

# Cartogram Training Manual v.1



2017

By Paul J. Alexander

Environment Research Institute

University College Cork

[paul.alexander@ucc.ie](mailto:paul.alexander@ucc.ie)

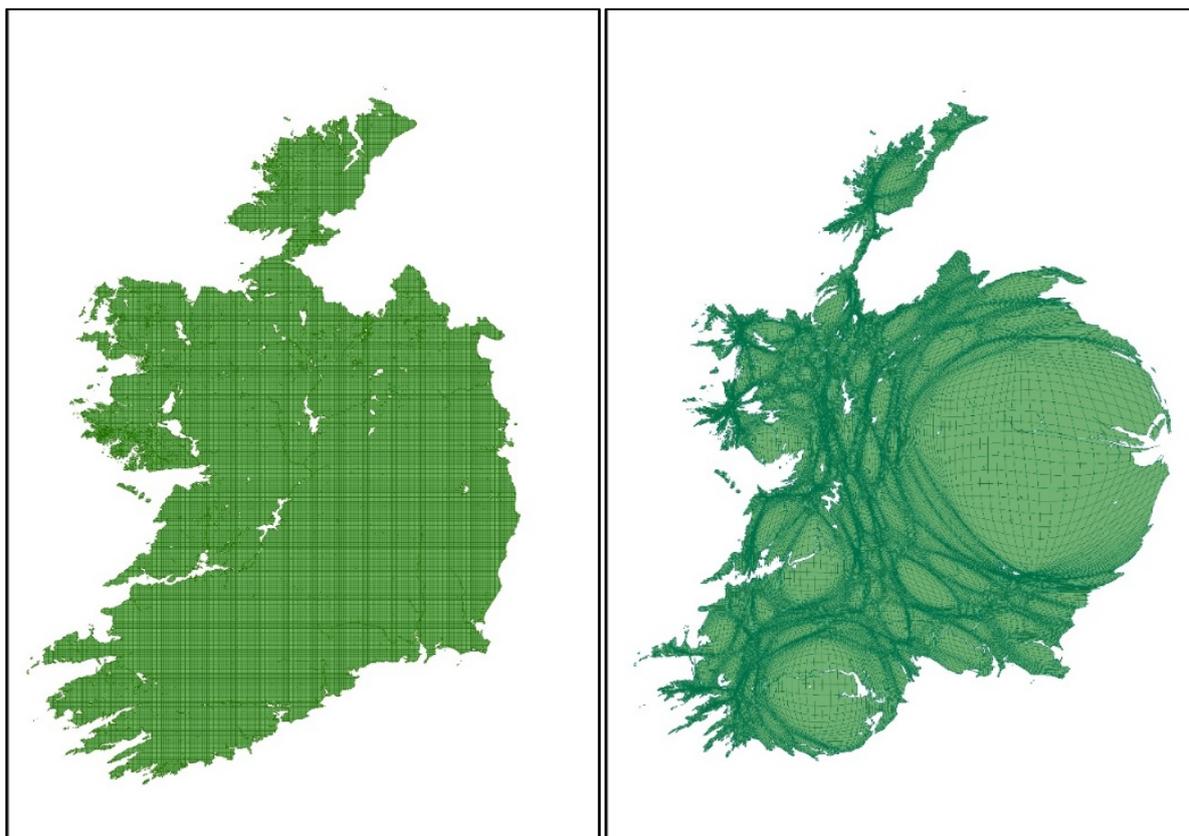
## Contents

<b>1. Preface</b> .....	<b>2</b>
1.1 What is a Cartogram? .....	2
1.2 So what’s the contest? .....	2
1.3 What are the rules?.....	3
1.4 Who can enter?.....	3
1.5 What do you need?.....	3
1.6 Using this Manual.....	3
1.7 What is a Tessellation?.....	3
<b>2. Getting Started</b> .....	<b>4</b>
2.1 Extracting Training material (The Digital Package) .....	4
2.2 Exploring the Digital Package .....	6
2.3 Adding the Cartogram Tool to ArcMap .....	9
2.4 Generating a Cartogram .....	16
2.4.1 Running the Cartogram Tool.....	20
<b>3. Zonal Statistics (Cartogram 2)</b> .....	<b>25</b>
3.1 Enable Spatial Analyst.....	25
3.2 Using the “Blank Tessellation” with Data Example (Zonal Statistics) .....	26
<b>4. Exporting your Cartogram (Cartogram 3)</b> .....	<b>33</b>
4.1 Adding the elevation data and transforming 0 values.....	33
4.2 Transforming to Non-Zero Values Example (Add Field, Field Calculator) .....	34
4.3 Exporting a Map .....	38

## 1. Preface

### 1.1 What is a Cartogram?

A cartogram is a map used to indicate geographically-bound statistical information, typically region-by-region values of a given variable where the relative areas of graph regions are proportional not to the relative areas of the land regions they represent, but rather to another quantitative variable, such as population or gross domestic product. Below is a simple example of a cartogram of the Republic of Ireland based on a fairly quirky question: **What would Ireland look like if the size of the landscape was based on the population living there?** The image on the left shows the land surface broken up into 1x1km grids each contains total population based on 2011 census data, a traditional method would be to use these data to generate a choropleth map to show population amounts. On the right is a cartogram where the 1x1km grids have been resized based on their population, this pulls out urban areas (most notably Dublin!) so their size becomes more representative of the population they contain!



### 1.2 So what's the contest?

We are looking for the most interesting **cartogram for Ireland** which fits in with the conference theme this year 'Disruptions and Transgressions'. Delegates at the conference will vote on the entries and the most interesting cartogram will receive a prize, though all entrants will have a feature written up in *GeoNews* to mark their efforts.

If there is sufficient interest, we may also pursue a joint publication in the *Journal of Irish Geography* for which every entrant wishing to be included will be a co-author.

### 1.3 What are the rules?

Full training will be given to each entrant on how to generate a cartogram, thereafter entrants are free to pick a variable of their interest and generate the most interesting cartogram!

### 1.4 Who can enter?

The cartogram contest is open to students in Geography **ideally** you will also be attending the conference this year!

### 1.5 What do you need?

A PC or Laptop with ArcMap installed (version 10), **ideally you will have admin rights on the machine you're using for troubleshooting** in section 2.3. I also highly recommend you use a USB device (minimum 4GB) to store your data. You should be somewhat familiar with ArcMap and working with Geographic Data. **You also need to be patient!** Generating a Cartogram can take quite a while (up to 12 minutes in testing) so be sure to wait for the tool to run.

### 1.6 Using this Manual

This training manual more or less mirrors the three online training videos. It may be beneficial to use both the manual and the videos since material reproduced here is of course “static”. The manual might seem long, but there are lots of pictures so overall its very concise. There are three sections:

1. Getting Started
2. Using Zonal Statistics for your own data
3. Exporting maps

Where you see a link in Blue and underlined ([looks like this](#)), you can click this to jump to a particular part of the manual.

### 1.7 What is a Tessellation?

At many points in the manual, I refer to “tessellation”. Tessellation is just another term used for breaking up a surface (or data) into “grids” or “boxes”. So a “tessellation of population” means breaking up population data into a grid, a “tessellation of elevation” means breaking up elevation data into a grid and so on.

## 2. Getting Started

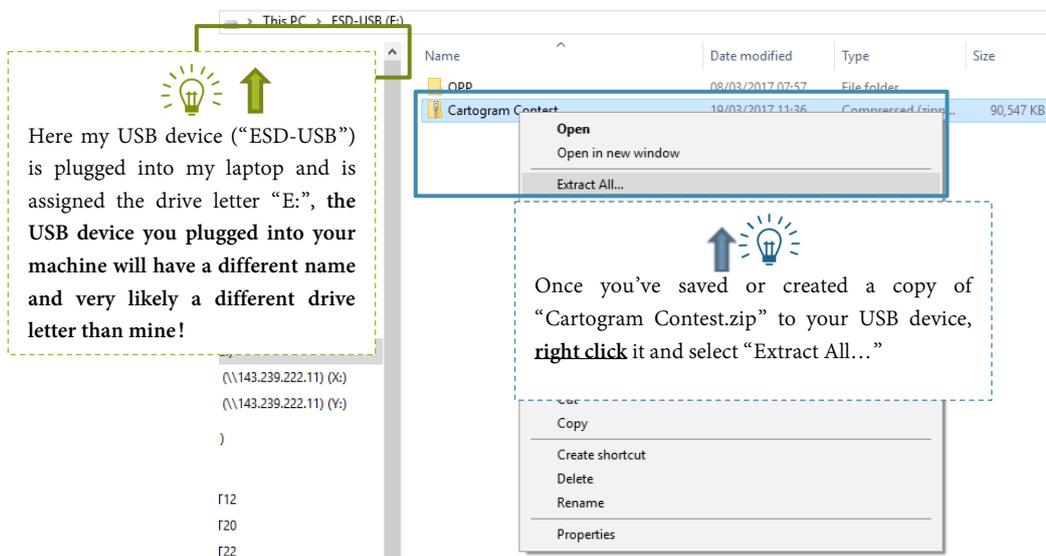
In this section, an overview of the training material is provided followed by instructions to install the cartogram geoprocessing tool in ArcMap 10.x. Finally, an example of generating a cartogram is provided to illustrate how the tool works.

### 2.1 Extracting Training material (The Digital Package)

Once you registered for the contest, you should have received a link to download a digital package from HEAnet (if you did not receive this, send an email to paul.alexander@ucc.ie). This is a compressed (“zipped” or .zip) folder which contains most of everything you’ll need. By virtue of the fact you are reading this, it is likely you’ve already figure out how to extract (“unzip”) the folder! If so, skip to [Exploring the Digital Package](#) otherwise read on.

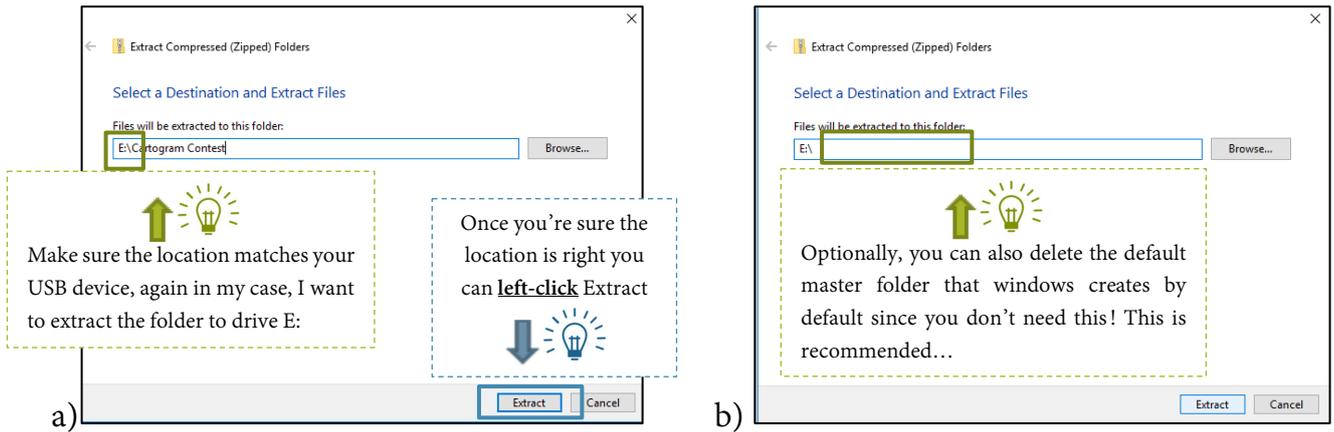
Here is the recommended procedure step-by-step:

1. Save or Copy the folder “Cartogram Contest.zip” to your USB device
2. Navigate to your USB device on your computer and right click on the folder and select “Extract All...”



NB: Images are produced in HD but resized to fit into the manual, you can zoom in with your PDF reader to see them in more detail!

3. You may be prompted to identify “where” to extract the folder
4. Make sure the folder is being extracted to your USB device. On most machines, by default windows will create a new “master folder” called Cartogram Contest, you can remove this if you wish as it just places the main folder into yet another folder!



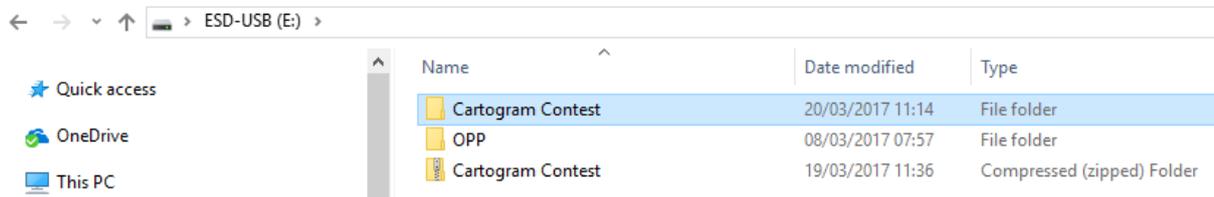
Results from a)



Results from b)



- You should now have a file folder on your USB device (please ignore the “OPP” folder in the image below, this is just another folder on my USB device unrelated to this manual!):



## 2.2 Exploring the Digital Package

This section simply highlights the contents of the unzipped digital package. I refer back to these locations in the manual in subsequent sections (e.g. later on I provide a step in a procedure saying “Add the 1km grid located in folder 3.1”) so it’s a good idea to become familiar with the general layout of the package, which is why I highlight it below

At the top level, you should have 3 subfolders under “Cartogram Contest”:

1. EsriCartograms	15/03/2017 19:29	File folder
2. Irish Data	15/03/2017 19:29	File folder
3. Contest Material	15/03/2017 19:29	File folder

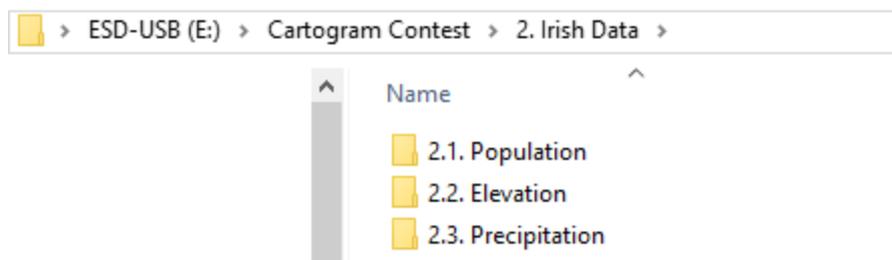
Under “1. EsriCartograms” there should be 1 subfolder:

ESD-USB (E:) > Cartogram Contest > 1. EsriCartograms >			
Name	Date modified	Type	
1.1 Cartograms	19/03/2017 09:19	File folder	

Under “1.1 Cartograms” there should be 3 folders, 2 dynamic link libraries (dlls or “application extensions”), an ArcMap document, an ArcMap Toolbox and finally a word and PDF ReadMe file (this ReadMe is excellent for more guidance on using the tool by the way!) and a .bat file:

ESD-USB (E:) > Cartogram Contest > 1. EsriCartograms > 1.1 Cartograms		
Name	Date modified	
CartogramSample.gdb	19/03/2017 09:11	
HelpFiles	15/03/2017 07:50	
results.gdb	19/03/2017 09:11	
BnchMrkCartogram.dll	15/03/2017 07:50	
BnchMrkGPCartogram.dll	15/03/2017 07:50	
Cartogram	15/03/2017 07:50	
Cartogram	15/03/2017 07:50	
ReadMe	15/03/2017 07:50	
ReadMe	15/03/2017 07:50	

Back to the top level, under “2. Irish Data” there should be three subfolders:



Under “2.1 Population” there are three files for ArcMap:

*COP2011\_Grid\_ITM\_IE\_1km.shp* – a shape file which covers the **Republic of Ireland** in 1x1 km grids and contains a count of people based on 2011 census, some missing values

*Population\_2011.tif* – A raster dataset which interpolates the population into a continuous surface (i.e. fills missing values) which was generated using *COP2011* and county level census data from Northern Ireland

*Tessellation\_Population.shp* – A 1x1 km grid covering the **Island of Ireland** which counts the population based on *Population\_2011.tif* **this is what ultimately gets used for generating our cartogram**

Under “2.2 Elevation” there is only 1 file for ArcMap:

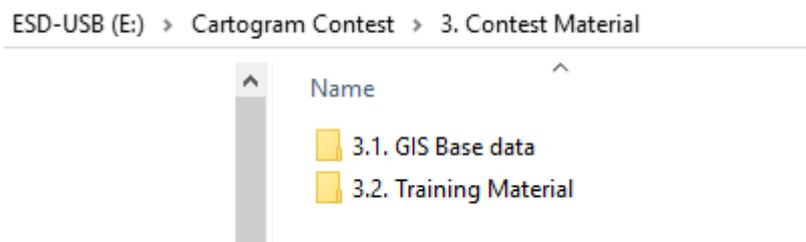
*Tessellation\_Elevation.shp* – A 1x1 km grid covering the **Island of Ireland** which contains the mean elevation of the underlying landscape. This was generated using NASA's SRTM 30m Digital Elevation Model, however since the SRTM file is so large (>1GB) I don't include the data here, only the resulting tessellation

Under “2.3 Precipitation” there are 2 files for ArcMap:

*Annual\_Precip.tif* – a raster dataset which interpolates normal (i.e. average from 1981-2010) annual precipitation accumulations from Met Éireann across the **Island of Ireland**

*Tessellation\_Precipitation.shp* – a 1x1 km grid covering the **Island of Ireland** which contains the sum of precipitation accumulations for the underlying area. This was generated using *Annual\_Precip.tif*

Back to the top level, under “3. Contest Material” there should be two subfolders:



Under “3.1 GIS Base data” there are 4 files for ArcMap:

*Ireland\_1km\_tessellation.shp* – a shape file which covers the **Island of Ireland (and some off-shore islands)** this is a “blank” tessellation which can be used by contestants to breakup their own data for the purposes of generating a cartogram

*Ireland\_Counties.shp* – a shape file which covers the **Island of Ireland** and contains administrative **counties** for both NI and ROI, again, this can be used by contestant who only have county level data

*Ireland\_ING.shp* – a shape file which covers the **Island of Ireland** and only provides an outline of ROI and NI.

*Ireland\_Natural\_look.tif* – A RGB (red, green, blue) raster dataset providing a very low-resolution natural look of Ireland from space

Under “3.2 Training Material” there is a template file for ArcMap (optional) and a PDF of this training manual!

## 2.3 Adding the Cartogram Tool to ArcMap

In this section, I attempt to provide a quick workflow for getting everything setup, with as little explanation as possible<sup>1</sup> – while this may be frustrating for users already familiar with ArcMap it serves to keep instructions concise. In theory, you should be able to follow the steps listed below in a short amount of time with only limited prior knowledge of ArcMap.

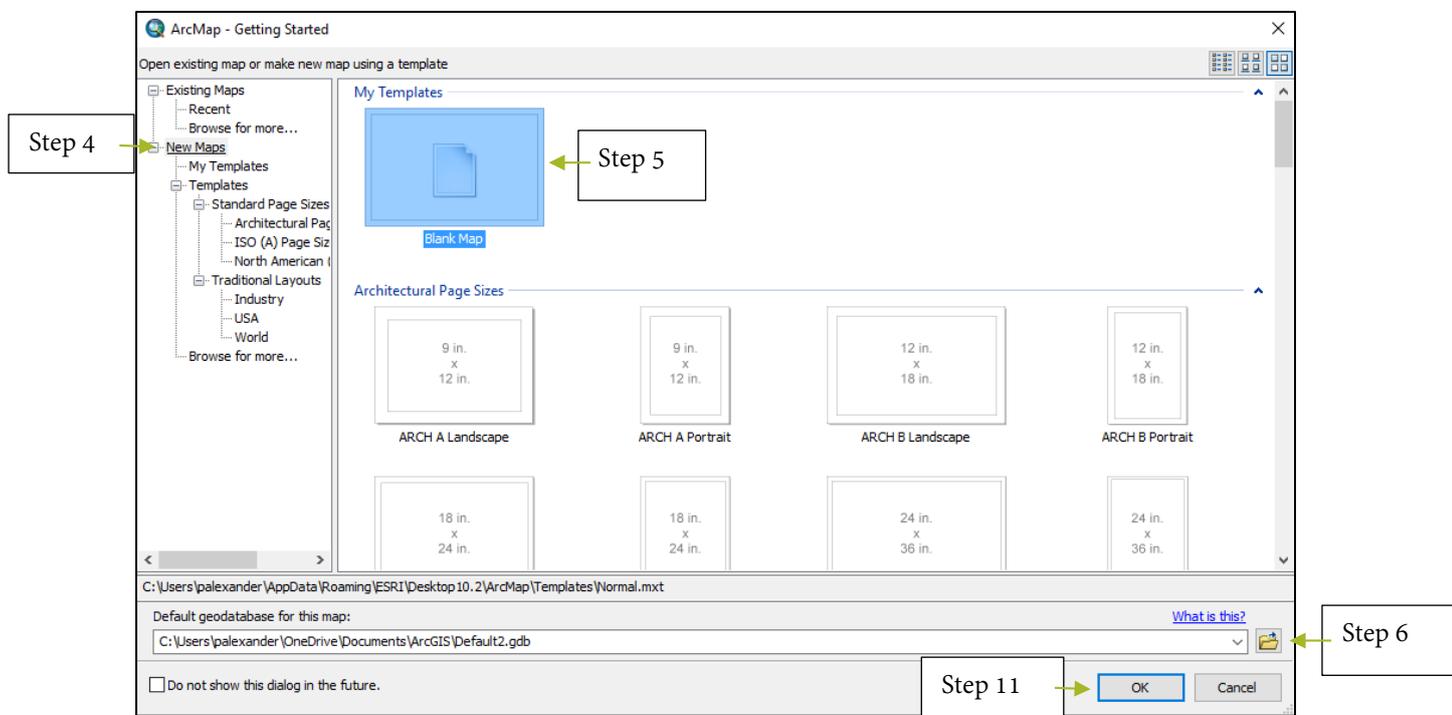
Depending on how ArcMap is installed on your machine, you may have to repeat this section each time you run ArcMap, which is another reason the instructions are kept short and to the point!

NB: In the screen shots that follow, you may notice your layout of ArcMap is different to mine, don't be concerned with this, I will always show you how to follow steps using elements of ArcMap that are common on every installation.

1. Launch ArcMap on your machine, usually there will be a desktop shortcut or

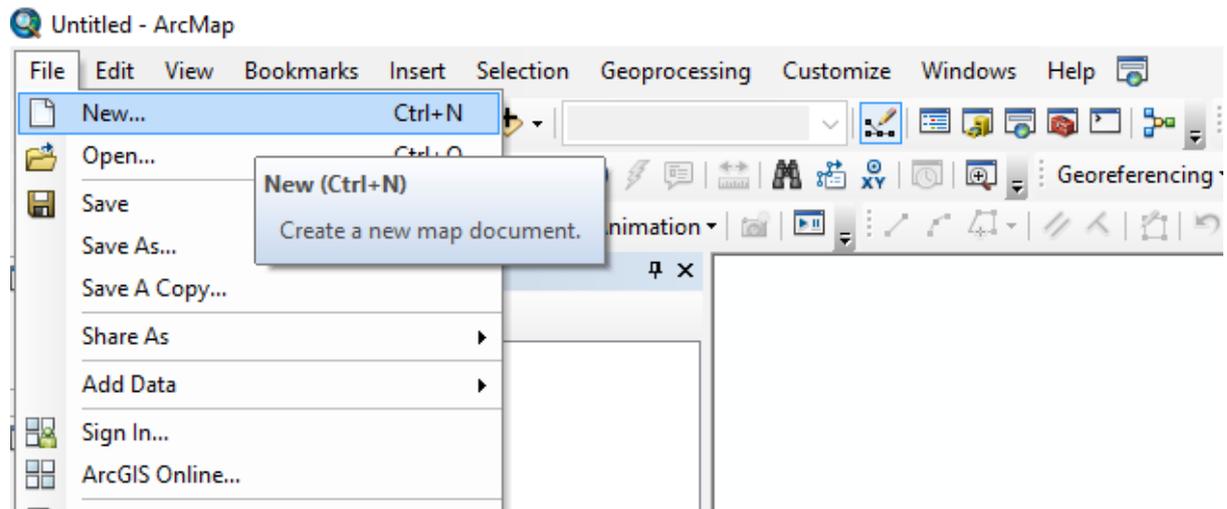
taskbar shortcut on your machine which looks like this: 

2. If you are shown the “Getting Started” Screen (below) **skip to step 4**

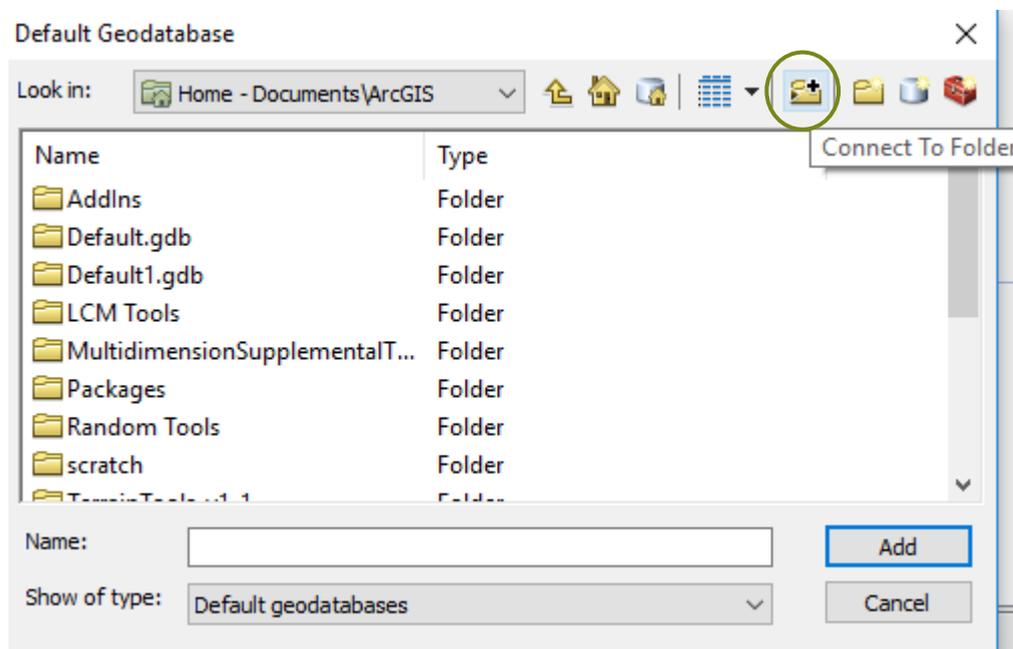


<sup>1</sup> i.e. this section is (unapologetically) a “buttonology”, it tells you what buttons to press and in what order, but not necessarily why to press it or in that order!

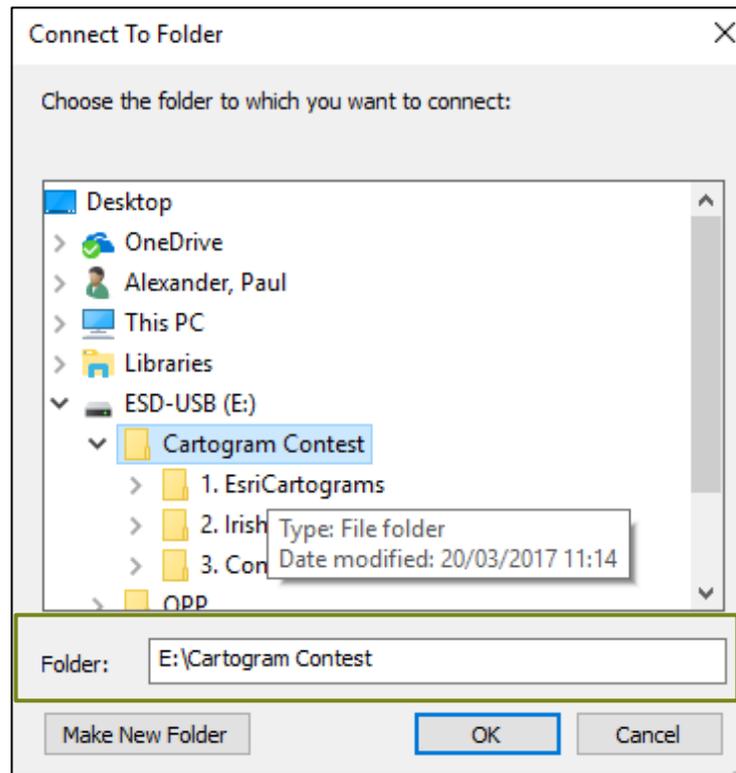
- If you are not shown the Getting Started Screen, but are brought straight into ArcMap, in the top left corner select File > New, you should then be shown the “New Document” Screen which is essentially the same as the “Getting Started” Screen



- On the left hand pane of the screen, left click “New Maps”
- On the right hand pane of the screen left click “Blank Map”
- Under “Select default geodatabase for this map:” click the folder icon 
- Left click the connect to Folder Icon:

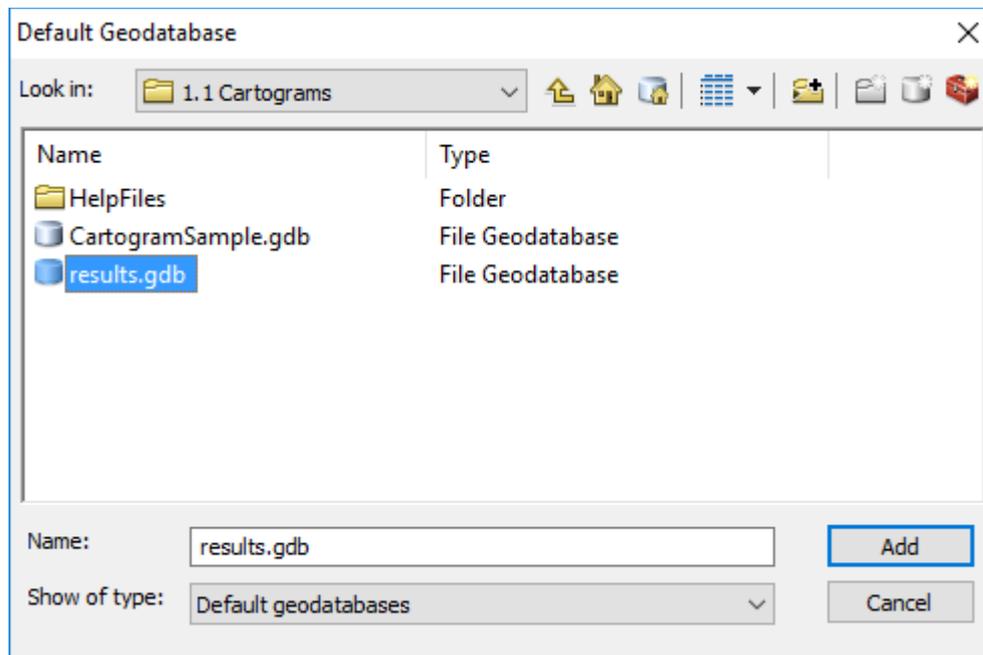


8. Navigate to your USB Device and select the Cartogram Contest Folder:



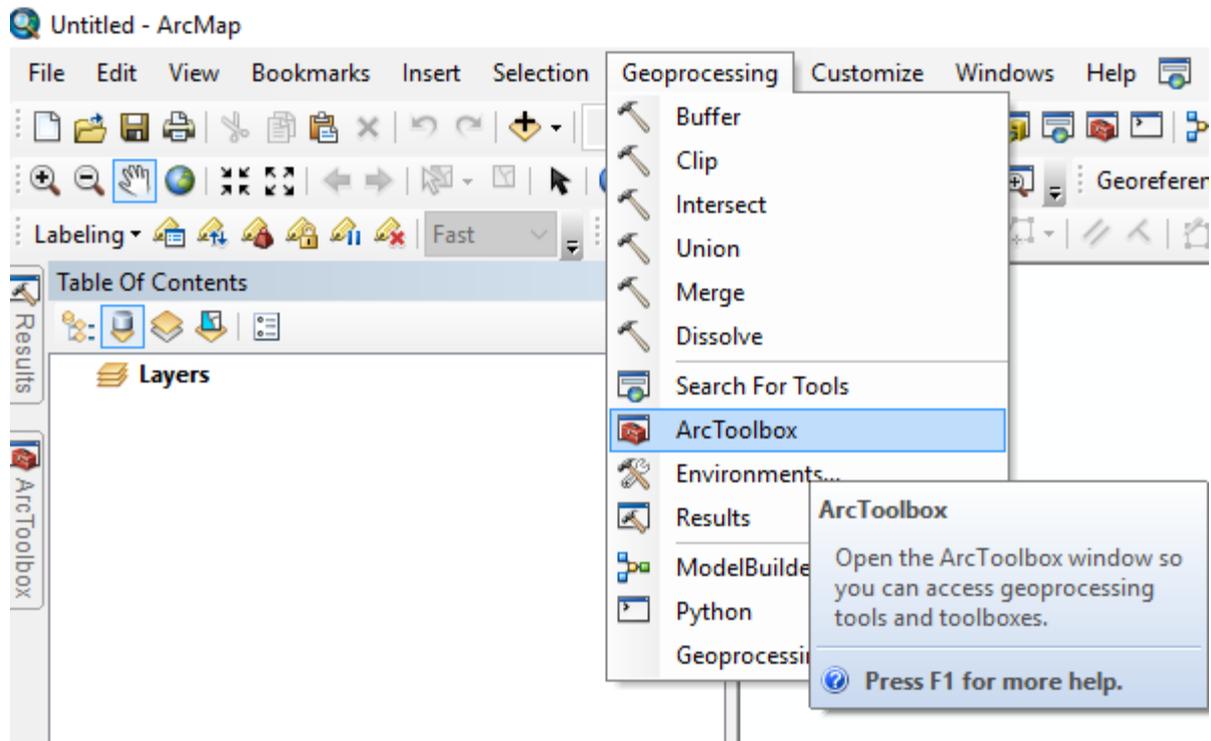
9. Click “OK”

10. Navigate to subfolder “1.1 Cartograms” and select (by left clicking once) “results.gdb” and then click “Add”:

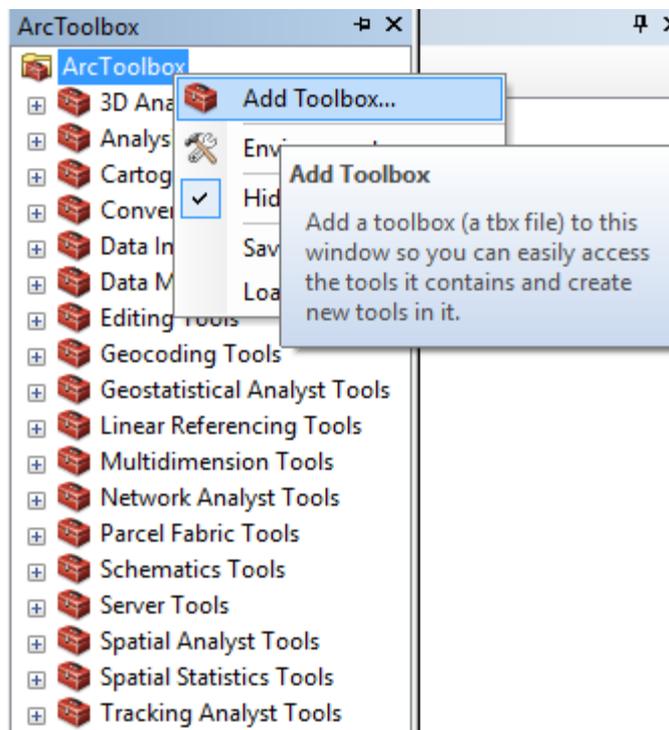


11. Finally Click “OK” at the bottom of the Getting Started / New Map Screen

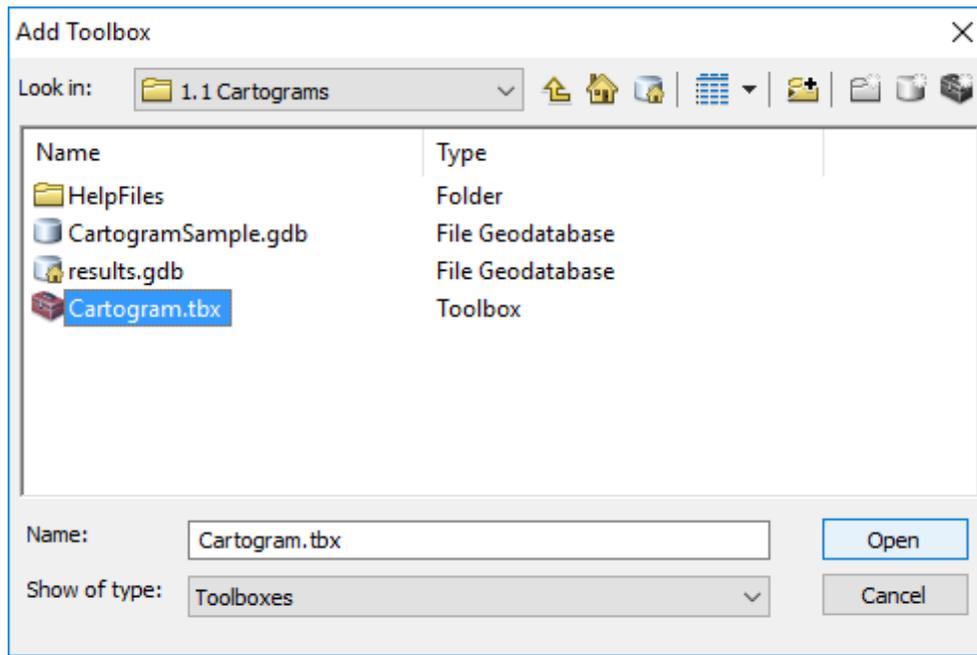
12. Once you’re in the new blank map, on the top menu bar select Geoprocessing > ArcToolbox:



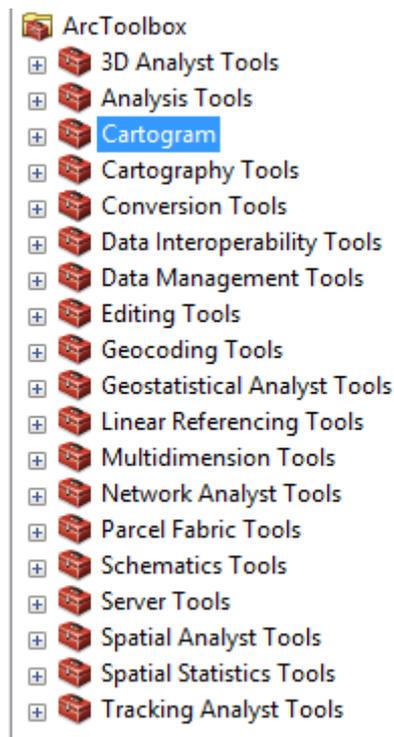
13. Once the ArcToolbox opens, **right click** the highest folder level (A folder with a red toolbox and the name “ArcToolbox”) and select “Add Toolbox...”:



14. The Add Toolbox screen should now open in subfolder 1.1 Cartograms, if not, navigate there yourself, select (by left clicking once) “Cartogram.tbx” and then click “Open”:

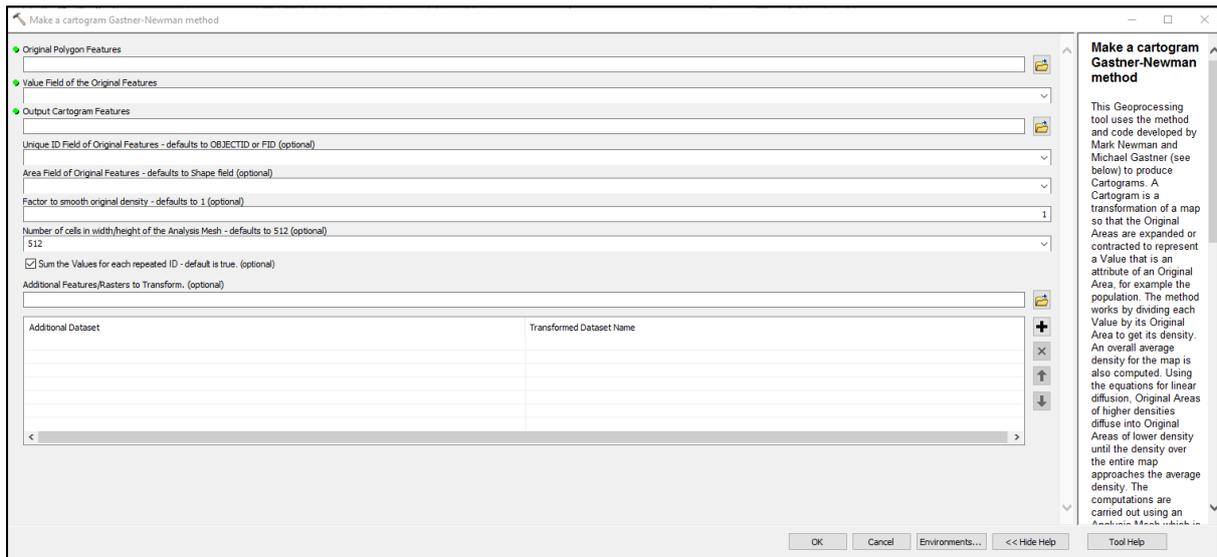


15. You should now see the Cartogram tool listed under ArcToolbox:

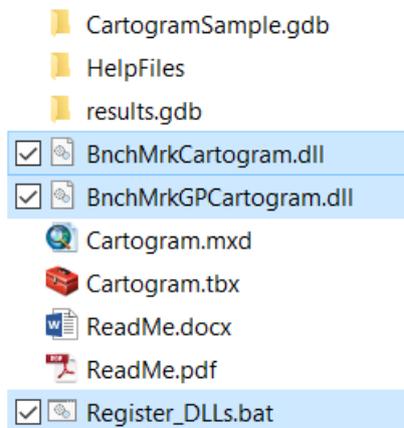


16. Open this tool box (by left clicking the expand icon ) and double left click on “Make a Cartogram Gastner-Newman method”

17. If the tool opens, it’s likely the installation has been successful!:



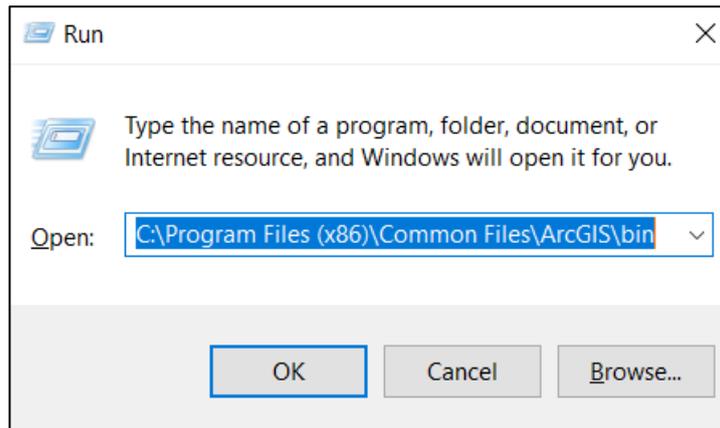
18. If the tool doesn't open, but instead you see a red x over the tool, then it **has not been added successfully**:  Make a cartogram Gastner-Newman method
19. Close ArcMap and open your USB device, navigating to folder 1.1
20. Copy the two .dll and .bat files from this folder (right-click>Copy or select the files and hit CTRL+C on your keyboard):



21. Press and hold the windows key and press the R key on your keyboard:



22. This should open up the run command window

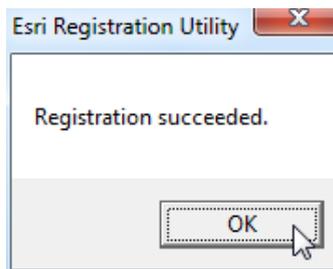


23. Type the following into the box next to “Open:” and press enter:

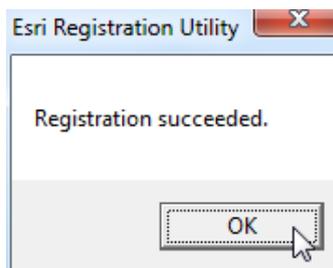
C:\Program Files (x86)\Common File\ArcGIS\bin

24. Assuming you have admin rights<sup>2</sup> on the machine, you should now be in a folder entitled “bin” in windows, paste the .dll and .bat files here

25. Double click on “Register\_DLLs.bat” and to run this script – it may ask you to confirm you want it to run, which you should. It will install both .dll files after the first one has installed you should see the following window:



Click ok to install the second .dll file, again you should see the following:



Once this has completed, reopen ArcMap and run through steps 1-17 again

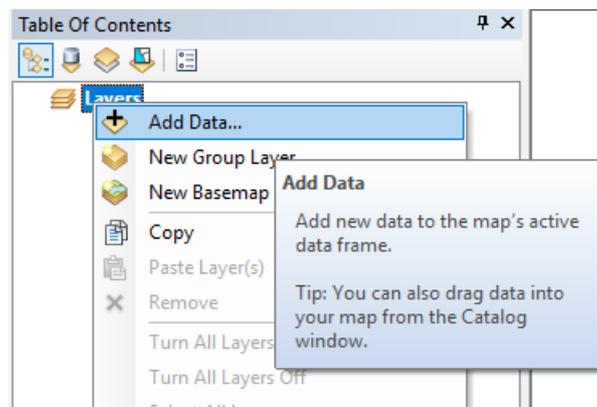
---

<sup>2</sup> If you do not have admin rights contact paul.alexander@ucc.ie and I will send instructions for your IT technician

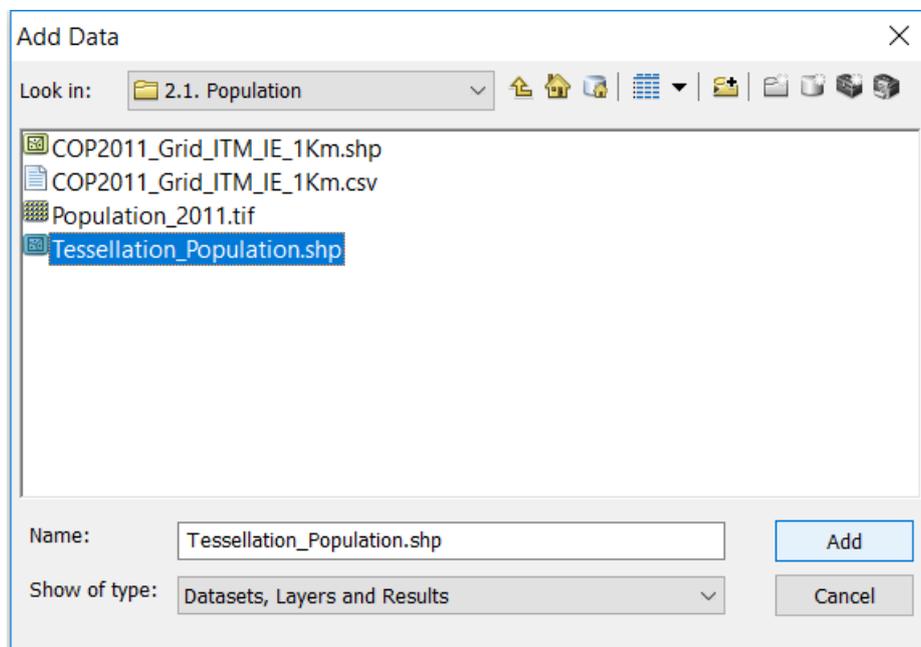
## 2.4 Generating a Cartogram

Now that you have the tool installed, in this section an overview of the usage of the tool is provided. Recall that the basic principle of a cartogram is to draw geographic data not based on an areas size, but rather on some other quantitative property. Using population statistics from the 2011 census, this example will show you how to use the cartogram tool.

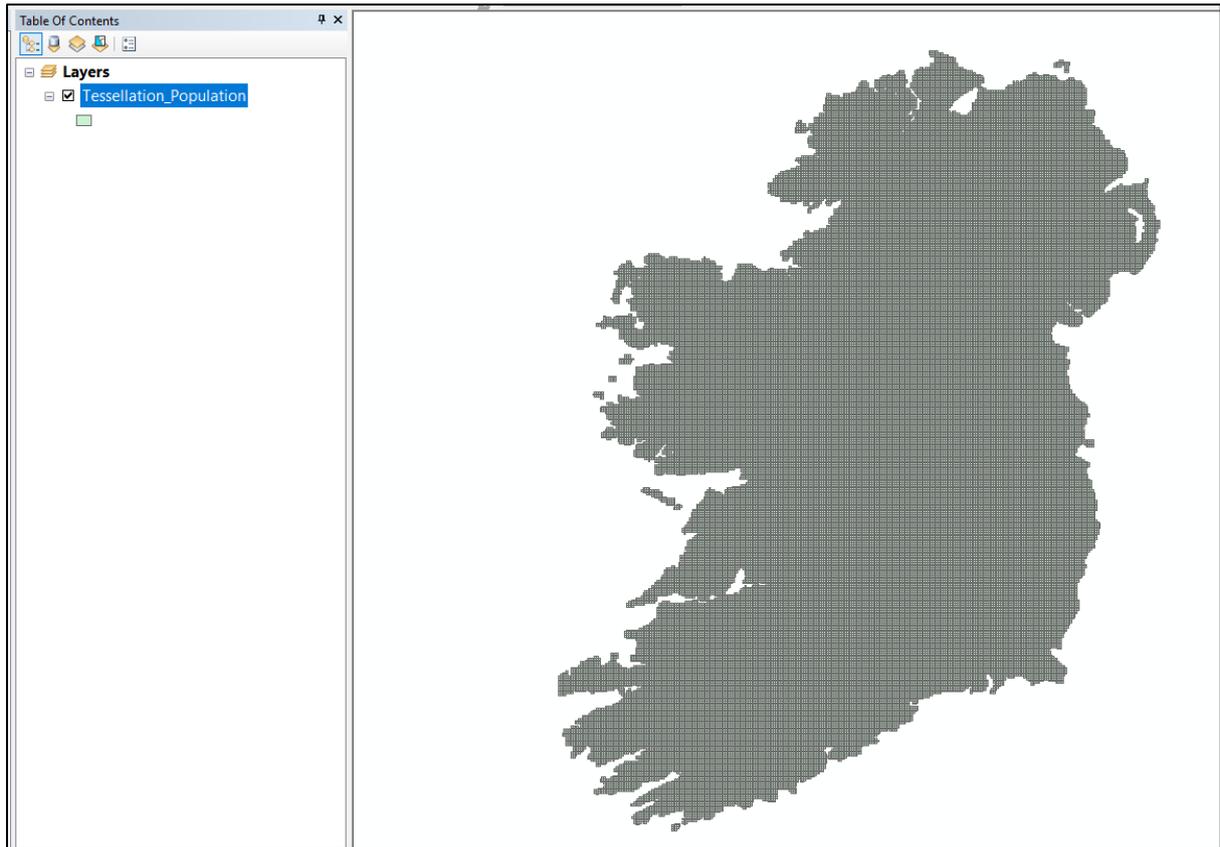
1. First, we need to add our data to ArcMap, right click on “Layers” under the table of contents and select “Add data”:



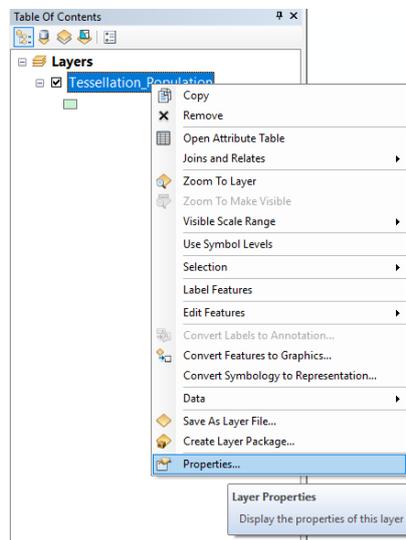
2. Navigate to subfolder 2.1 and add the “Tessellation\_Population.shp” layer:



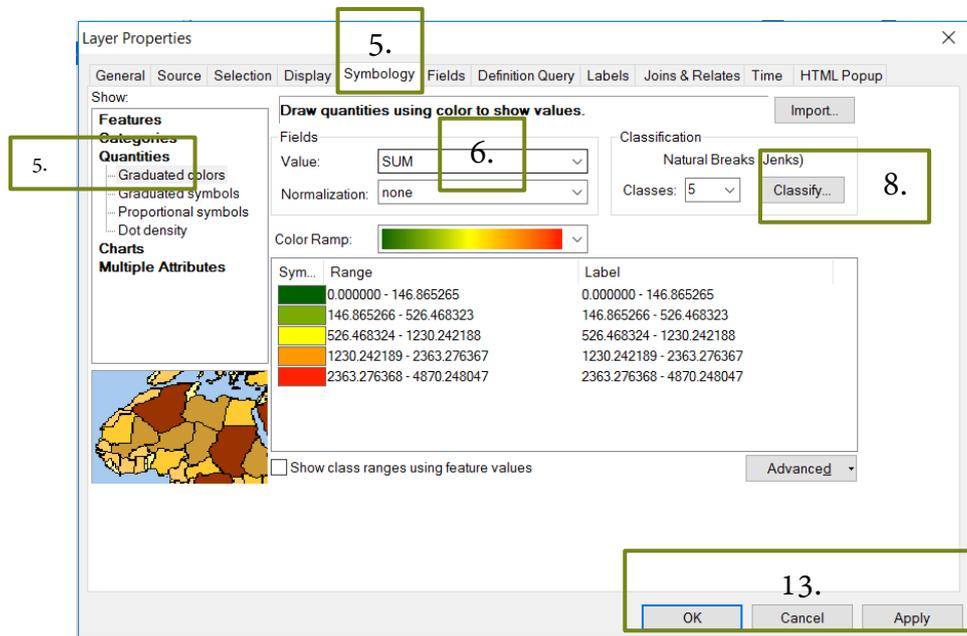
3. This will display the population for the Island of Ireland in ArcMap:



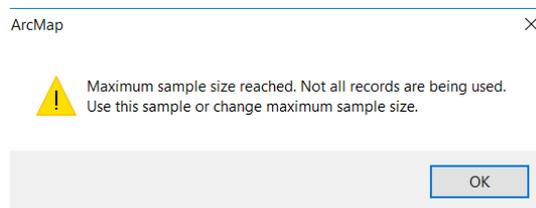
4. First, let's display a standard choropleth map, right click on the Tessellation\_Population layer in the Table of Contents and select "Properties":



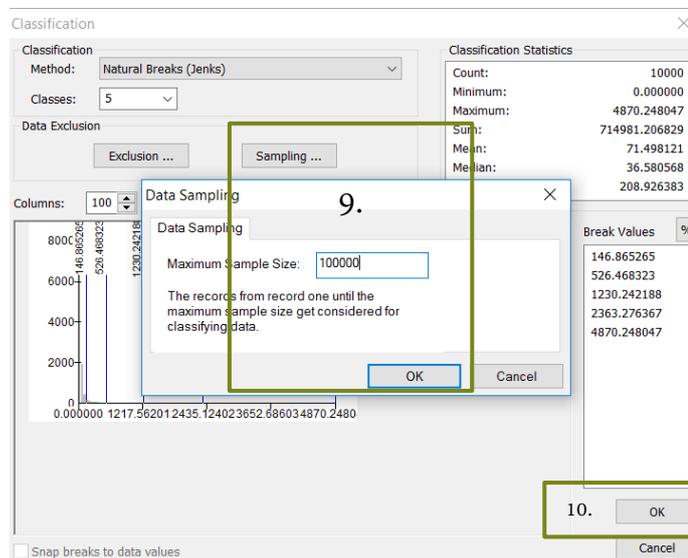
- Click on the **Symbology** tab, and select **Quantities** on the left pane,
- Under the Fields section, select “SUM” from the Value drop down menu, this is the sum of the population in each grid



- You'll be told that the sample size is too large once you do this, for now accept this by clicking OK in the message:

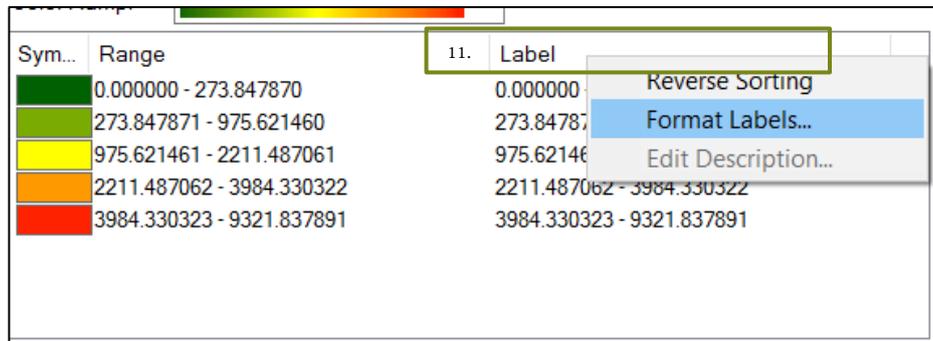


- Click on “Classify...” under the classification section
- Click on “Sampling...” under Data Exclusion and change the Maximum Sample size from 10,000 to 100,000 and click OK:

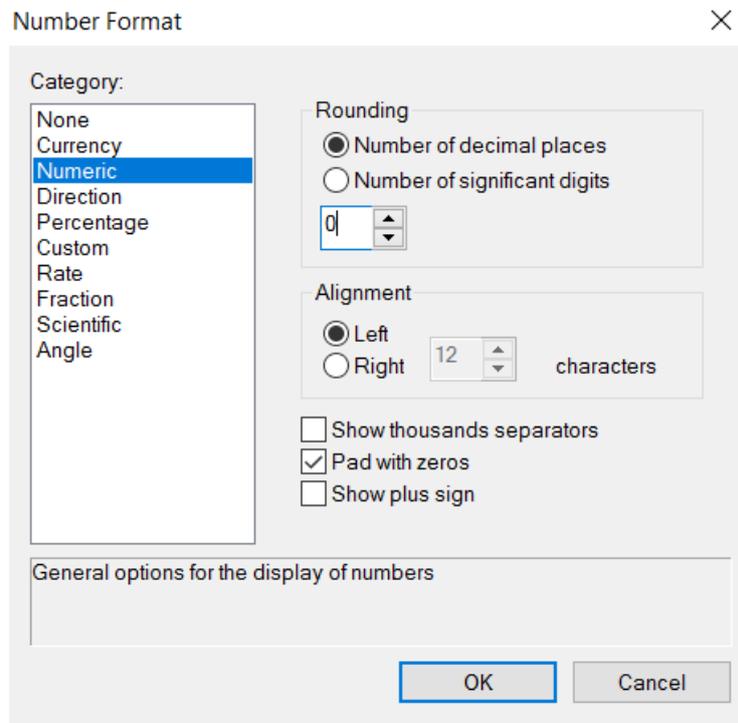


10. Click OK at the bottom left of the Classification screen

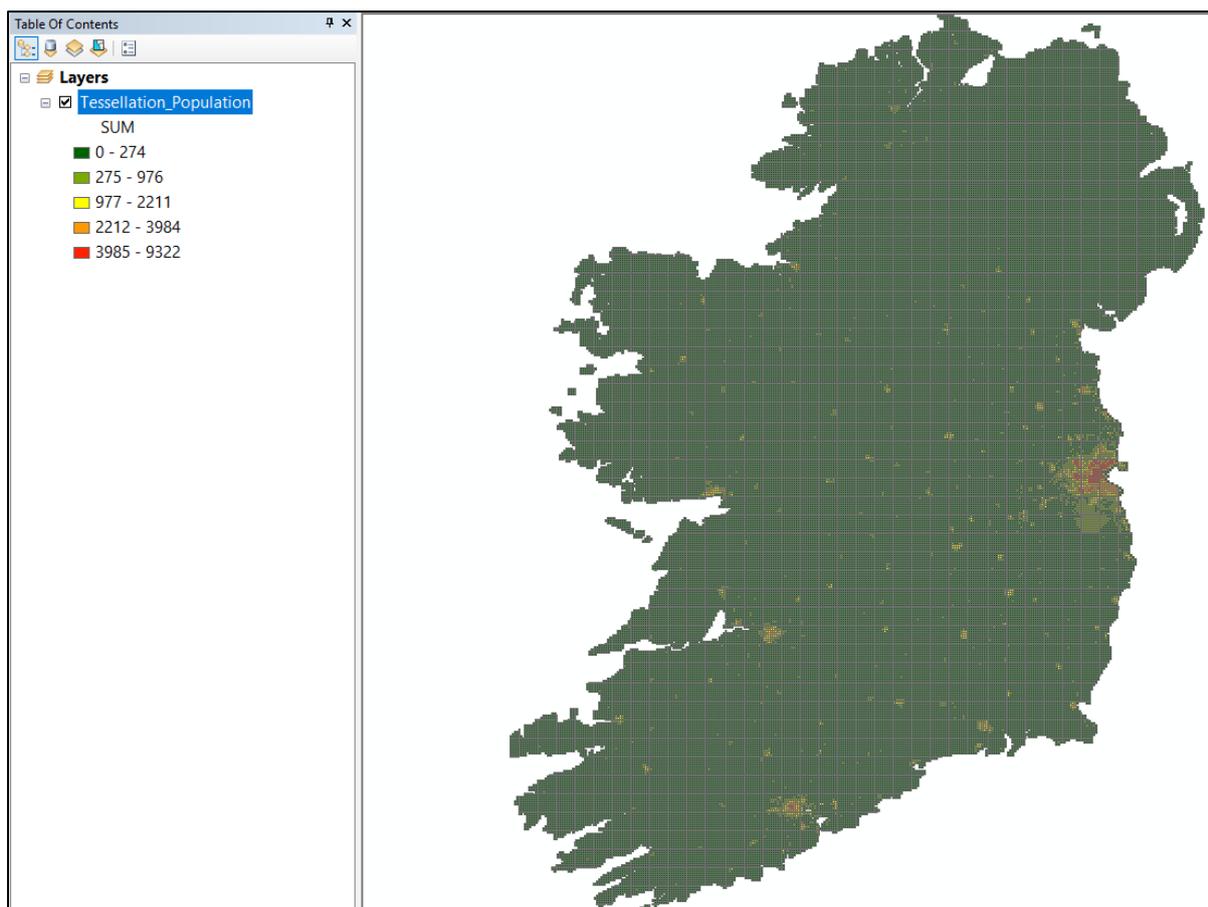
11. Left click on “Label” and select Format Labels:



12. Since Population (like age) is a discrete numerical variable (i.e. not continuous like say height or weight, meaning it has no decimal!) we should remove any decimal place and round to the nearest person:



13. Click OK, at the bottom right of the Symbology tab click “Apply” then click “OK”:



We end up with a fairly depressing-looking Choropleth map! In the example shown, red areas = high population, green areas = low population

#### 2.4.1 Running the Cartogram Tool

Now lets turn this into a more interesting looking cartogram! Open up the cartogram tool

1. For “Original Polygon Features” select “Tessellation\_Population”
2. For “Value Field of the Original Features” select “SUM”
3. **\*\*\*VERY IMPORTANT\*\*\*** for “Output Cartogram Features” Make sure the output file will be written to your USB device and will be placed into the “results.gdb” geodatabase, you can call it what you like (so long as there are no spaces!), in my example I’ve called it “My\_first\_cartogram”
4. Finally click Ok
5. You’ll eventually notice the tool will fail to generate a cartogram as “an area of zero” was found in the dataset – this is a critical point; **the tool cannot handle no data or null data values. So we need to remove values of zero from our dataset (and don’t be disheartened that your first cartogram was a failure, this was deliberate on my part 😊!)**

Make a cartogram Gastner-Newman method

Original Polygon Features

1. Tessellation\_Population

Value Field of the Original Features

2. SUM

Output Cartogram Features

3. D:\Cartogram Contest\1. EsriCartograms\1.1 Cartograms\results.gdb\My\_first\_cartogram

Unique ID Field of Original Features - defaults to OBJECTID or FID (optional)

Area Field of Original Features - defaults to Shape field (optional)

Factor to smooth original density - defaults to 1 (optional)

1

Number of cells in width/height of the Analysis Mesh - defaults to 512 (optional)

512

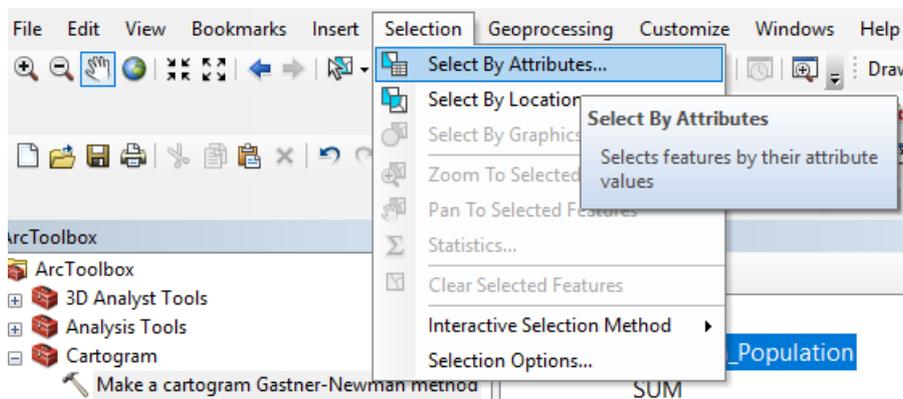
Sum the Values for each repeated ID - default is true. (optional)

Additional Features/Rasters to Transform. (optional)

Additional Dataset	Transformed Dataset Name

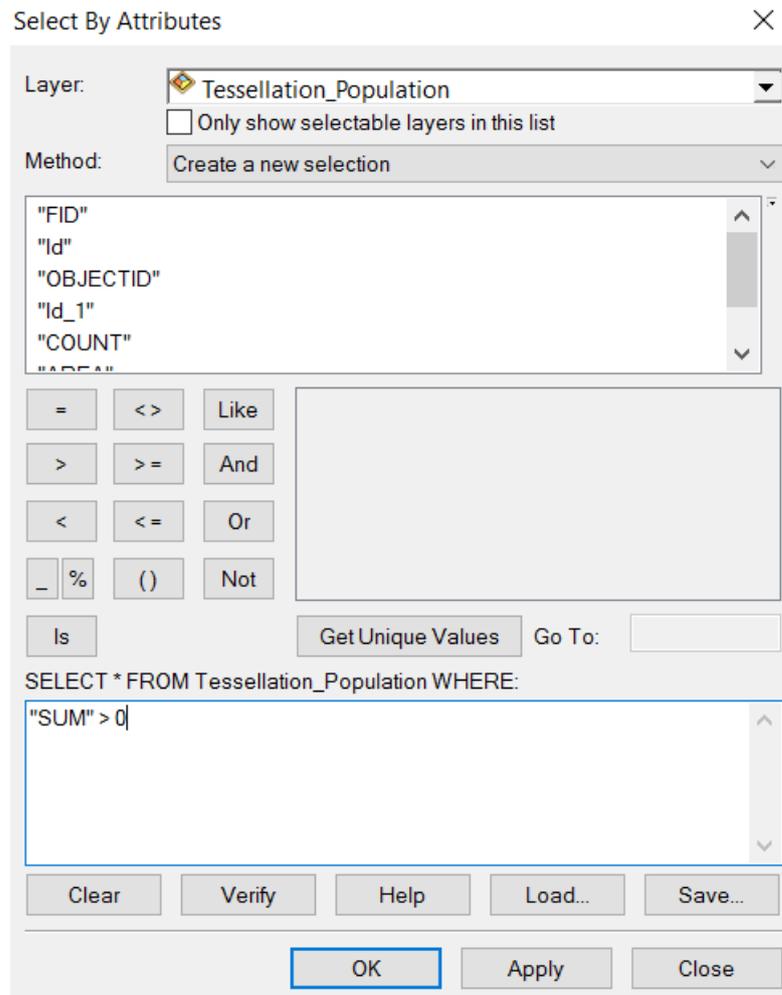
4. OK Cancel Environments... << Hide Help

6. Close the cartogram tool by clicking cancel
7. In ArcMap at the menu bar at the top left click on “Selection” and chose “Select By Attributes...”:

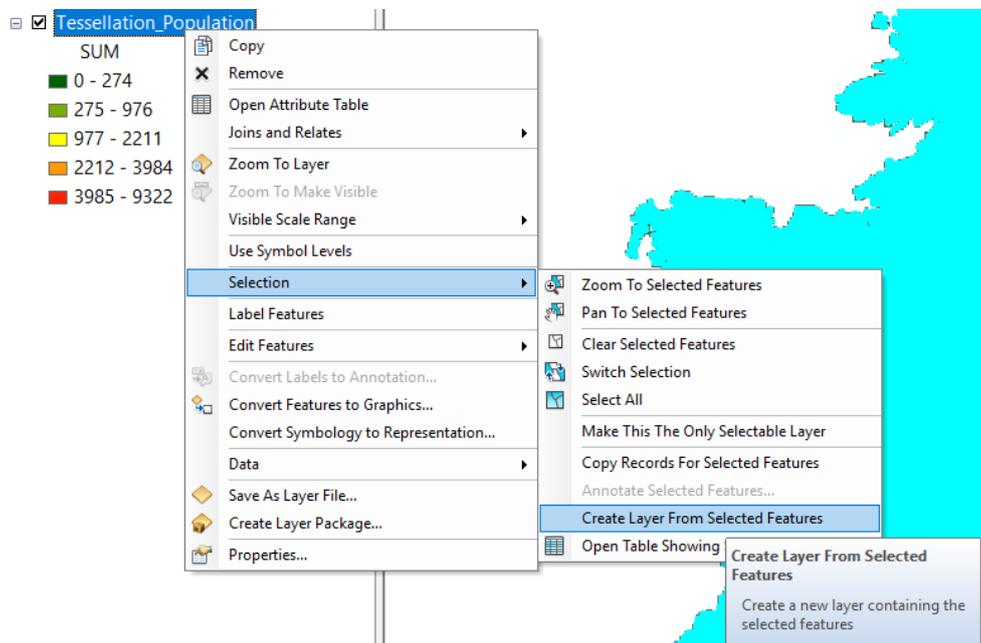


8. In the selection window, enter the criteria:  
“SUM” > 0

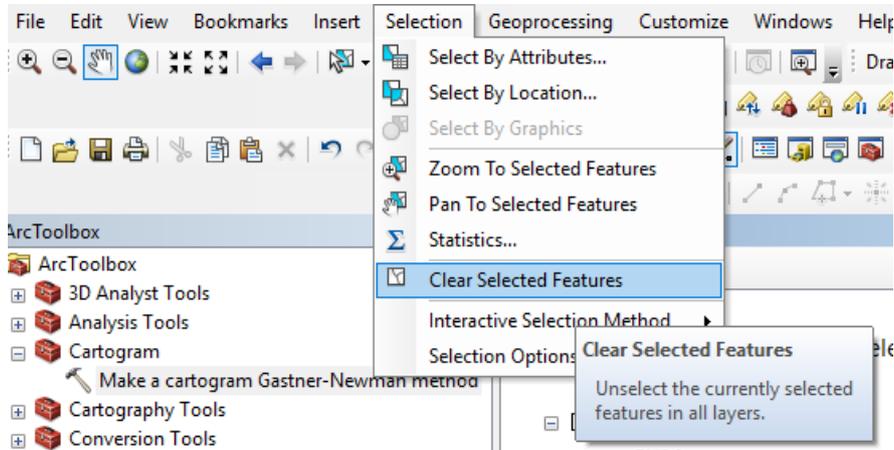
It will look like this:



9. This means ArcMap will select only grids where the population is greater than 0
10. Click OK
11. Now **right click** on Tessellation\_Population in the Table of contents, Under Selection > chose “Create Layer From Selected Features”:



- This will create a new layer called “Tessellation\_Population selection” under the table of contents, on the top menu bar go to “Selection” and chose “Clear Selected Features”:



- Now repeat steps 1-4, make sure you select “Tessellation\_Population selection” as the input feature this time (and remember to check the output file is going to the USB device (I’ve also named it “My\_second\_Cartogram” this time 😊. Finally, don’t worry if the tool takes a long time to run (can take up to 10 minutes with the population data!) just be patient!

 Make a cartogram Gastner-Newman method

Original Polygon Features  
 Tessellation\_Population selection

Value Field of the Original Features  
 SUM

Output Cartogram Features  
 D:\Cartogram Contest\1. EsriCartograms\1.1 Cartograms\results.gdb\My\_Second\_Cartogram

Unique ID Field of Original Features - defaults to OBJECTID or FID (optional)  
 :

Area Field of Original Features - defaults to Shape field (optional)  
 :

Factor to smooth original density - defaults to 1 (optional)  
 1

Number of cells in width/height of the Analysis Mesh - defaults to 512 (optional)  
 512

Sum the Values for each repeated ID - default is true. (optional)

Additional Features/Rasters to Transform. (optional)

Additional Dataset	Transformed Dataset Name

OK Cancel Environments... << Hide Help

## Summary:

For your own Cartogram, you can use any shapefile (e.g. Counties, Electoral Divisions, Small Areas, or in my case, a simple Tessellation!) and base the cartogram on any **numeric data** as long as this is not the size/area of the polygon! If you have any **no-data values** (e.g. a value of 0 or a missing value) you must either **remove** this or **transform** these data (e.g. convert all your 0 values to 1) before you generate a cartogram!

## To run the tool, you only need to specify three things:

1. The original shapefile you're using (a polygon)
2. The value you're using to draw the cartogram (some numeric value in the polygon)
3. Where you want to put the new cartogram (must always be stored in a .gdb file, ideally on your USB device, this way you'll always know where your cartogram is! When naming your cartogram, don't use special characters or spaces!)

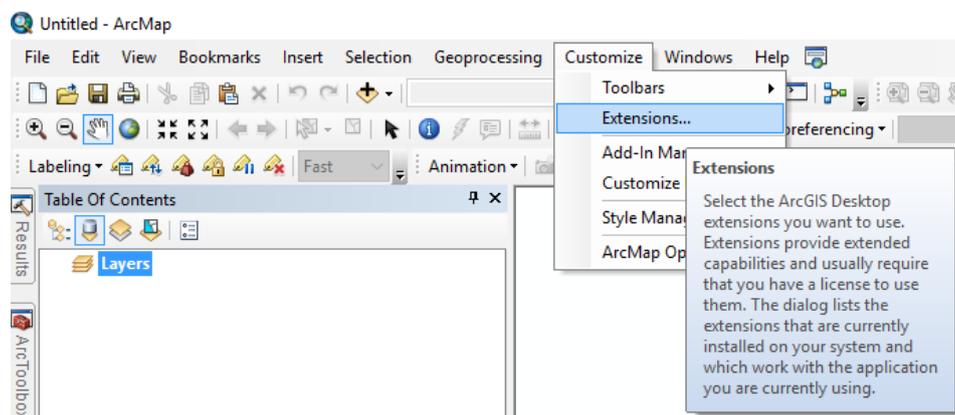
### 3. Zonal Statistics (Cartogram 2)

The purpose of this section is to provide another opportunity for you to generate a cartogram and give you some insights of how to use a blank tessellation with “raw” data. Again, a cartogram stretches areas based on some numeric value other than the size of the area, in this example, we’ll use **zonal statistics** to merge precipitation data with a blank tessellation.

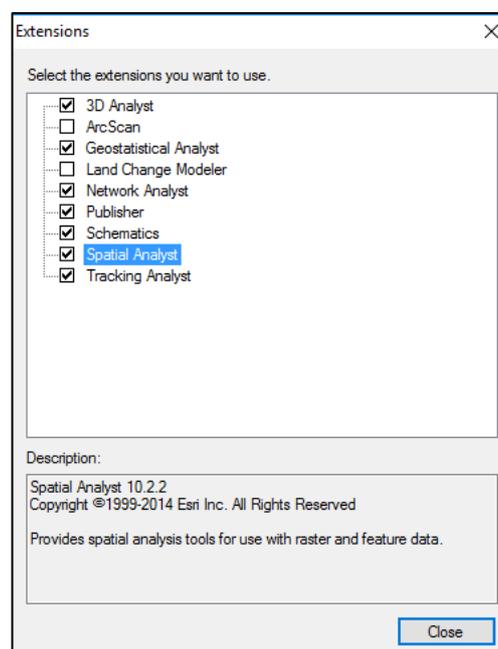
If required, launch ArcMap and follow steps 1-17 in [2.3 Adding the Cartogram Tool to ArcMap](#) to set the default geodatabase to results.gdb under folder 1.1 of your USB device and add the cartogram tool to the ArcToolbox before you continue.

#### 3.1 Enable Spatial Analyst

1. Once you’ve setup ArcMap again, at the top menu, select “Customize” and select “Extensions”:

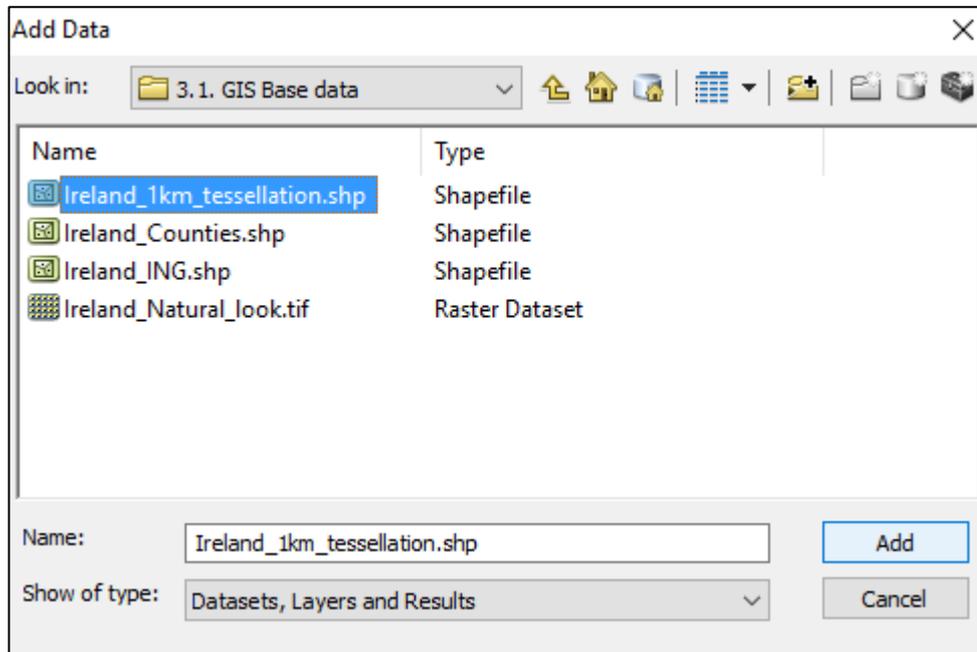


2. Ensure that the spatial Analyst extension is enabled, **this is needed to run the zonal statistics tool!**

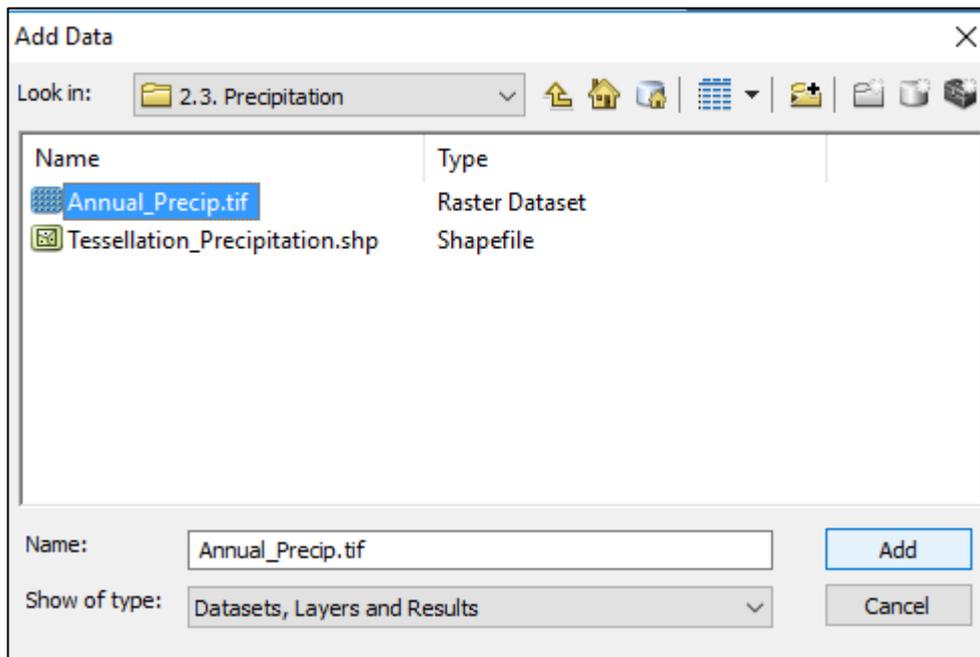


### 3.2 Using the “Blank Tessellation” with Data Example (Zonal Statistics)

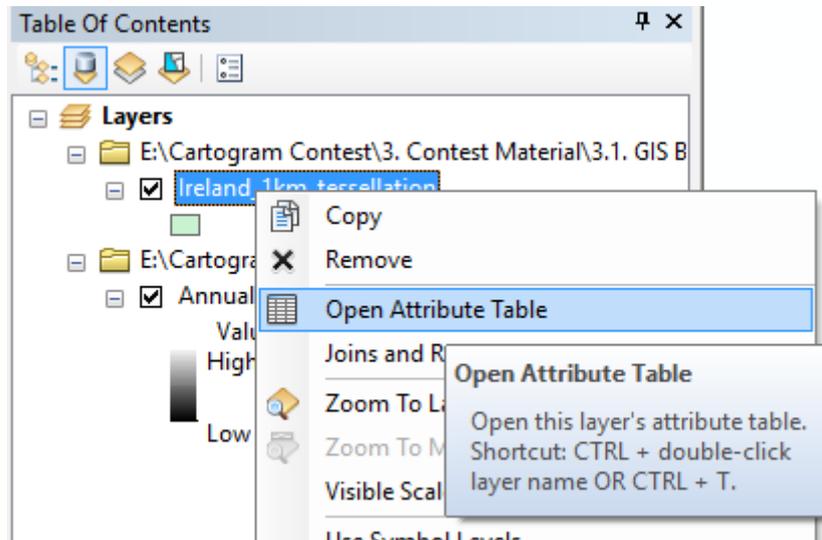
3. Close the extension manager, and add the *Ireland\_1km\_tessellation.shp* polygon under folder 3.1 on your USB:



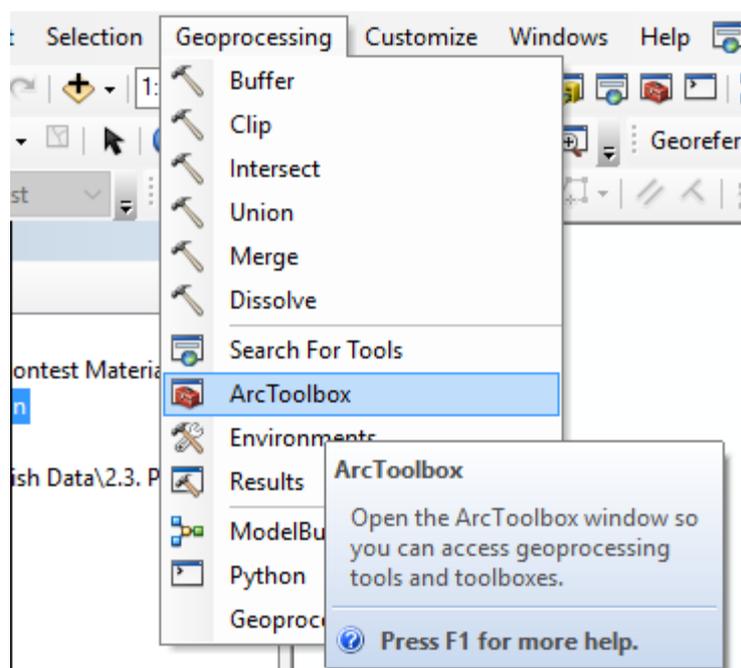
4. Also add the *Annual\_Precip.tif* raster data set under folder 2.3 on your USB:



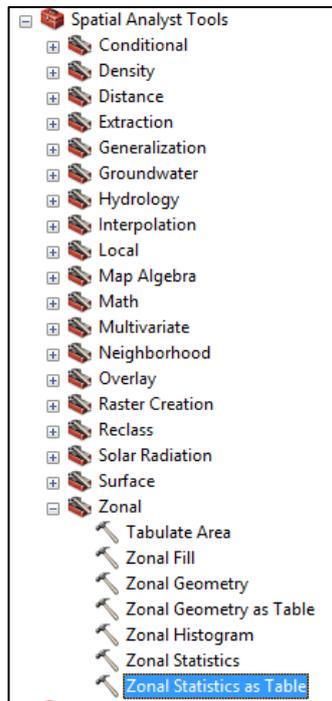
- Left click on Ireland\_1km\_Tessellation under the ArcMap table of contents and hit CTRL + T or right click on it and select “Open attribute table”:



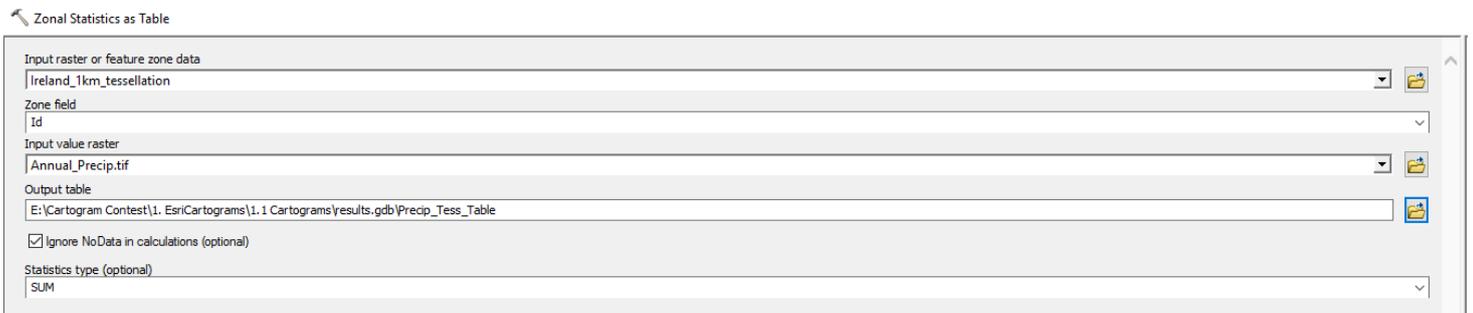
- You'll notice this is a **completely blank tessellation**, it breaks up the island of Ireland into 86,226 1x1 km grids, each grid has a feature id (FID), is identified as a polygon (Shape), and has a unique identifier (ID). Otherwise, **there are no numeric values** we can use to generate a cartogram,
- In my example, I want to generate a cartogram showing the wettest spots in Ireland, so we need to assign annual precipitation accumulations to each grid if we want to make such a cartogram, to do this, we'll use the “Zonal Statistics as Table” tool in the ArcToolbox
- Open the ArcToolbox:



- Expand out the Spatial Analyst Tools, then expand out the Zonal Tools and double click the “Zonal Statistics as Table” tool:

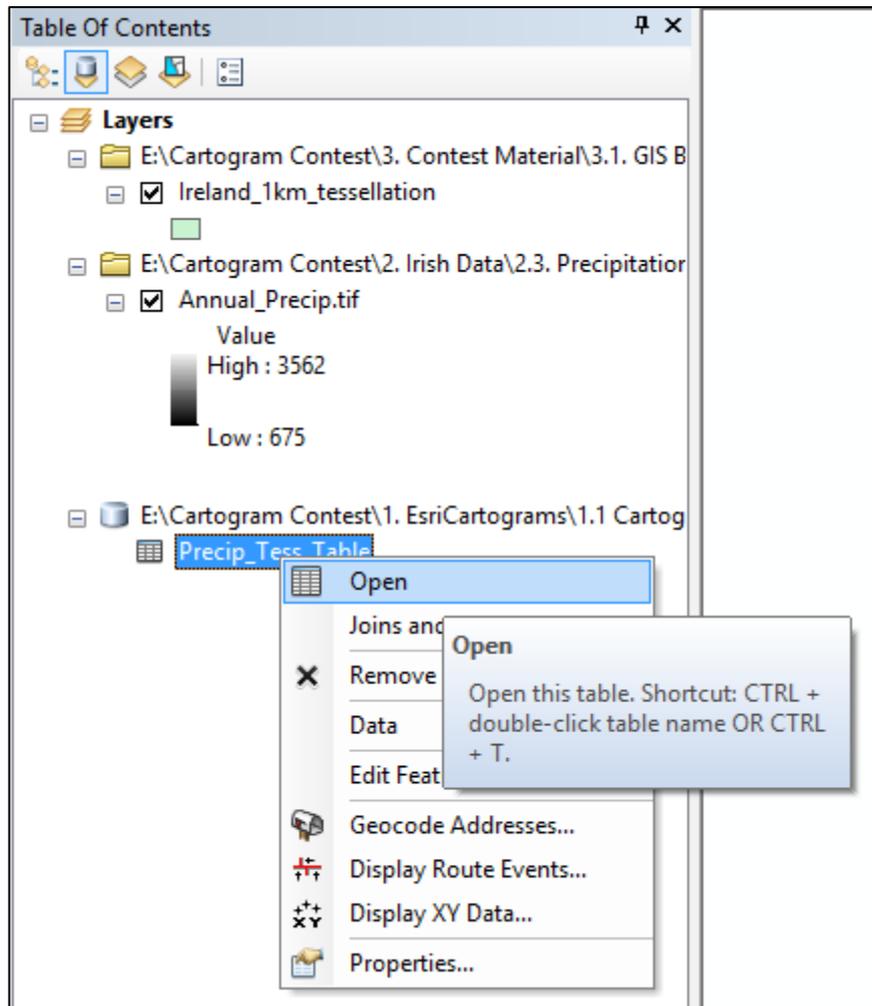


- This tool uses a unique ID of a feature (polygon) to calculate statistics from an underlying raster dataset, in this case, we want to know how much rain falls in each grid of our tessellation:

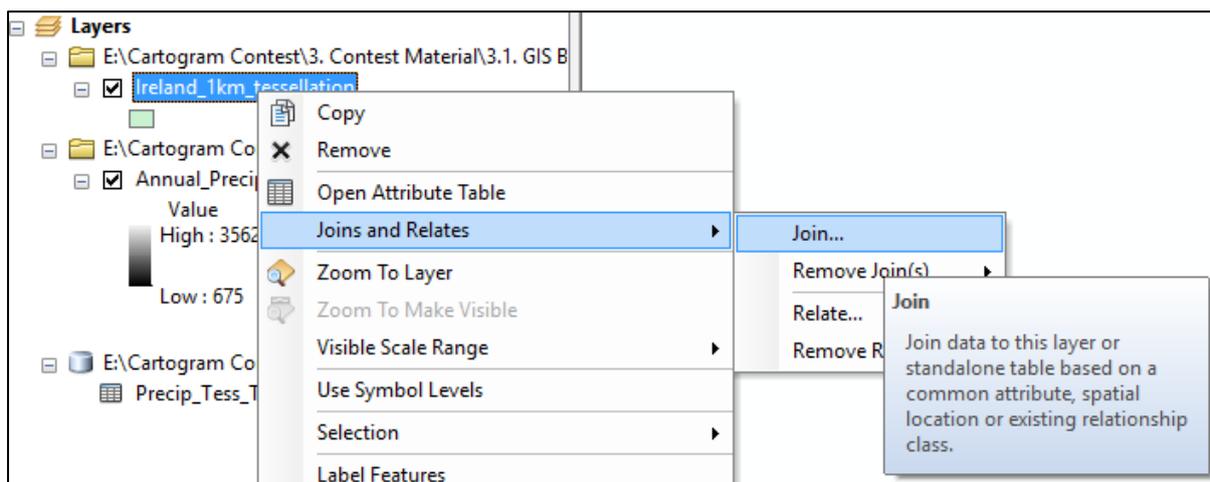


- So here, the polygon that contains our zones (grids) is “Ireland\_1km\_tessellation”, its zone field (unique ID) is ID and the dataset containing the values we want is “Annual\_Precip.tif”. We want to know the total amount of rainfall in each grid, so we want the statistic “SUM” - Make sure your output will be written to your USB Device, in this example I’m naming my output table “Precip\_Tess\_Table”

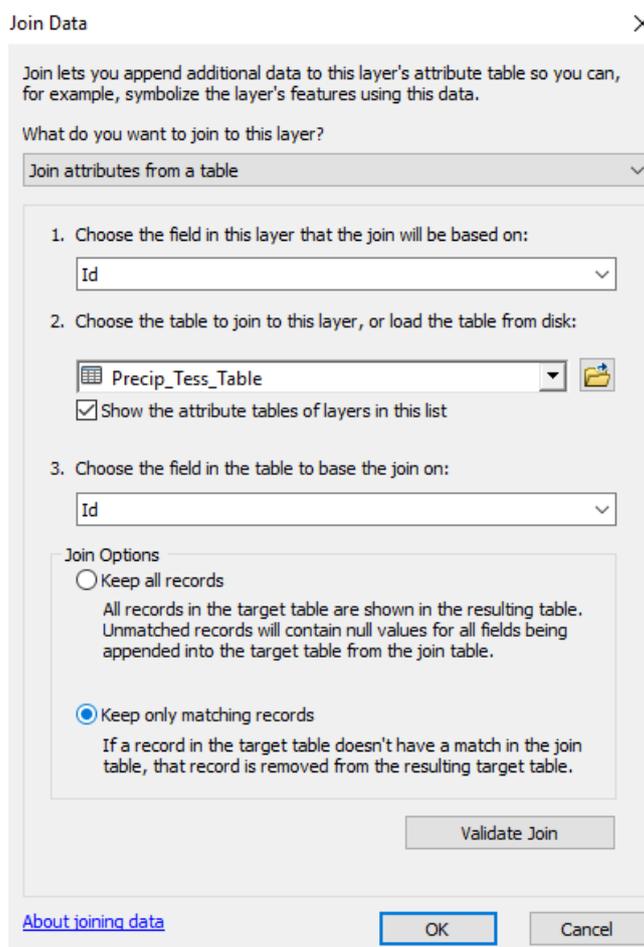
12. Once the tool has run, there should be a new table under table of contents, open this and have a quick look:



13. The object ID is the row id for this new table, the ID is the unique ID from our original tessellation, COUNT tells you how many values were used to calculate the statistics, Area is the area of zone considered and SUM is the annual precipitation accumulation for that zone (grid)
14. NOTE That the ID starts at 4, meaning grids 1-3 received no values, this is because there was no underlying data to calculate a SUM, so these grids were simply omitted from the table!
15. Now we need to join this table to our original blank tessellation
16. Right click on Ireland\_1km\_Tessellation in the ArcMap table of contents and scroll to “Joins and Relates >” and left click “Join”:



17. This will open the join data screen, you want to join attributes from a table to this layer, by default it should detect the only Table available is the table you created, you need to specify how the data will be joined the to feature, we will use the Unique ID number to join the data, also I will select “Keep only matching records” since some grids (step 14.) had no values



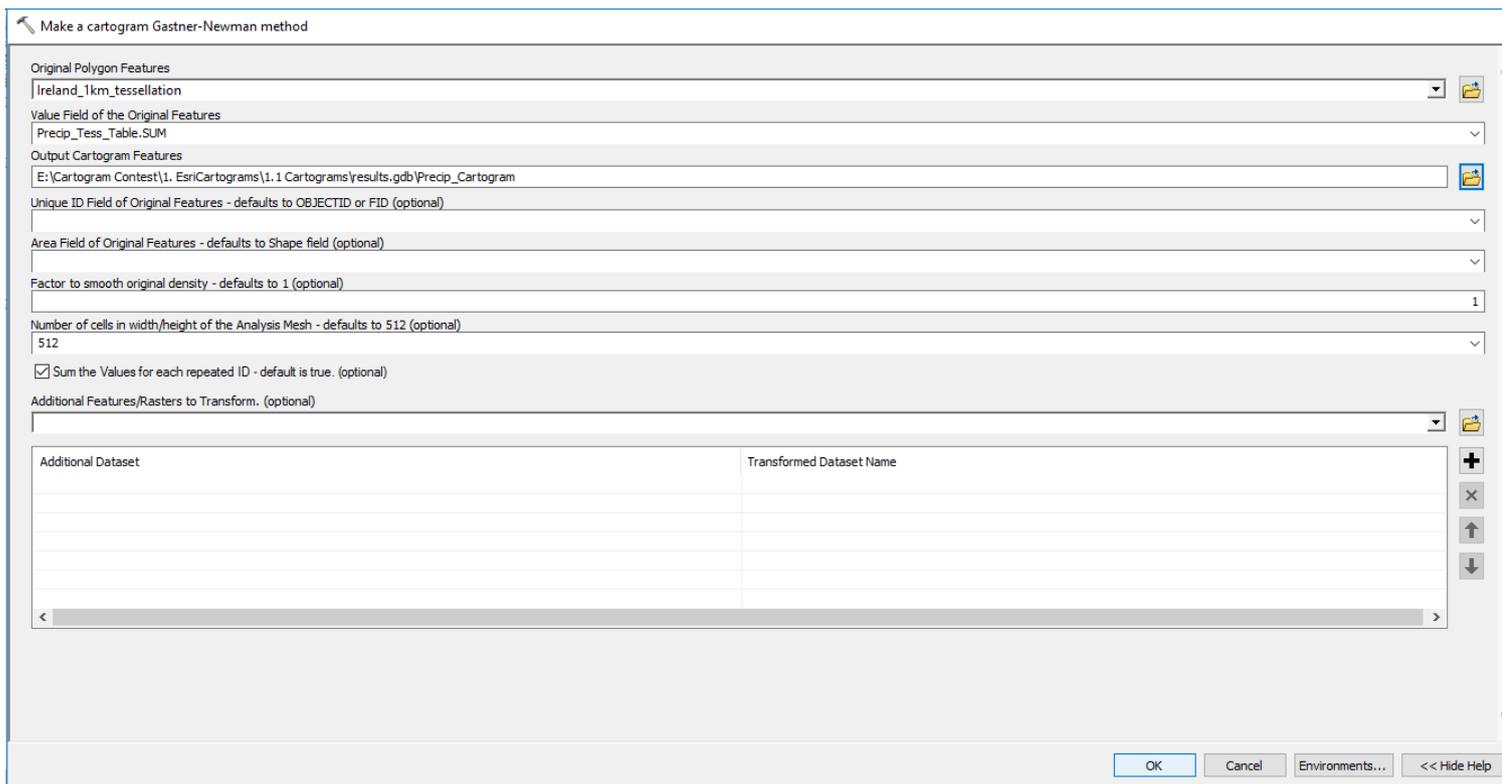
18. Click “OK”

19. Open the attribute table of Ireland\_1km\_Tessellation again, this time you'll notice we have some additional columns:

FID	Shape	Id	OBJECTID*	Id*	COUNT	AREA	SUM
3	Polygon	4	1	4	1	100000	1151.119995
4	Polygon	5	2	5	1	100000	1149
5	Polygon	6	3	6	1	100000	1159
6	Polygon	7	4	7	1	100000	1145.467896
7	Polygon	8	5	8	1	100000	1159.307373
8	Polygon	9	6	9	1	100000	1153.394531
9	Polygon	10	7	10	1	100000	1145
10	Polygon	11	8	11	1	100000	1147
11	Polygon	12	9	12	1	100000	1156.727539
12	Polygon	13	10	13	1	100000	1283
13	Polygon	14	11	14	1	100000	1278.644653
14	Polygon	15	12	15	1	100000	1157.510864
15	Polygon	16	13	16	1	100000	1156.012207
16	Polygon	17	14	17	1	100000	1158.425293
17	Polygon	18	15	18	1	100000	1155.428833
18	Polygon	19	16	19	1	100000	1310
19	Polygon	20	17	20	1	100000	1335
20	Polygon	21	18	21	1	100000	1298
21	Polygon	22	19	22	1	100000	1283
22	Polygon	23	20	23	1	100000	1277.666626
23	Polygon	24	21	24	1	100000	1274
24	Polygon	25	22	25	1	100000	1173.1875
25	Polygon	26	23	26	1	100000	1164
26	Polygon	27	24	27	1	100000	1160.767456
27	Polygon	28	25	28	1	100000	1312.916626
28	Polygon	29	26	29	1	100000	1316
29	Polygon	30	27	30	1	100000	1314
30	Polygon	31	28	31	1	100000	1308
31	Polygon	32	29	32	1	100000	1301

20. Now each grid has an additional numeric value which we can use to generate a cartogram! Also note this time we only have 86,152 grids (from the original 86,226) as we've removed areas with 0 or null values!

21. Run the cartogram tool again (steps 1-4 under section "[2.4.1 Running the Cartogram Tool](#)"):



22. Again, be patient, this can take some time to run! For my USB Stick (which is quite old) it took about 10 minutes to finish writing the cartogram and displaying it in ArcMap!



23. Above is my resulting cartogram, I've also recoloured it using steps 1-13 in section 2.4 [Generating a Cartogram](#) You can zoom in with your PDF viewer to have a closer look, but you should notice even at this size that the SW, W and NW of the country have become bigger than our original blank tessellation!

#### 4. Exporting your Cartogram (Cartogram 3)

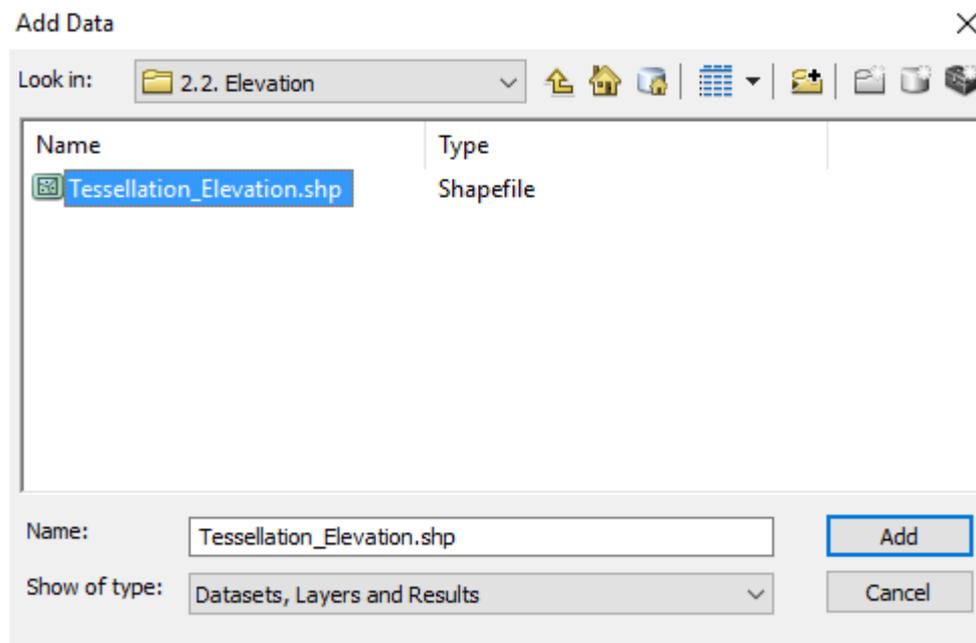
In this section, we'll generate one more cartogram to make sure you're completely familiar with the tool, and then we'll export our cartogram as a nice image file, ready to be entered into the competition!

If required, launch ArcMap and follow steps 1-17 in [2.3 Adding the Cartogram Tool to ArcMap](#) to set the default geodatabase to results.gdb under folder 1.1 of your USB device and add the cartogram tool to the ArcToolbox before you continue.

#### 4.1 Adding the elevation data and transforming 0 values

We will follow the same workflow as Cartograms 1 and 2, however since the raw elevation data file was too large to include in the digital package, I've already used zonal statistics to assign elevation values to each grid for you!

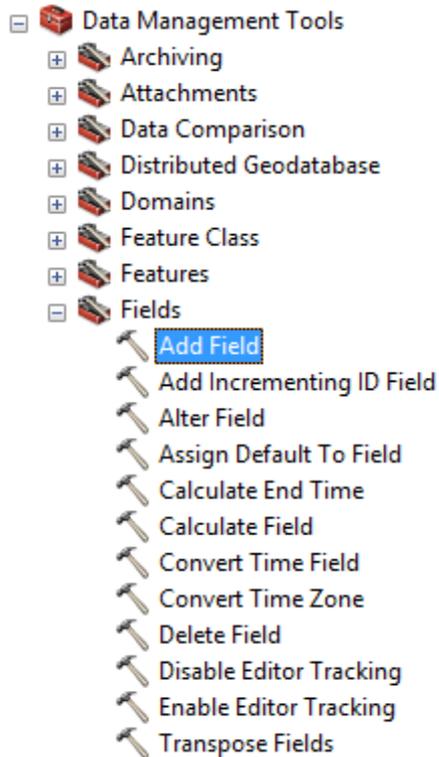
1. Add the *Tessellation\_Elevation.shp* polygon to ArcMap which is located under folder 2.2. on your USB device



2. While I've used zonal statistics and joined the data, I **did not remove** any values of 0, you can follow steps 7-13 under section [21](#) to select grids with values greater than 0 and then create a new layer from this selection, however another option you may want to consider would be to "transform" values of 0 to something else so we can run the cartogram tool.

## 4.2 Transforming to Non-Zero Values Example (Add Field, Field Calculator)

- Open the ArcToolbox, expand “Data Management Tools”, expand “Fields” and select the “Add Field” tool:

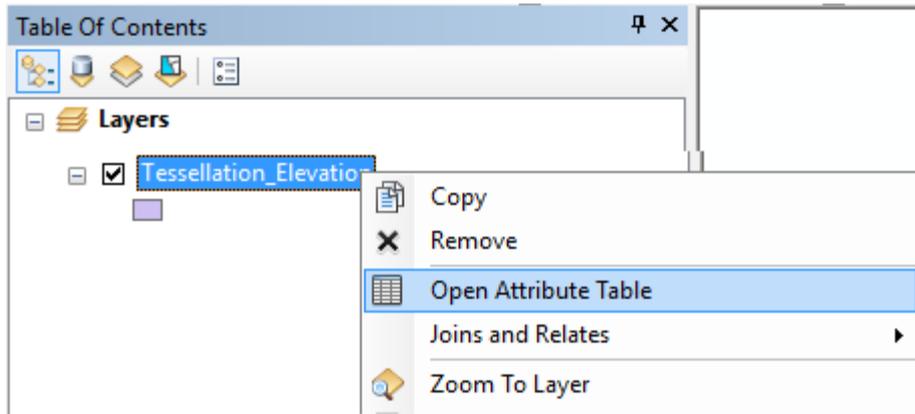


- We will add a new field to our tessellation called “Transform” this field will eventually contain the values used to generate our cartogram:

 Add Field

Input Table	Tessellation_Elevation
Field Name	Transform
Field Type	LONG

- Click OK
- Once the tool has finished open the attribute table of Tessellation\_Elevation:



7. You should notice the new field you created:

Table

Tessellation\_Elevation

FID	Shape *	Id	OBJECTID	Id_1	COUNT	AREA	MEAN	Transform
0	Polygon	1	1	1	275	247500	17.90875	0
1	Polygon	2	2	2	726	653400	27.39265	0
2	Polygon	3	3	3	142	127800	86.415009	0
3	Polygon	4	4	4	441	396900	32.038925	0
4	Polygon	5	5	5	1156	104040	37.440148	0
5	Polygon	6	6	6	1098	988200	89.91419	0
6	Polygon	7	7	7	449	404100	23.358791	0
7	Polygon	8	8	8	2	1800	15.492374	0
8	Polygon	9	9	9	320	288000	30.078114	0
9	Polygon	10	10	10	911	819900	54.105639	0
10	Polygon	11	11	11	1050	945000	61.369379	0
11	Polygon	12	12	12	164	147600	21.629018	0

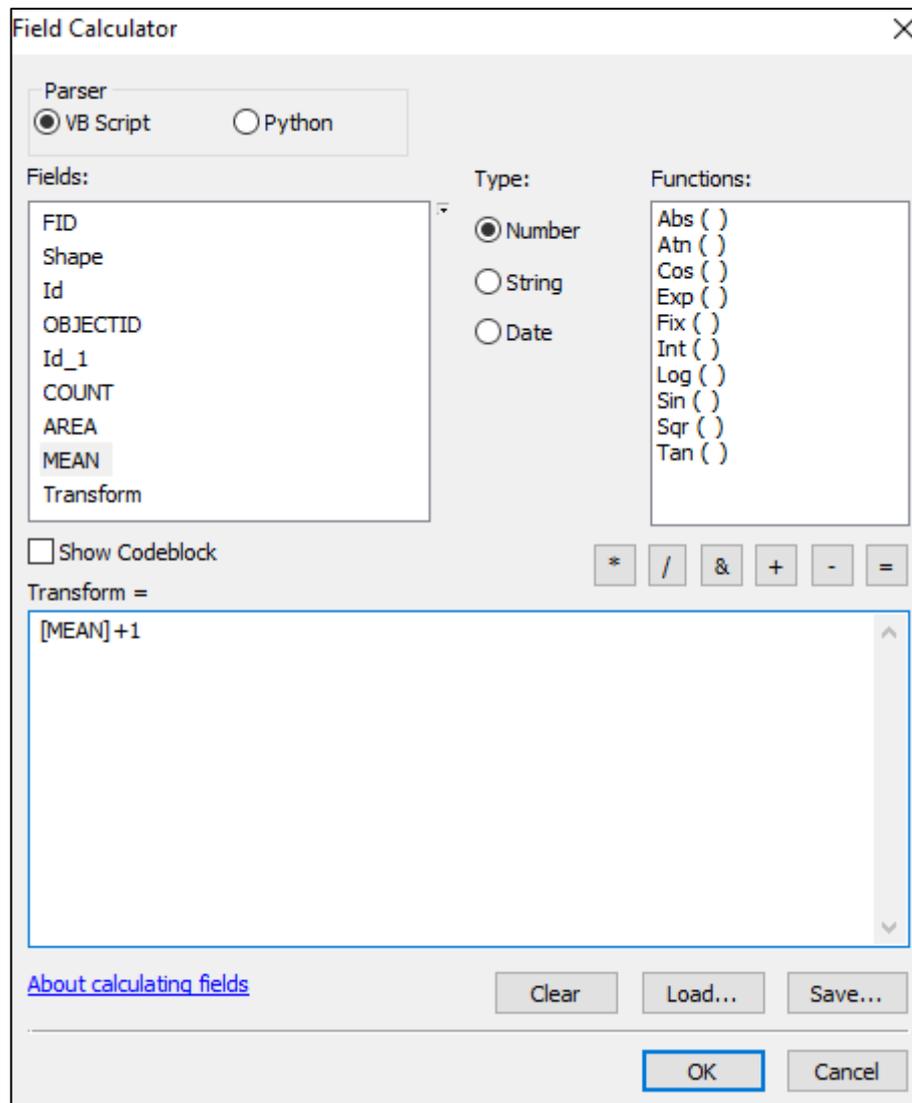
8. Right click on the column header “Transform” and select “Field Calculator”:

Table

Tessellation\_Elevation

FID	Shape *	Id	OBJECTID	Id_1	COUNT	AREA	MEAN	Trans
0	Polygon	1	1	1	275	247500	17.90875	
1	Polygon	2	2	2	726	653400	27.39265	
2	Polygon	3	3	3	142	127800	86.415009	
3	Polygon	4	4	4	441	396900	32.038925	
4	Polygon	5	5	5	1156	104040	37.440148	
5	Polygon	6	6	6	1098	988200	89.91419	
6	Polygon	7	7	7	449	404100	23.358791	
7	Polygon	8	8	8	2	1800	15.492374	
8	Polygon	9	9	9	320	288000	30.078114	
9	Polygon	10	10	10	911	819900	54.105639	
10	Polygon	11	11	11	1050	945000	61.369379	
11	Polygon	12	12	12	164	147600	21.629018	
12	Polygon	13	13	13	122	109800	77.87902	
13	Polygon	14	14	14	17	15300	99.320295	
14	Polygon	15	15	15	31	27900	10.836024	
15	Polygon	16	16	16	381	342900	11.7824	
16	Polygon	17	17	17	225	202500	0.622526	0
17	Polygon	18	18	18	35	31500	0.224057	0

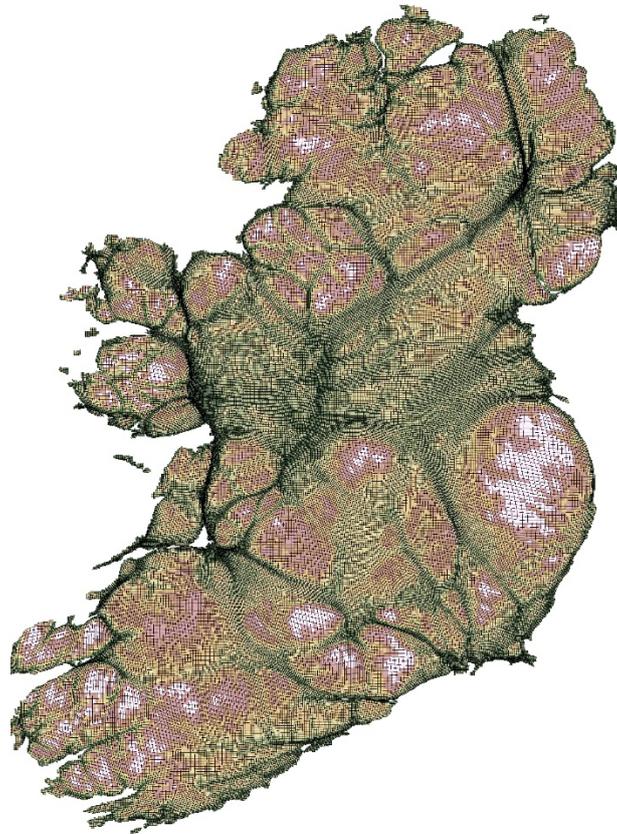
9. To transform our elevation values (Which are contained in the column entitled “MEAN”, we will simply add a value of 1 to every grid, thus removing zero values, NB you can double click on MEAN under the “Fields:” to add it to your transformation or you can simply type MEAN into the transformation formula, but you must place it in square brackets i.e. [MEAN]



10. Click OK, this might take a little while to run
11. Now in our Transform field, we have numeric values, all greater than 0 that we can use to generate our cartogram!
12. Run the Cartogram Tool using the Transform field as the numeric value ([20](#)):

Make a cartogram Gastner-Newman method	
Original Polygon Features	Tessellation_Elevation
Value Field of the Original Features	Transform
Output Cartogram Features	E:\Cartogram Contest\1. EsriCartograms\1.1 Cartograms\results.gdb\Elevation_Cartogram

13. Again, **be patient!** This took 8-10 minutes to finish writing the cartogram to my USB device !:

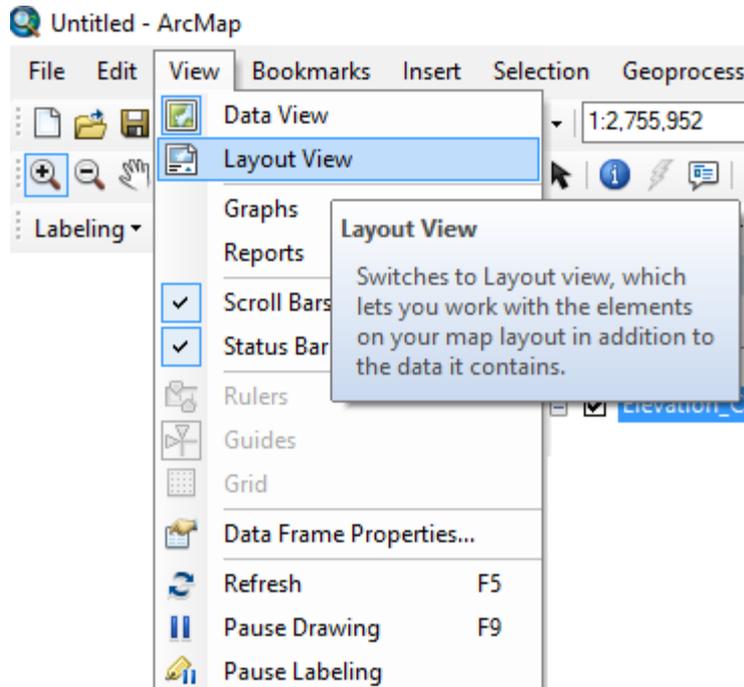


14. Above is my resulting cartogram, I've also recoloured it using steps 1-13 in section 2.4 [Generating a Cartogram](#) You can zoom in with your PDF viewer to have a closer look, but you should notice even at this size all the main topographic features of the country have become more exaggerated than our original blank tessellation! This also illustrates the “Bowl” effect around the midlands

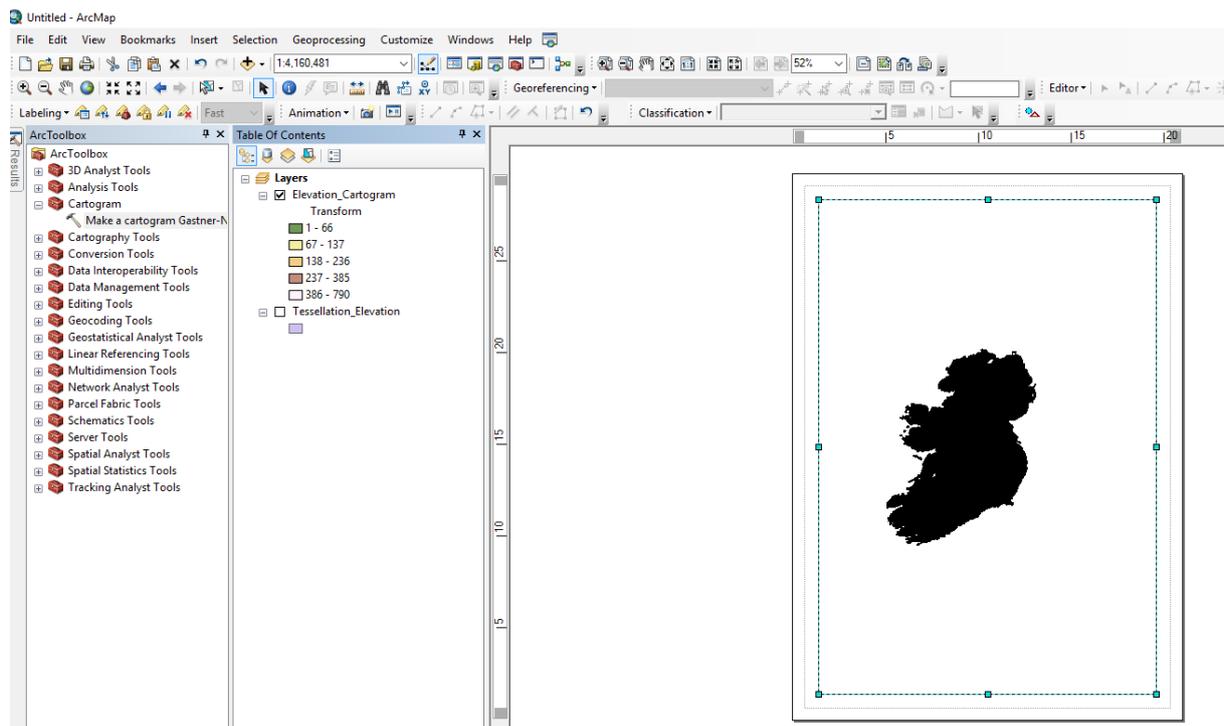
## 4.3 Exporting a Map

Once you've generated your cartogram and coloured it how you want (recall steps 1-13 in section 2.4 [Generating a Cartogram](#)) you can now export the map so it can be included in the contest.

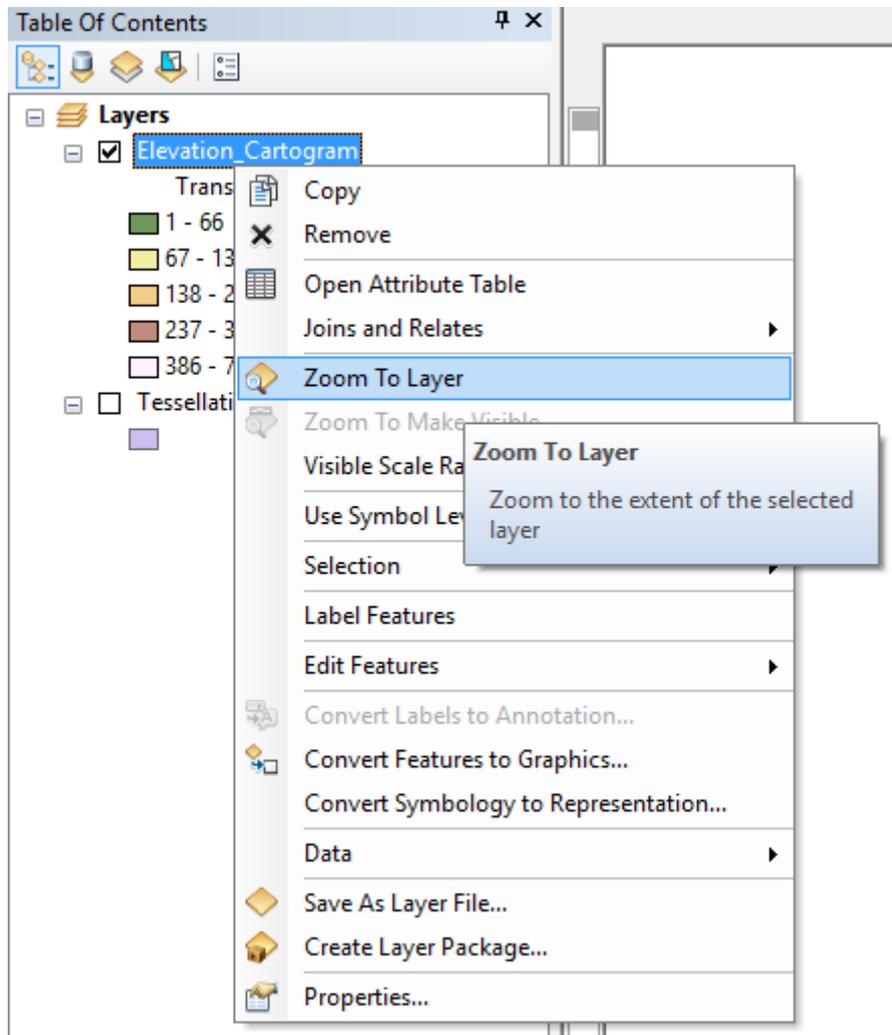
1. On the top menu bar of ArcMap select "View" and chose "Layout View":



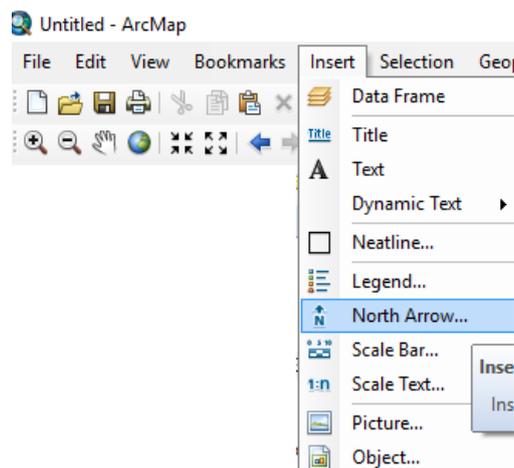
2. This will switch ArcMap to a layout (similar to "print preview") view of the map:

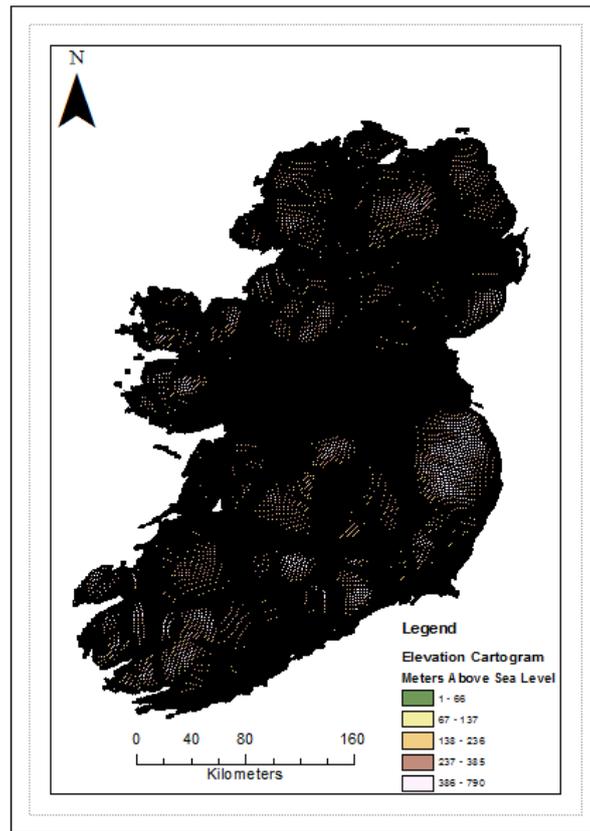


3. Firstly, it's always a good idea to zoom in and centre you map, an easy way to do this is to right click on your cartogram in the ArcMap Table of Contents and select "Zoom to Layer":



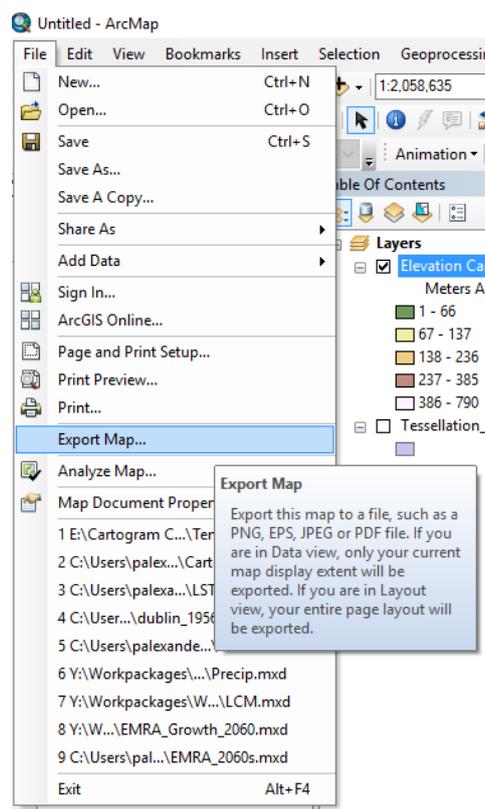
4. Don't worry too much if you think you cannot make out details of the cartogram at this stage, as the map **will look different once exported**.
5. Optionally, you can insert a North Arrow, Scale Bar etc. using the insert options located at the top menu bar:



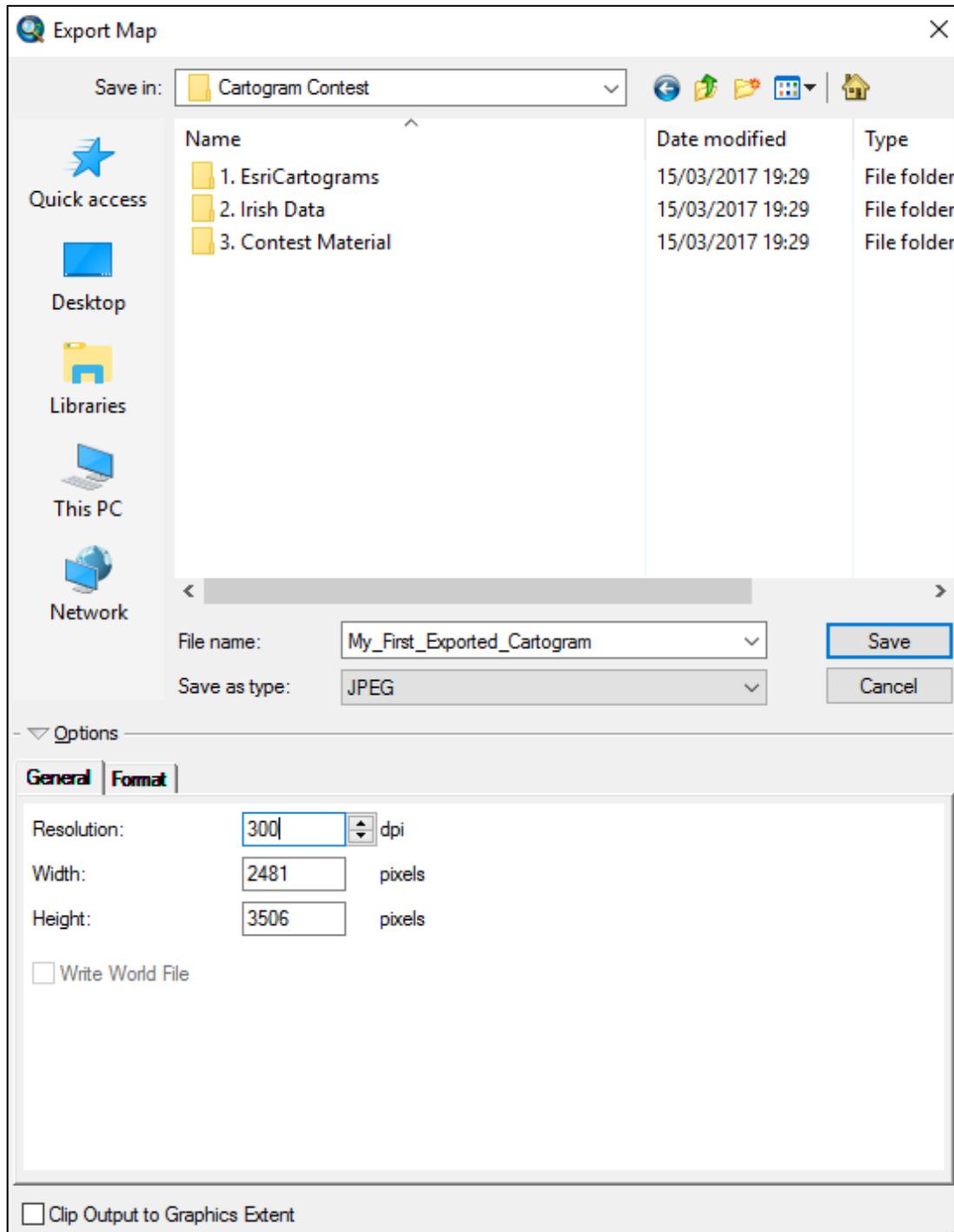


In the layout view I've added a North arrow, Scale Bar and Legend for my Cartogram (these elements are optional, but generally recommended for maps 😊)

6. Once you're happy with how everything looks in Layout view, you can now export the map by click File > Export Map in the top menu bar of ArcMap:

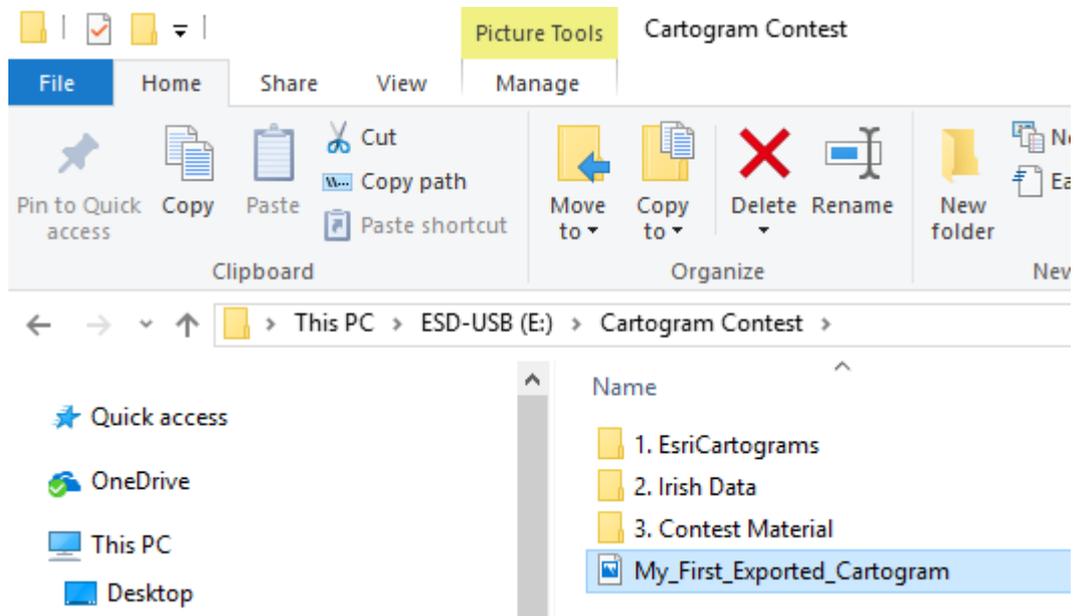


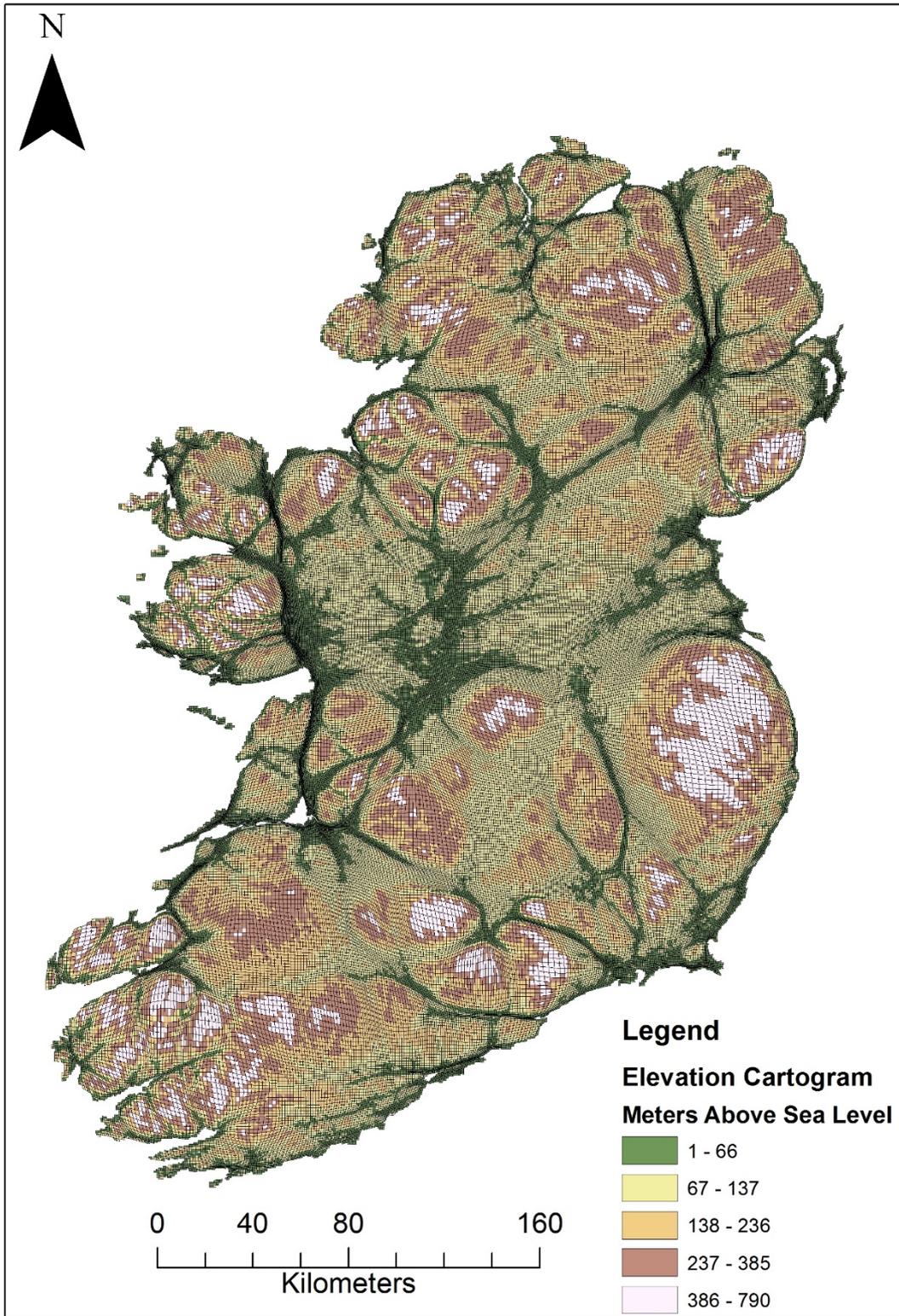
- This will open the export map screen, you should export your map to you USB Device, the map should be JPEG and minimum resolution of 300 dots per inch (DPI) In the example below, I've named my name "My\_First\_Exported\_Cartogram", of course you should name your name something a bit more unique 😊



- When ready click save

9. Navigate to your USB device in WINDOWS and check to see if the file was successfully exported, open the file with an image viewer to see how it turned out!





10. Once you're happy, email your Cartogram JPEG and a description of it (300 words or less) to [paul.alexander@ucc.ie](mailto:paul.alexander@ucc.ie)
11. You'll receive back a PDF of the final product to approve within 1 working day, once you approve this, it will be entered into the contest!