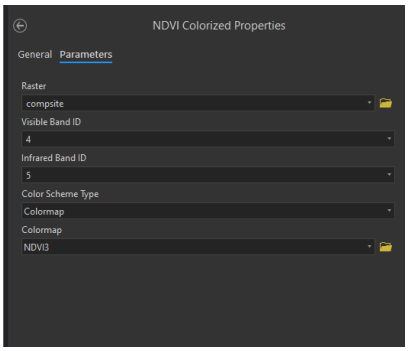
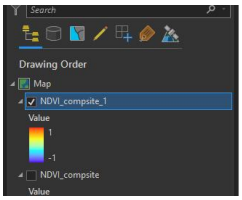


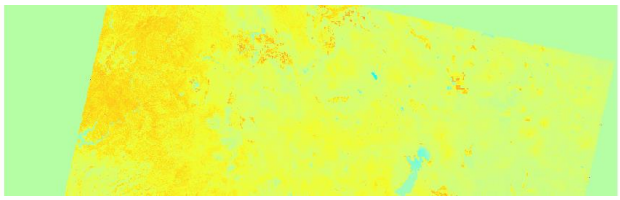
Image analyst tool: Raster Functions can do some pre-created calculations on your bands.



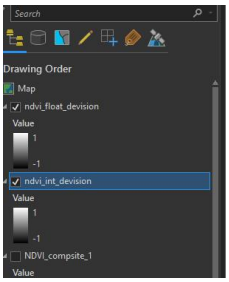


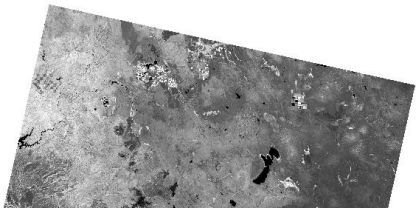
Scientific Output: Returns actual values of NDVI (between -1 and 1)

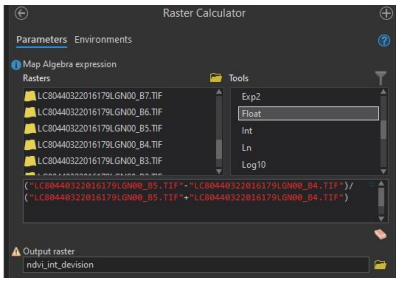




Using Raster Calculator to calculate NDVI:

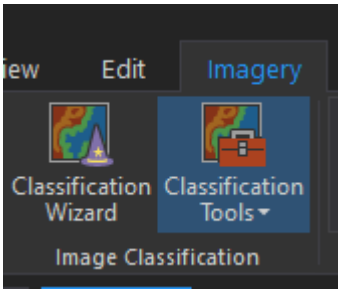






Apparently, in ArcMap, if you divide bands without using float() function, the result would be int(rounded numbers), but in ArcGIS Pro, it doesn't matter (I believe because ArcGIS Pro uses Python at its core. But keep it in mind if this problem ever occurs to you.

4-10 – Image Classification:



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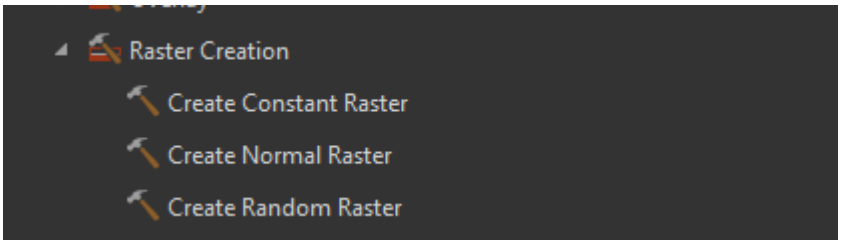
4-12 -Con tool:

Change raster value based on a condi

4-14 – Random Raster, Normal Raster, Constant Raster

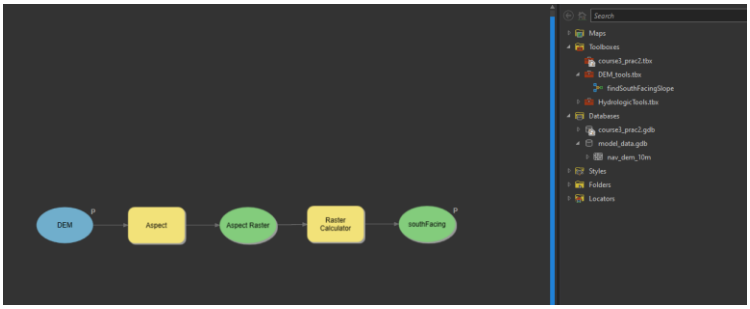


Keep in mind that Random Raster Creates a raster between 0 and 1, and in order to change that, you need to use the raster calculator on it and change the data.

4-17 – Model builder:

In the Catalog pane, right-click on toolboxes, create a new tool, then click on the tool and create a new model.

Drag and drop the tools you want, and define their input and output by double-clicking on them.



For this model to act like a standard tool, you need to right-click on input and output boxes and set them as a **Parameter**.

Ellipsoids are variables, and rectangles are functions. By right-clicking on variables, you can show them on display.

Precondition: when branching, you need to use precondition, so the process completes before the model passes the branch.

4-24 – Geocoding and Reverse Geocoding

Tools that convert addresses to locations x,y, and vice versa

https://developers.google.com/maps/documentation/javascript/geocoding

4-25 – Time enabled data:

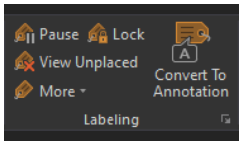
Showing the data that has time as an animation and even export it as a video.

4-26 – Spatial Statistics Toll (important)

Grouping analysis: unsupervised clustering.

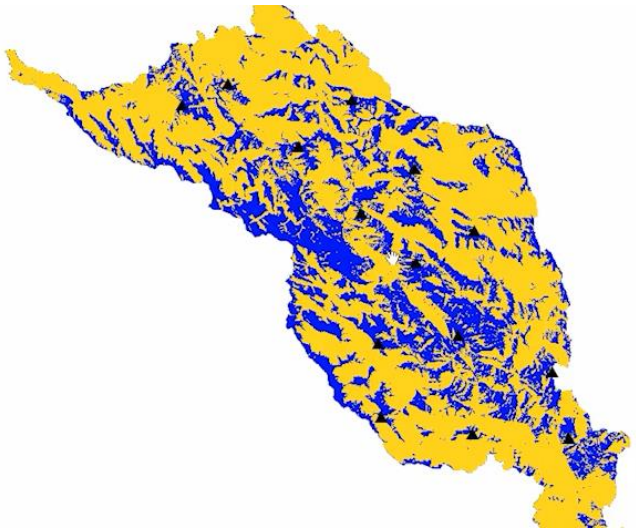
4-29 – Countors:

Labaling panel can be quite useful.



4-31 – ViewShed and Visibility Tool:

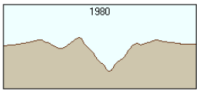
Show you line of sight and how much of an area you can see from a point in you map.



4-32 – CutFill tool:

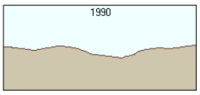
Cutfill tool Finds the areas of difference between 2 dem rasters.

The first graphic shows the surface in its original state:



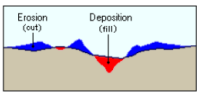
Before surface profile

The second graphic shows the surface after a period of time where erosional and depositional forces have acted on it:



After surface profile

The third graphic shows how the Cut Fill tool identifies the areas where material has been removed (cut) and where it has been gained (filled):



Cut/fill erosion and deposition

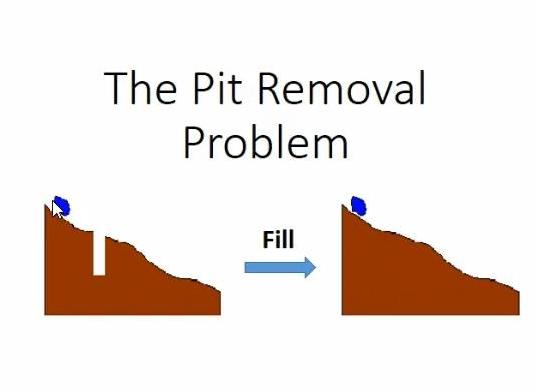
4-33 – Suitiblity Analysis:

Finding the best spot to place something (town, business, ets.)

4-34 – Fuzzy Suitiblity Analysis:

Fuzzy classification.

Reclassification: rename the class names into points which we can use to assess the area.



4-35 – Pit Fill: pit removal

Filling the sincks and pits that are not real but can affect the stream lines and water sheds.

4-38 – Region Group:

It's a Zonal tool that groups raster with the same values into the same zones,

Zontal Statistic: we used to use **zonal statistics as a table** when our zones were vectors, but now that we have our zones defined as a raster we can use normal zonal statistics.

4-39 – Focal statistics and swiss hillshade

Focal statistics are kernels – mean, max, median, etc.

4-40 – Reclassify and colormap

Reclassify changes the classification and names associated with the classes.

Colormap copies the color palette of one classification so we can use it on another one.

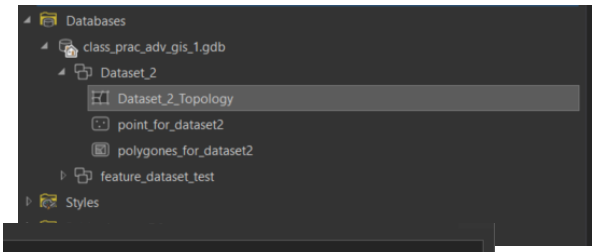
4-41 – Density tool

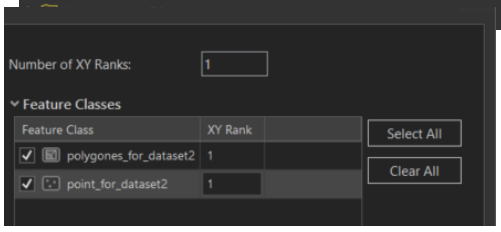
6- Other Stuff:

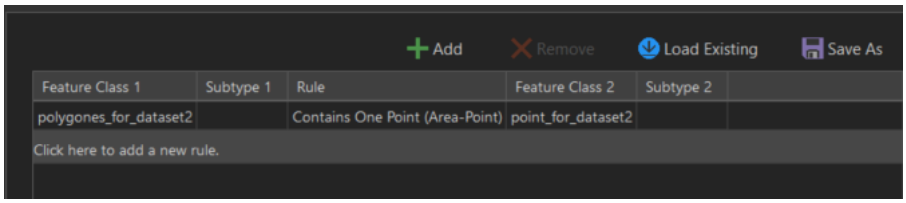
6-1 – Topography Tools:

- Create Topology: https://www.youtube.com/watch?v=Evx3EysA_hw
- Use Topology: https://www.youtube.com/watch?v=GmbipA1rOpA

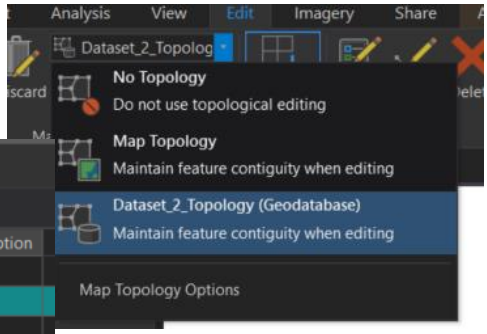
1- Create a Dataset in catalog pane(right-click on data your base) :
2- Create you feature classs in your dataset.
3- Create a New Topology:
4- Select feature classes you want
5- define your rules

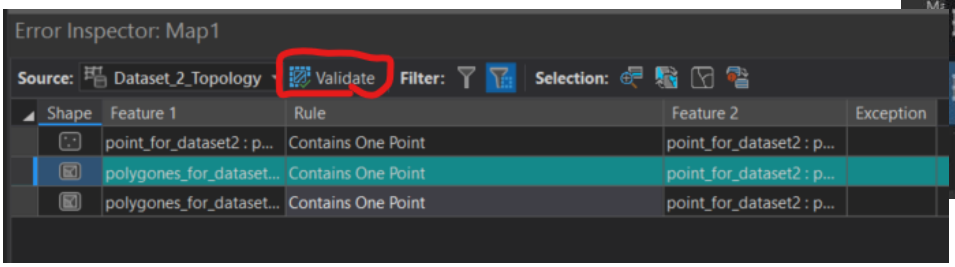






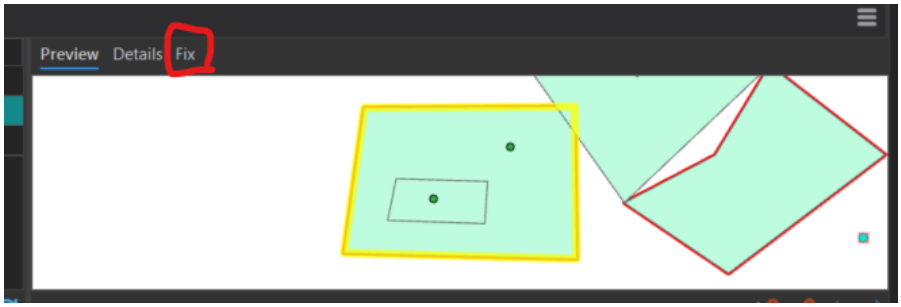
6- Add topology in to your map (by righ-clicking or drag and droping)
7- In the edit tap select your topology – then peress Error Inspector:
8- Use validate to find your errors:

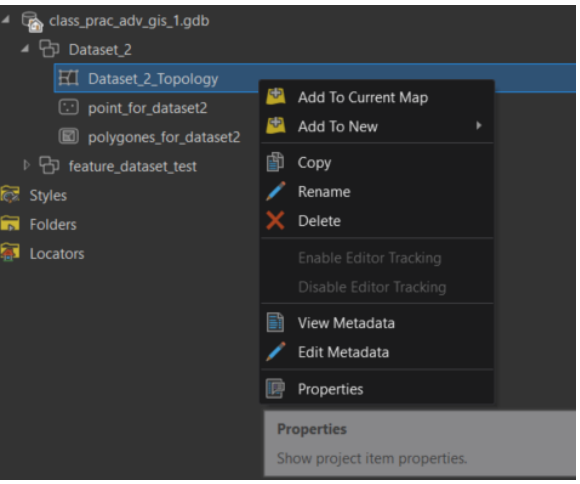




9-

10- Use fix to to find soloutions.
11- You can select each error like selection rows in a table.

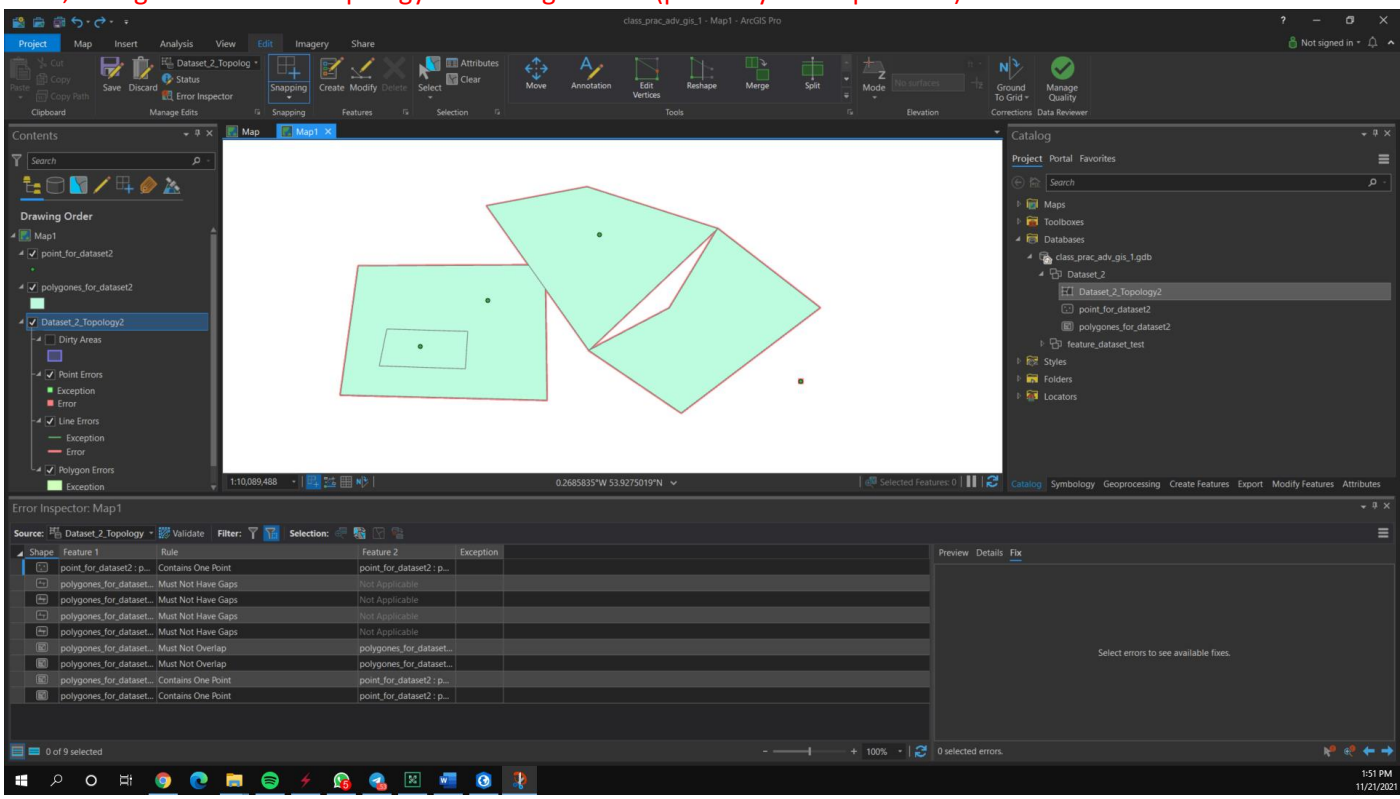




12- You can edit rules by going to properites of your topology:

But first you need to remote topology from cnotets, do you edit then bring it back – you'll get a error otherwise.

13- Bug – when you remove topology from contents pane and edit the rules, change the name of topology then bring it back. (probably cache problem).



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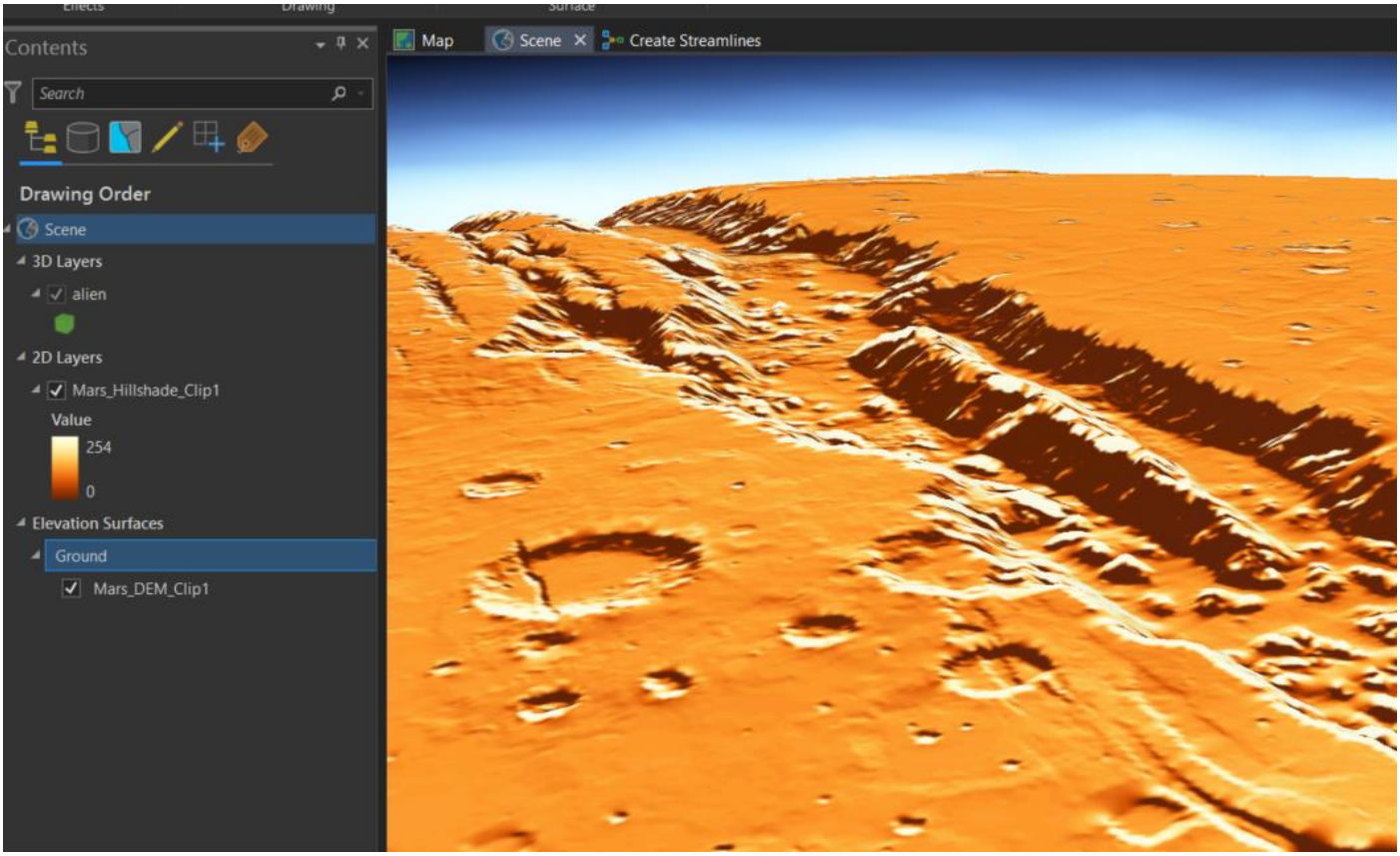
6-2 – how to create 3D Surface in arcgis scene:

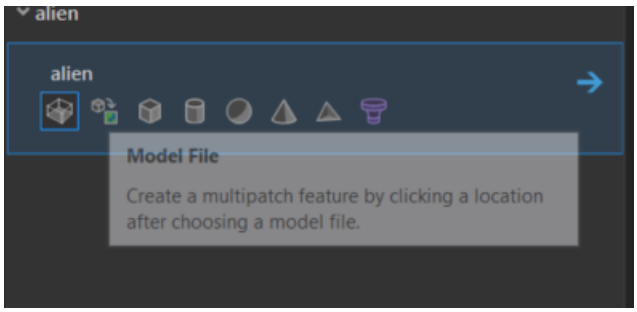


You need to have 2 layers DEM or TIN for Elevation Surafce an one in 2d layers(as texture).

Make sure that the exajration in appreacne tab is more than 0

6-3 – How to import 3D Object files in arcgis sene:

1- Create a Multipatch feature class.
2- Go to edit – create and Import your supported 3d fils.

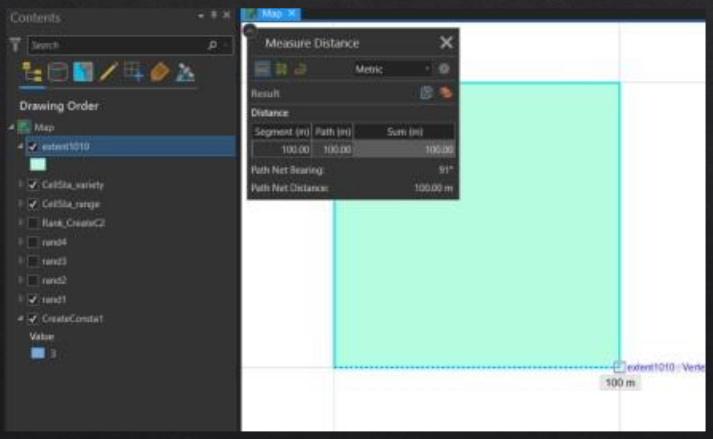


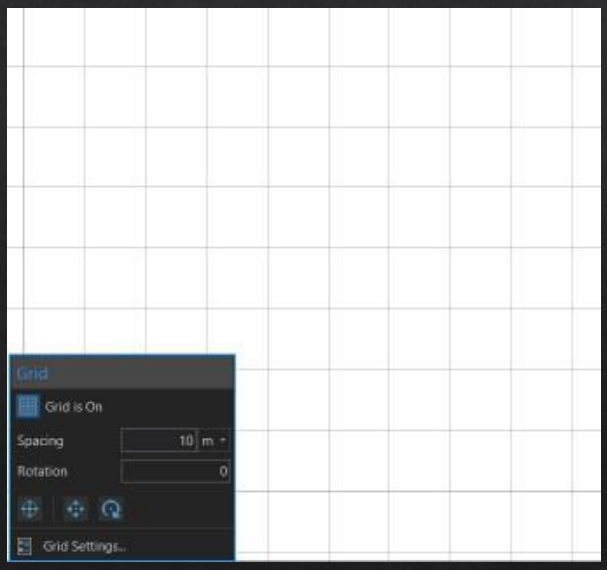
6-4 - Local Statistics: Rank, Range, Variety

This tool in arc gis pro is called **Cell Statistics** , this tool checks each pixel with anoher.

Creating Rasters

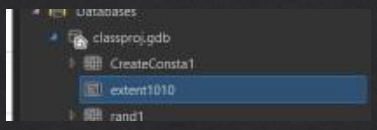
- Creating 10x10 girds



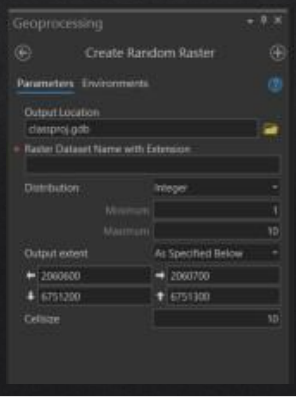


Creating Rasters

- Creating a 100m x 100m polygon for raster extent



- Creating 10m x10m random and constant rasters Using our extent



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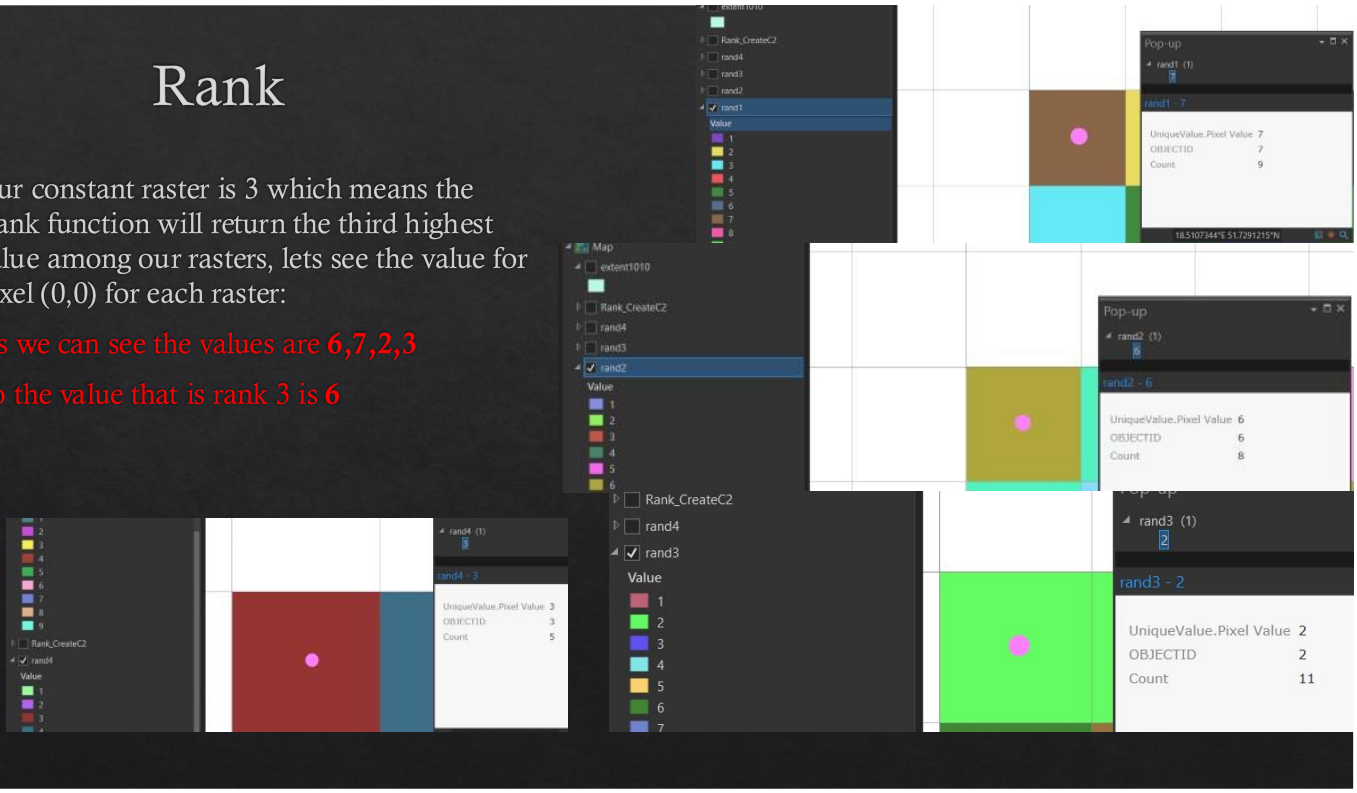
Rank

Our constant raster is 3 which means the Rank function will return the third highest value among our rasters, lets see the value for pixel (0,0) for each raster:

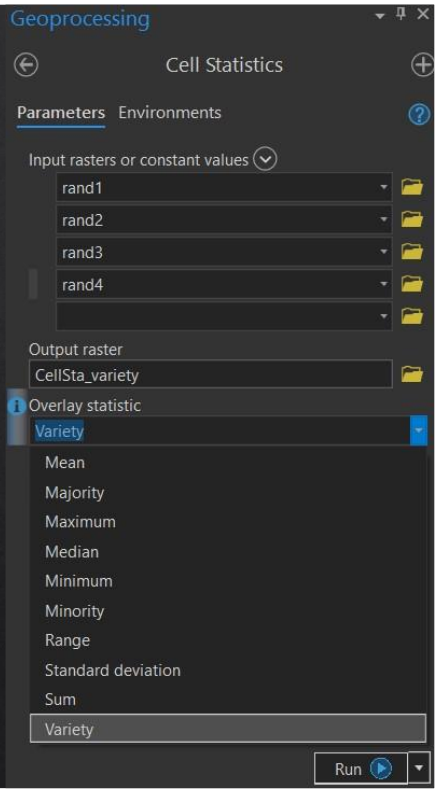
As we can see the values are **6,7,2,3**

So the value that is rank 3 is **6**



Cell Statistics

- In ArcGIS pro we have a new tool called Cell Statistics which is the same as Local statistics
- Remember on pixel (0,0) we had values **6,7,2,3** on random rasters 1,2,3 and 4 .
- So now we use Range and Variety Options on them.
- It is obvious that range should be 5 and variety should be 4
- Will check it out in the next slide.



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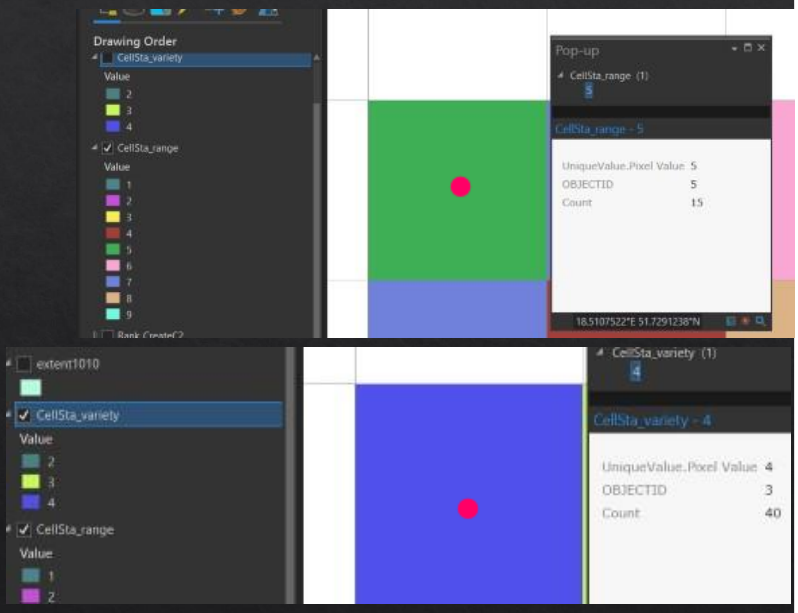
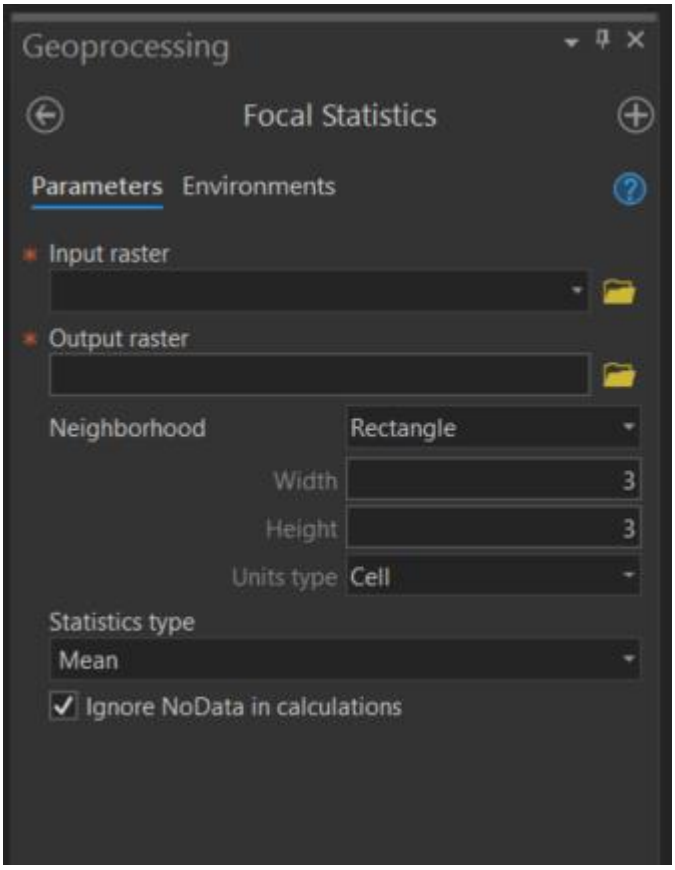
Range and Variety

- And this is the final Result



6-5 Focal Statistics:

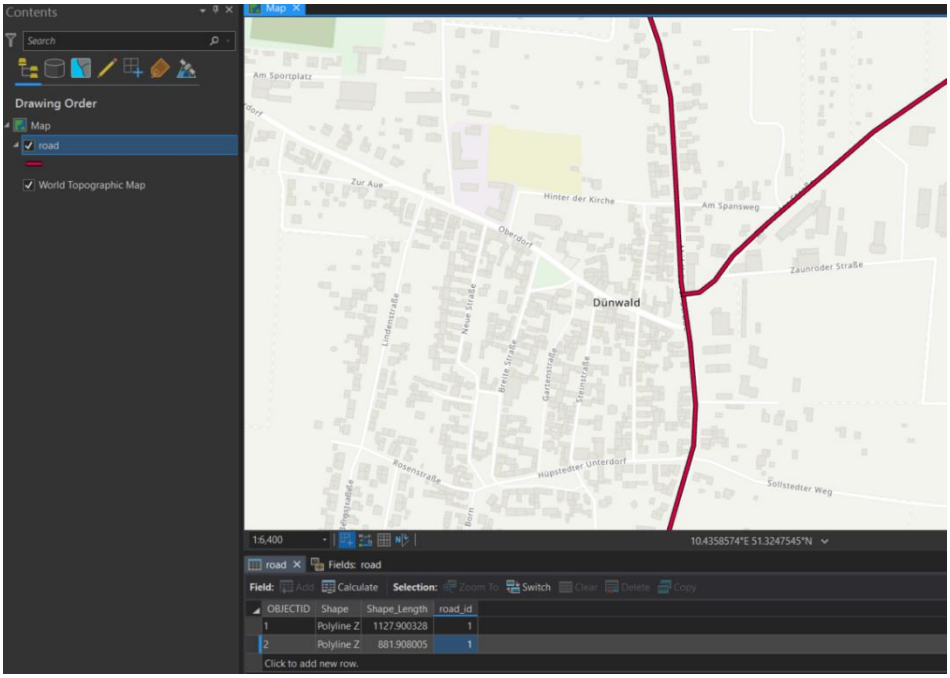
it is the same as filters and kernels in in image processing



6-6 – Linear Refrencing:

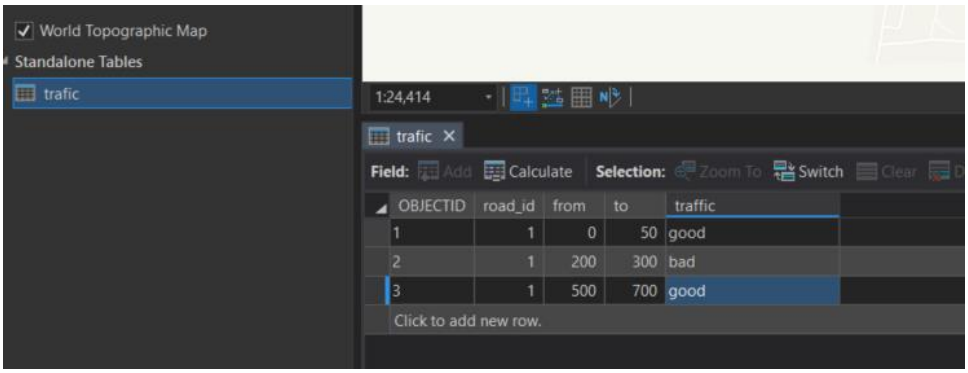
Lets say we have a road with an attribute table which has the road id in it.

We want to describe the raod traffic without creating new lines or createing new features with spatial location, how would we do this?



Create an attribute table containing the situation of each road and the path from start (here we have it in meters)

To the end



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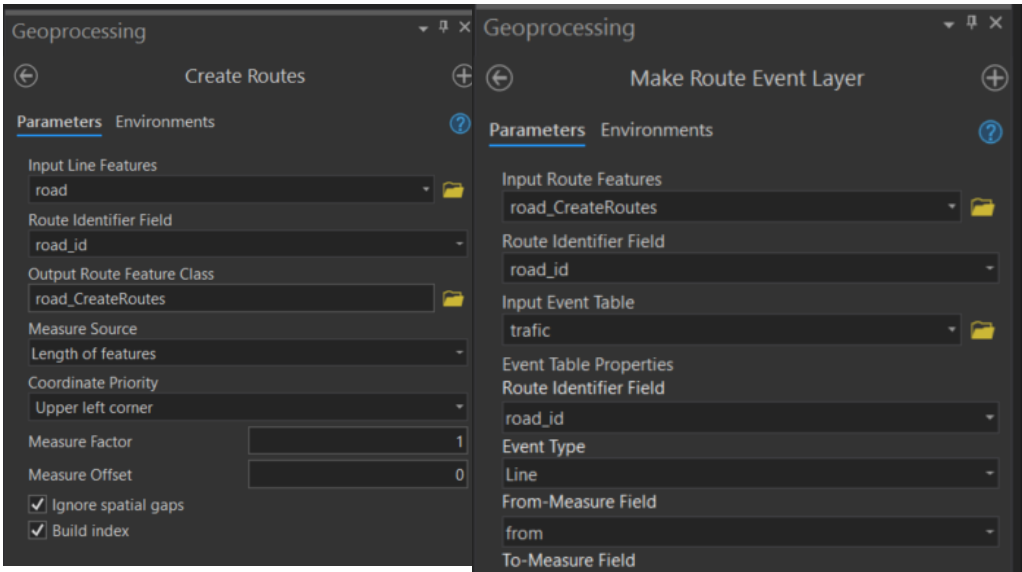
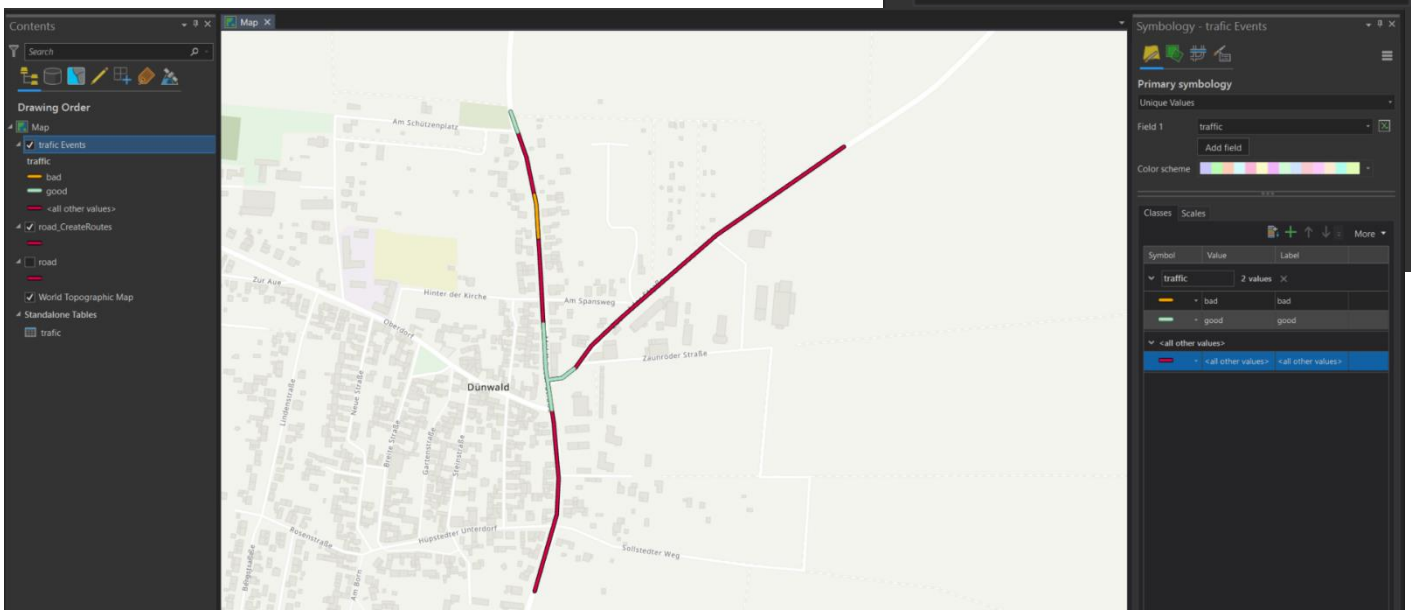
First turn your linear feature class into routes using Create Routes:

Then we give the routes and the table to the tool called Make Route Event Layer

After the tool ran use unice values symbology to identify the new features.





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