NYU DataServices

Introduction to Quantum GIS (QGIS)

Introduction

In this workshop, you will go through the process of finding publicly available data, cleaning it, using Quantum GIS (QGIS) to visualize this data on a presentable map, and exploring spatial patterns that can inform and enrich your study of the world.

QGIS is the most prominent and user-friendly open-source GIS platform in use today. Our workshop will only scratch the surface of what it can do, but it will hopefully provide you with a solid foundation for further exploration.

We will begin by exploring the World Bank Development Indicators, which is a rich source of country-level socioeconomic data. This data series is used extensively in published academic research from a variety of fields. While this data is provided in tabular form by the World Bank, visualizing country-level social and economic data on a map can allow us to identify patterns in the data that might otherwise be obscured.

In the following exercise, we will go through the following process:

1. Downloading tabular data from the World Bank Development Indicators website
2. Cleaning the data (CSV) to make it usable
3. Joining this data to a GIS layer of country boundaries
4. Displaying the data on a map
5. Exporting the map for future use.

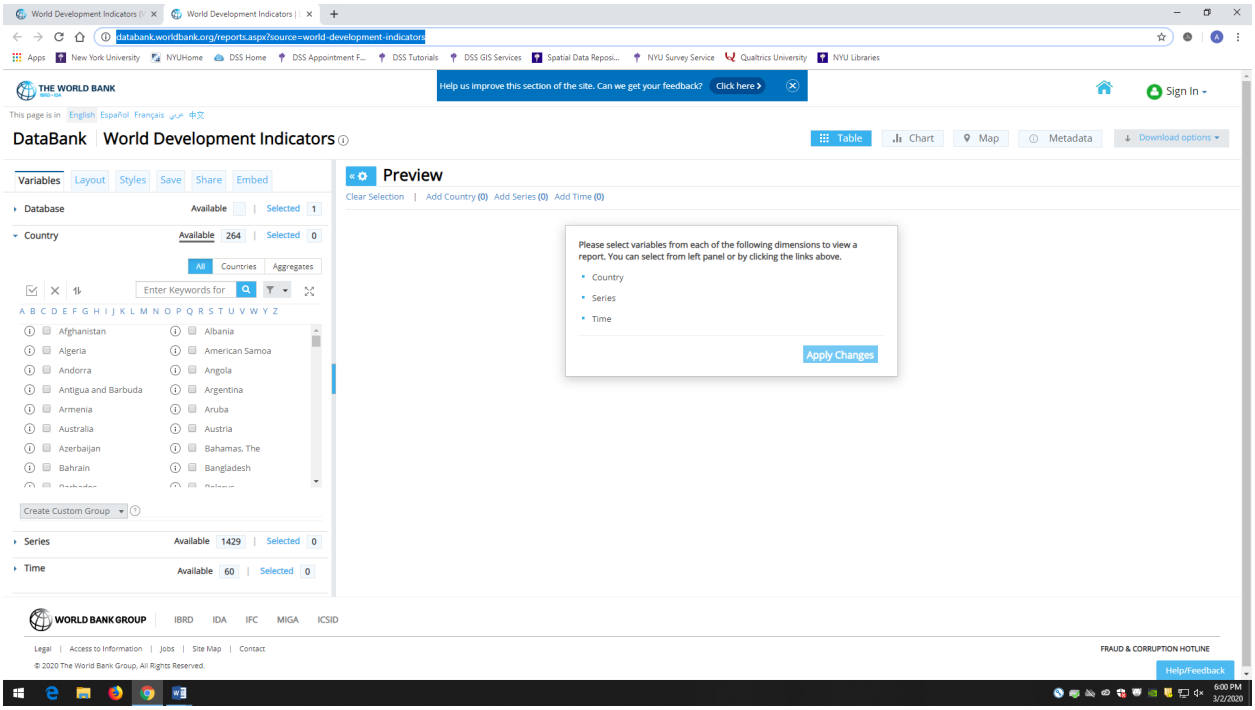
Our aim is to familiarize you with the QGIS interface so that you are able to conduct basic GIS analysis while engaging with the process of asking and answering spatial questions.

Step One: Downloading Tabular Data from the World Bank Development Indicators Website

The data can be found at this website:

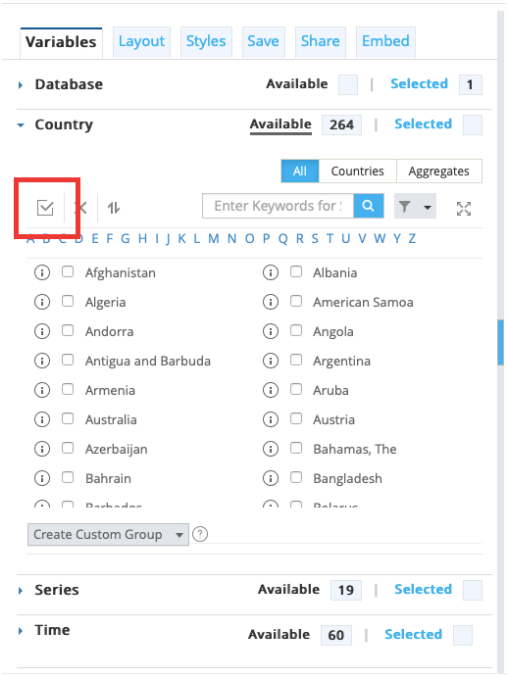
https://databank.worldbank.org/reports.aspx?source=world-development-indicators

It looks like this:

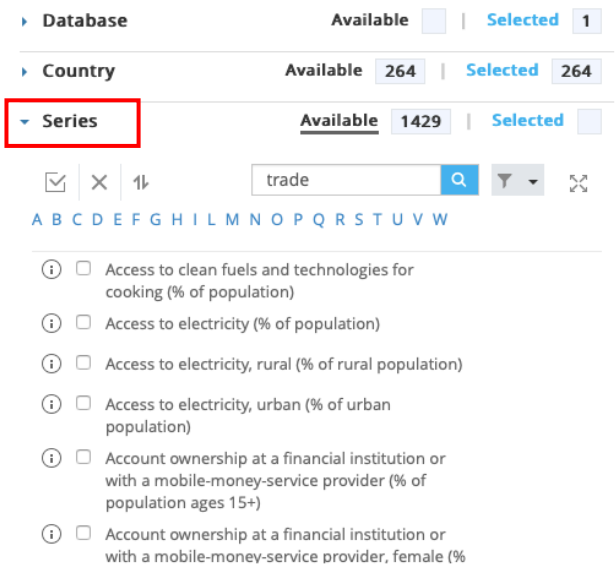


Before downloading data, you will need to select the country, series (i.e. variable of interest), and time period that you are interested in.

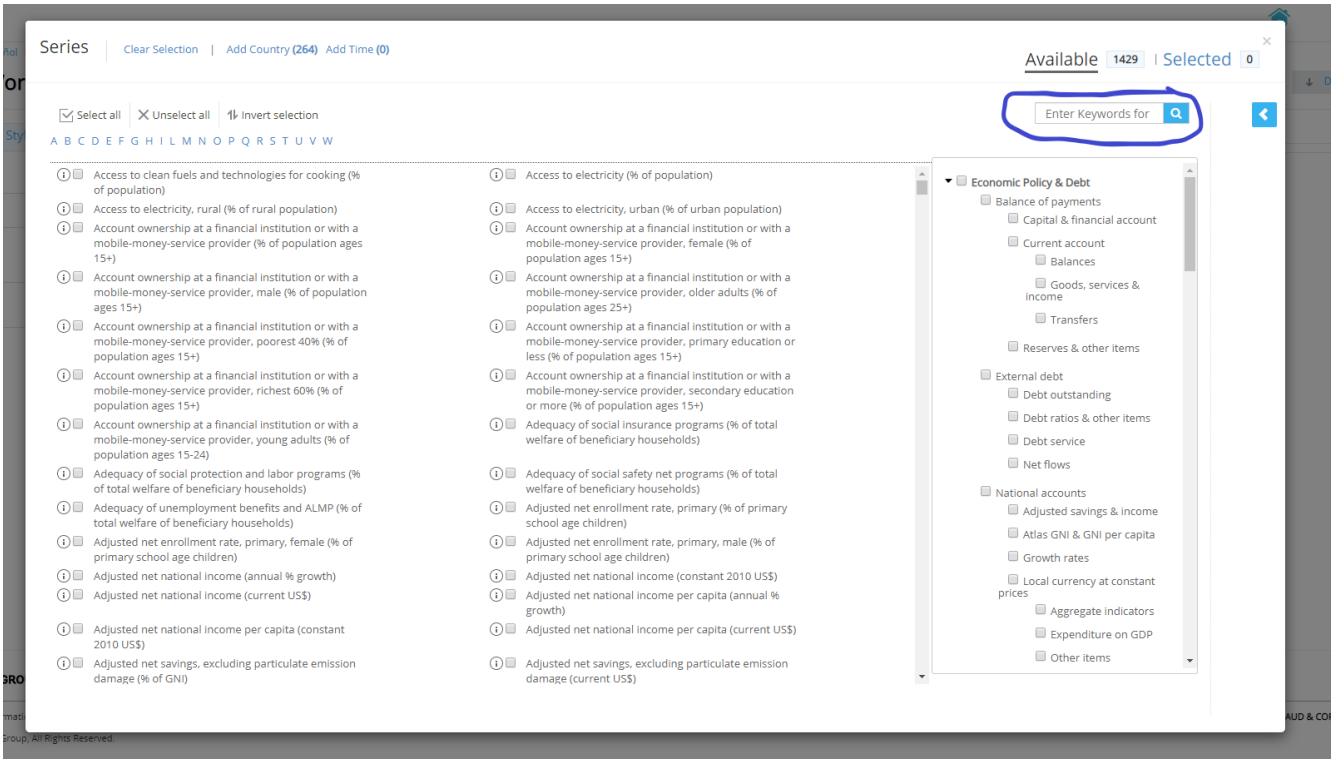
For our purposes, we want to map the global distribution of a single variable. Click the check box to automatically select all countries. (Note that, in practice, there are hardly any variables for which the Bank has truly global coverage; there will inevitably be some missing data, which will be reflected in the CSV that we ultimately generate.)



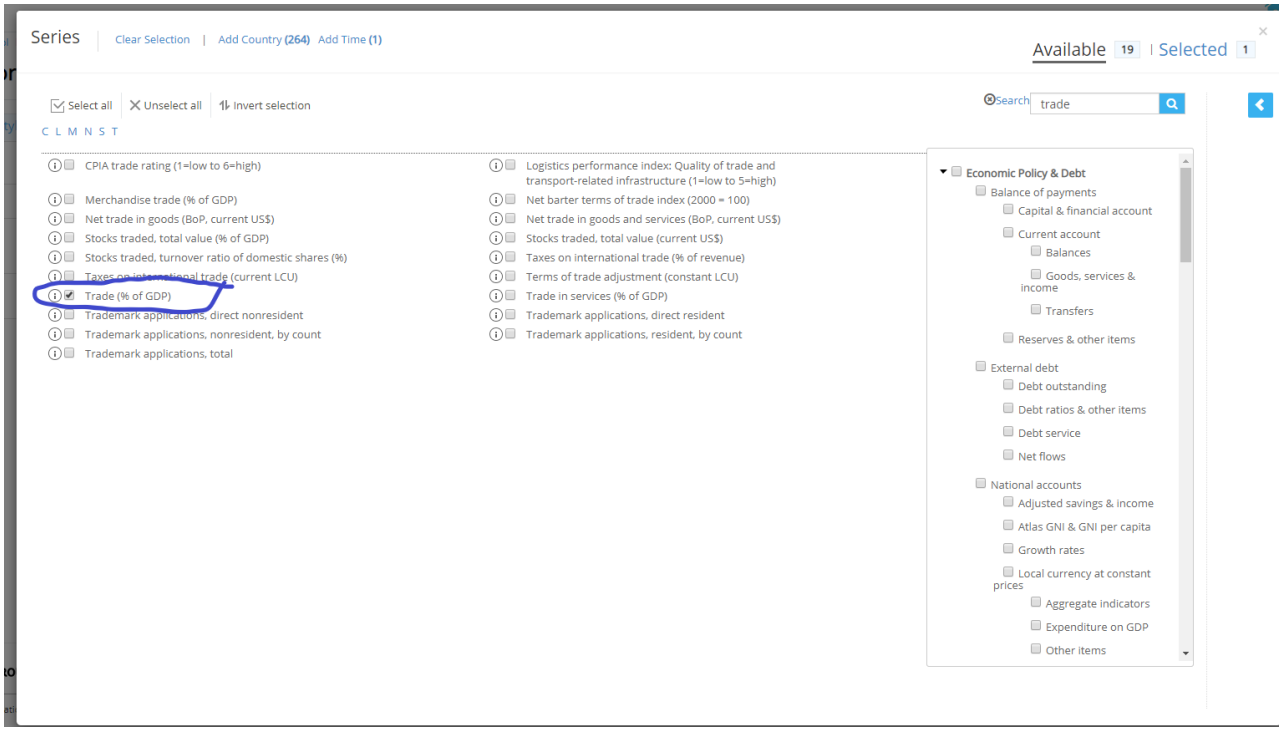
Next, select the variable you would like to map under the "series" tab. There are over 1000 options, so you can pick something that intrigues you or that is relevant to your current interests or concerns.



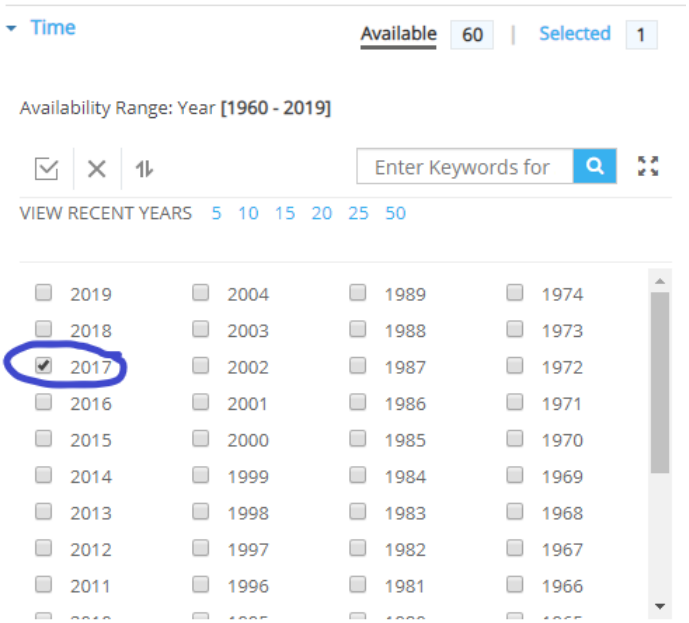
It could be useful to click on the "detailed view" icon ( ) to browse through the options, which will bring up the window shown below. You could also type in key words into the search bar.



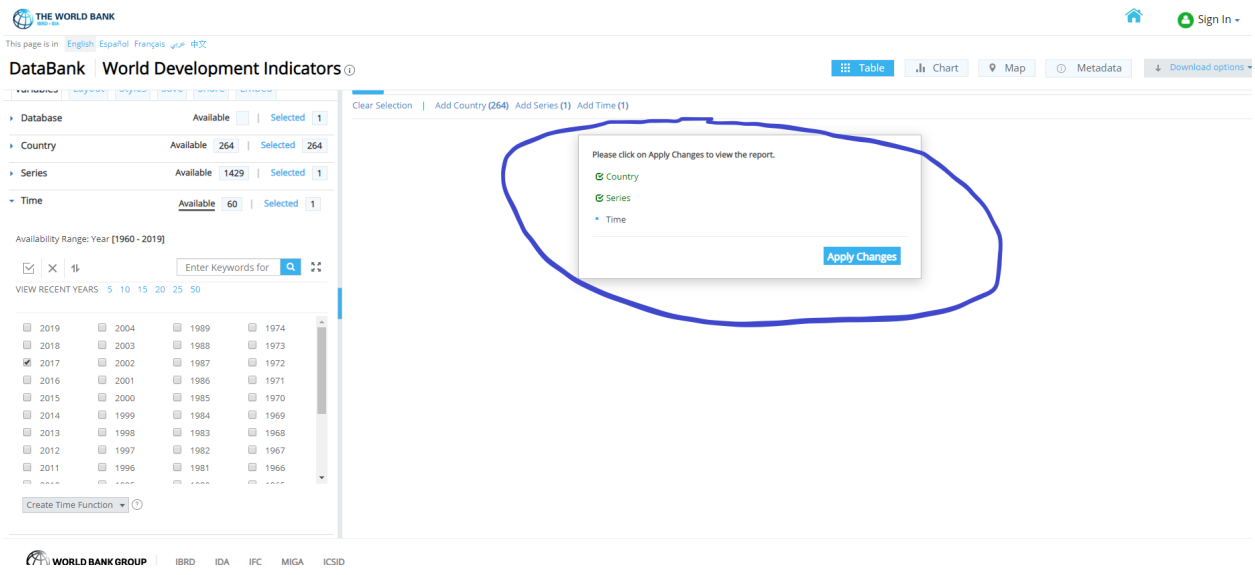
In this example, we're going to choose to map the variable "trade as a percentage of GDP", which is one way of capturing the extent of a country's integration into the global economy.



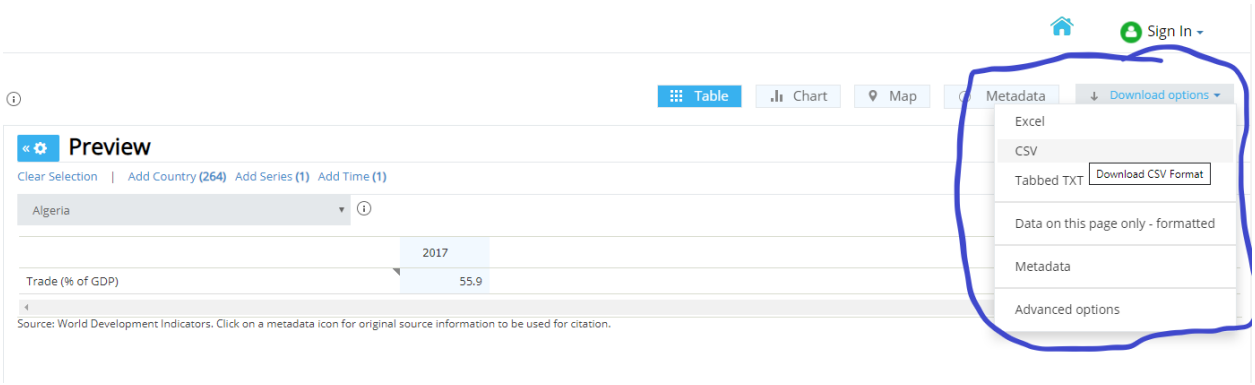
Finally, you should choose the year for which you want to map your variable. The World Bank interface gives you the option of selecting multiple years (allowing for the creation of a time-series dataset), but to keep things simple, we will only be selecting one year. It would make sense to pick a year that is relatively recent (since data coverage from long ago might be less extensive) but not too recent (since recent data may be subject to change or revision). In this example, we'll choose 2017.



Once you have made all three selections, click on "apply changes" to generate the dataset:



Then, to download the data, click on the “download options” tab and select “CSV”:



Extract the resulting zip file to a new folder that can be used to store materials from this workshop.

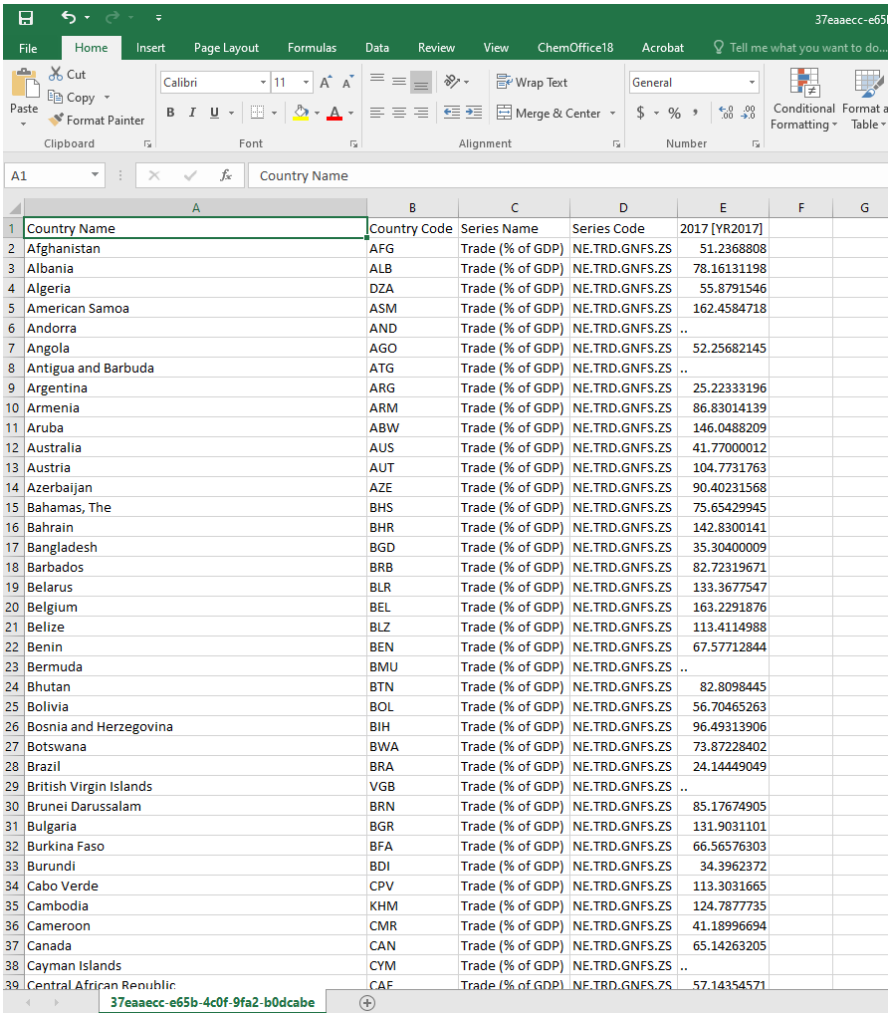
Before opening the CSV file, give the file a descriptive name and save it. Make sure there are no spaces in the filename since QGIS and other GIS software will not recognize filenames with spaces. Use underscores (“_”) to replace spaces. In this case, an example of a valid and descriptive filename would be “2017_TradePerGDP_AllCountries_Data”.

Note that the software will generate two CSV files; the first contains the actual data, while the second contains associated metadata. It is good practice to look at the metadata, and you should do so; after you have made a note of it, close it, and open the actual dataset.

Step Two: Cleaning the CSV file to make it usable in QGIS

Before we can join this tabular dataset to a spatial layer of country boundaries in QGIS, we must clean the tabular dataset to make it readable in QGIS. In more involved projects, you may wish to use specialized data cleaning software (check out our workshop on cleaning data for GIS projects if you're interested in learning more!). For our purposes, we'll make changes directly to the CSV file.

When you open the CSV file containing the data, it will look something like this:

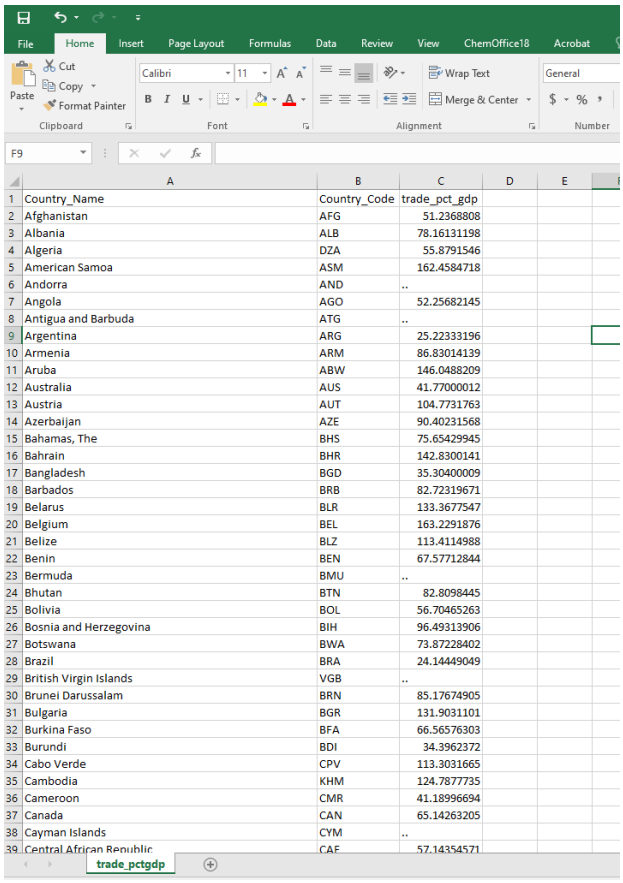


	A	B	C	D	E	F	G
1	Country Name	Country Code	Series Name	Series Code	2017 [YR2017]		
2	Afghanistan	AFG	Trade (% of GDP)	NE.TRD.GNFS.ZS	51.2368808		
3	Albania	ALB	Trade (% of GDP)	NE.TRD.GNFS.ZS	78.16131198		
4	Algeria	DZA	Trade (% of GDP)	NE.TRD.GNFS.ZS	55.8791546		
5	American Samoa	ASM	Trade (% of GDP)	NE.TRD.GNFS.ZS	162.4584718		
6	Andorra	AND	Trade (% of GDP)	NE.TRD.GNFS.ZS	..		
7	Angola	AGO	Trade (% of GDP)	NE.TRD.GNFS.ZS	52.25682145		
8	Antigua and Barbuda	ATG	Trade (% of GDP)	NE.TRD.GNFS.ZS	..		
9	Argentina	ARG	Trade (% of GDP)	NE.TRD.GNFS.ZS	25.22333196		
10	Armenia	ARM	Trade (% of GDP)	NE.TRD.GNFS.ZS	86.83014139		
11	Aruba	ABW	Trade (% of GDP)	NE.TRD.GNFS.ZS	146.0488209		
12	Australia	AUS	Trade (% of GDP)	NE.TRD.GNFS.ZS	41.77000012		
13	Austria	AUT	Trade (% of GDP)	NE.TRD.GNFS.ZS	104.7731763		
14	Azerbaijan	AZE	Trade (% of GDP)	NE.TRD.GNFS.ZS	90.40231568		
15	Bahamas, The	BHS	Trade (% of GDP)	NE.TRD.GNFS.ZS	75.65429945		
16	Bahrain	BHR	Trade (% of GDP)	NE.TRD.GNFS.ZS	142.8300141		
17	Bangladesh	BGD	Trade (% of GDP)	NE.TRD.GNFS.ZS	35.30400009		
18	Barbados	BRB	Trade (% of GDP)	NE.TRD.GNFS.ZS	82.72319671		
19	Belarus	BLR	Trade (% of GDP)	NE.TRD.GNFS.ZS	133.3677547		
20	Belgium	BEL	Trade (% of GDP)	NE.TRD.GNFS.ZS	163.2291876		
21	Belize	BLZ	Trade (% of GDP)	NE.TRD.GNFS.ZS	113.4114988		
22	Benin	BEN	Trade (% of GDP)	NE.TRD.GNFS.ZS	67.57712844		
23	Bermuda	BMU	Trade (% of GDP)	NE.TRD.GNFS.ZS	..		
24	Bhutan	BTN	Trade (% of GDP)	NE.TRD.GNFS.ZS	82.8098445		
25	Bolivia	BOL	Trade (% of GDP)	NE.TRD.GNFS.ZS	56.70465263		
26	Bosnia and Herzegovina	BIH	Trade (% of GDP)	NE.TRD.GNFS.ZS	96.49313906		
27	Botswana	BWA	Trade (% of GDP)	NE.TRD.GNFS.ZS	73.87228402		
28	Brazil	BRA	Trade (% of GDP)	NE.TRD.GNFS.ZS	24.14449049		
29	British Virgin Islands	VGB	Trade (% of GDP)	NE.TRD.GNFS.ZS	..		
30	Brunei Darussalam	BRN	Trade (% of GDP)	NE.TRD.GNFS.ZS	85.17674905		
31	Bulgaria	BGR	Trade (% of GDP)	NE.TRD.GNFS.ZS	131.9031101		
32	Burkina Faso	BFA	Trade (% of GDP)	NE.TRD.GNFS.ZS	66.56576303		
33	Burundi	BDI	Trade (% of GDP)	NE.TRD.GNFS.ZS	34.3962372		
34	Cabo Verde	CPV	Trade (% of GDP)	NE.TRD.GNFS.ZS	113.3031665		
35	Cambodia	KHM	Trade (% of GDP)	NE.TRD.GNFS.ZS	124.7877735		
36	Cameroon	CMR	Trade (% of GDP)	NE.TRD.GNFS.ZS	41.18996694		
37	Canada	CAN	Trade (% of GDP)	NE.TRD.GNFS.ZS	65.14263205		
38	Cayman Islands	CYM	Trade (% of GDP)	NE.TRD.GNFS.ZS	..		
39	Central African Republic	CAF	Trade (% of GDP)	NE.TRD.GNFS.ZS	57.14354571		

The last column contains the actual data for the variable we want to map. Currently, the name of this column indicates the year 2017 ("YR2017"), instead of actually describing our variable of interest (i.e. "trade as a percentage of GDP"). This is a bit confusing, so it would be better to change the column name to something that actually describes the data. Again, it is crucial that the column name does not contain spaces; use an underscore ("_") to connect multiple words into one word. In this demo, we will rename the last column "trade_pct_gdp".

The "Series Name" and "Series Code" columns don't really contain useful information for our purposes, so go ahead and delete them.

The "Country Name" and "Country Code" columns are important for descriptive and technical purposes (we will use the country codes to join this dataset to our spatial dataset in QGIS). However, as it stands, these variable names are problematic. To make sure that the data is readable in QGIS, insert an underscore after "Country" for both columns so that "Country Name" becomes "Country_Name" and "Country Code" becomes "Country_Code". The final product should look something like this:



	A	B	C	D	E
1	Country_Name	Country_Code	trade_pct_gdp		
2	Afghanistan	AFG	51.2368808		
3	Albania	ALB	78.16131198		
4	Algeria	DZA	55.8791546		
5	American Samoa	ASM	162.4584718		
6	Andorra	AND	..		
7	Angola	AGO	52.25682145		
8	Antigua and Barbuda	ATG	..		
9	Argentina	ARG	25.22333196		
10	Armenia	ARM	86.83014139		
11	Aruba	ABW	146.0488209		
12	Australia	AUS	41.77000012		
13	Austria	AUT	104.7731763		
14	Azerbaijan	AZE	90.40231568		
15	Bahamas, The	BHS	75.65429945		
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28	Brazil	BRA	24.14449049		
29	British Virgin Islands	VGB	..		
30	Brunei Darussalam	BRN	85.17674905		
31	Bulgaria	BGR	131.9031101		
32	Burkina Faso	BFA	66.56576303		
33	Burundi	BDI	34.3962372		
34	Cabo Verde	CPV	113.3031665		
35	Cambodia	KHM	124.7877735		
36	Cameroon	CMR	41.18996694		
37	Canada	CAN	65.14263205		
38	Cayman Islands	CYM	..		
39	Central African Republic	CAF	57.14354571		

Save the changes you made to the CSV and exit.

Step Three: Find a shapefile of the world's countries

A shapefile is one format in which spatial data (i.e. data which contains explicit geographic information that allows it to be displayed in GIS software) can be stored. More specifically, a shapefile is a composite file made up of the shape of the geographic area, the projection for the data, the table of data, and other elements.

In order to use GIS software to display the tabular World Bank data that we just downloaded and cleaned on a map, we need a spatial dataset of country boundaries to which we can join this tabular data. When you're looking for spatial data, a good place to start is NYU's very own Spatial Data Repository (SDR), which contains a large collection of spatial data from NYU's collections; it also allows you to search the spatial data catalogs of other universities with whom NYU collaborates:

https://geo.nyu.edu/

We can find a useful shapefile of world country boundaries by searching the NYU SDR:

https://geo.nyu.edu/catalog/stanford-ps917hm2349

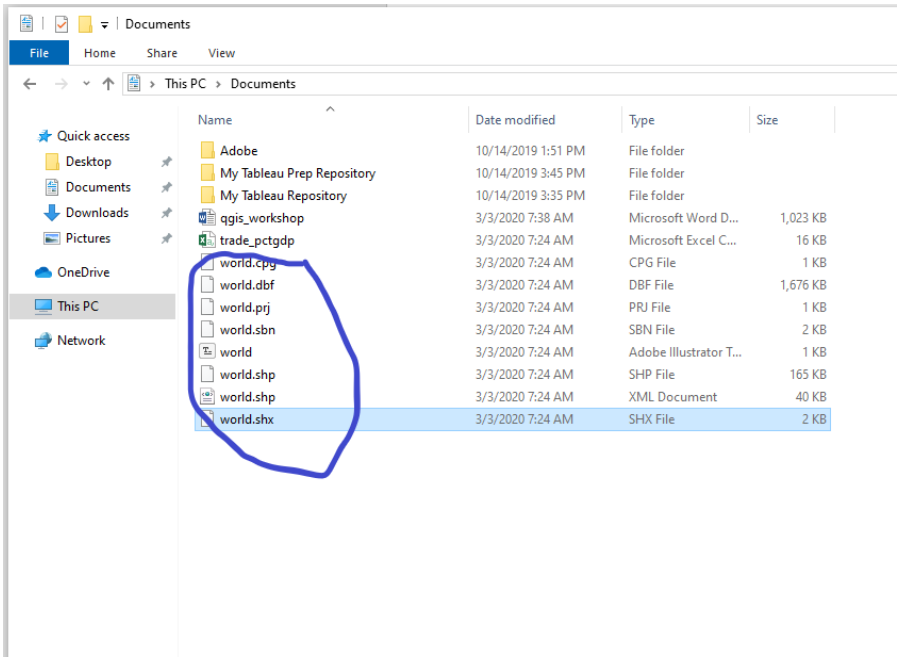
Note that this dataset is held by Stanford University, but because the data is indexed by NYU, you can find the record by searching NYU's SDR. (Note that in addition to allowing you to download the shapefile, the link above provides important metadata that will allow you to use the data in an appropriate way.)

While you could go ahead and download this shapefile if you were working on this project on your own, for the purposes of this workshop, please instead download the world countries shapefile that were made available to you at the start of the workshop. I downloaded the shapefile from NYU's SDR at the link above, but performed some minor cleaning on the shapefile to make it easier for you to work with (i.e. deleting some superfluous columns, deleting Antarctica etc.) I also set the projection of the shapefile to Mercator; keep in mind that this projection might not necessarily be the best for your purposes.

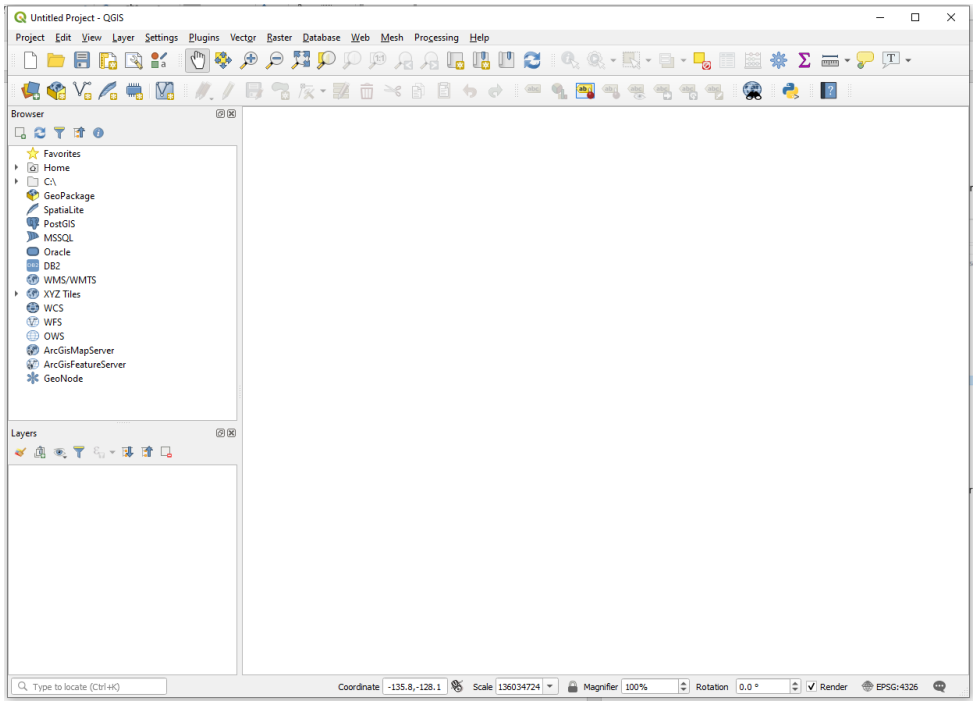
We will return to this point later, but if you'd like to learn a bit more about map projections (and Mercator in particular, see the following link: https://www.wired.com/2013/07/projection-mercator/). Make sure that this shapefile (which I shared with you earlier) is in your workshop folder.

Step Four: Open up the shapefile of world countries in QGIS

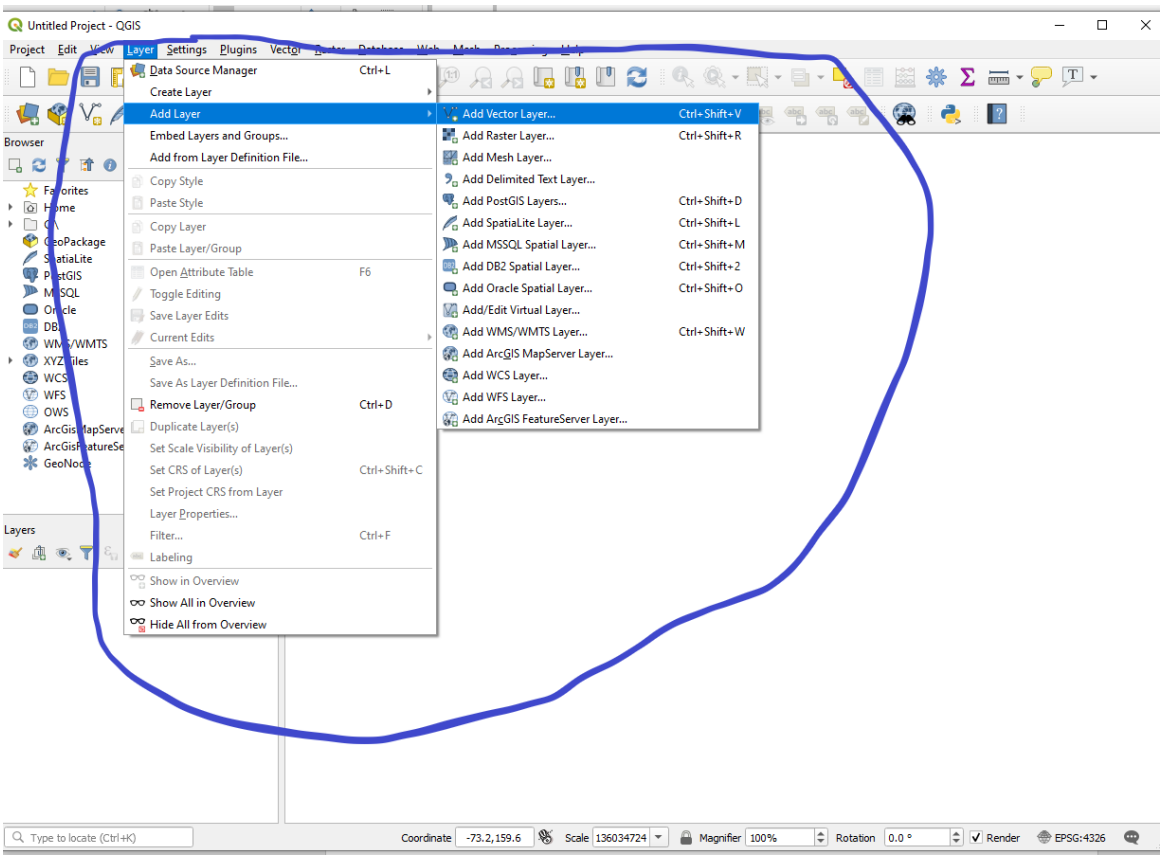
Recall from above that a single shapefile consists of multiple component files; make sure that ALL of these component files are in your workshop folder.



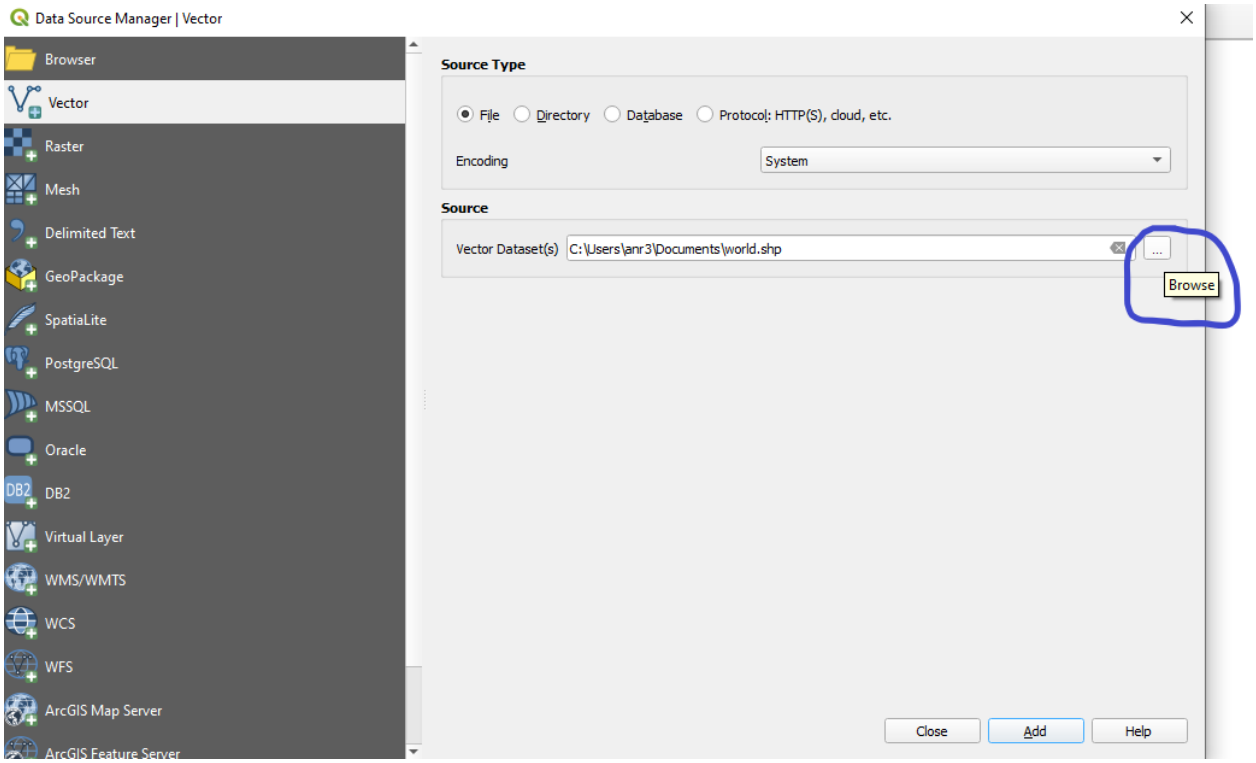
Once you ensure that all of the files are in your workshop folder, go ahead and open up QGIS. The window will look like this:



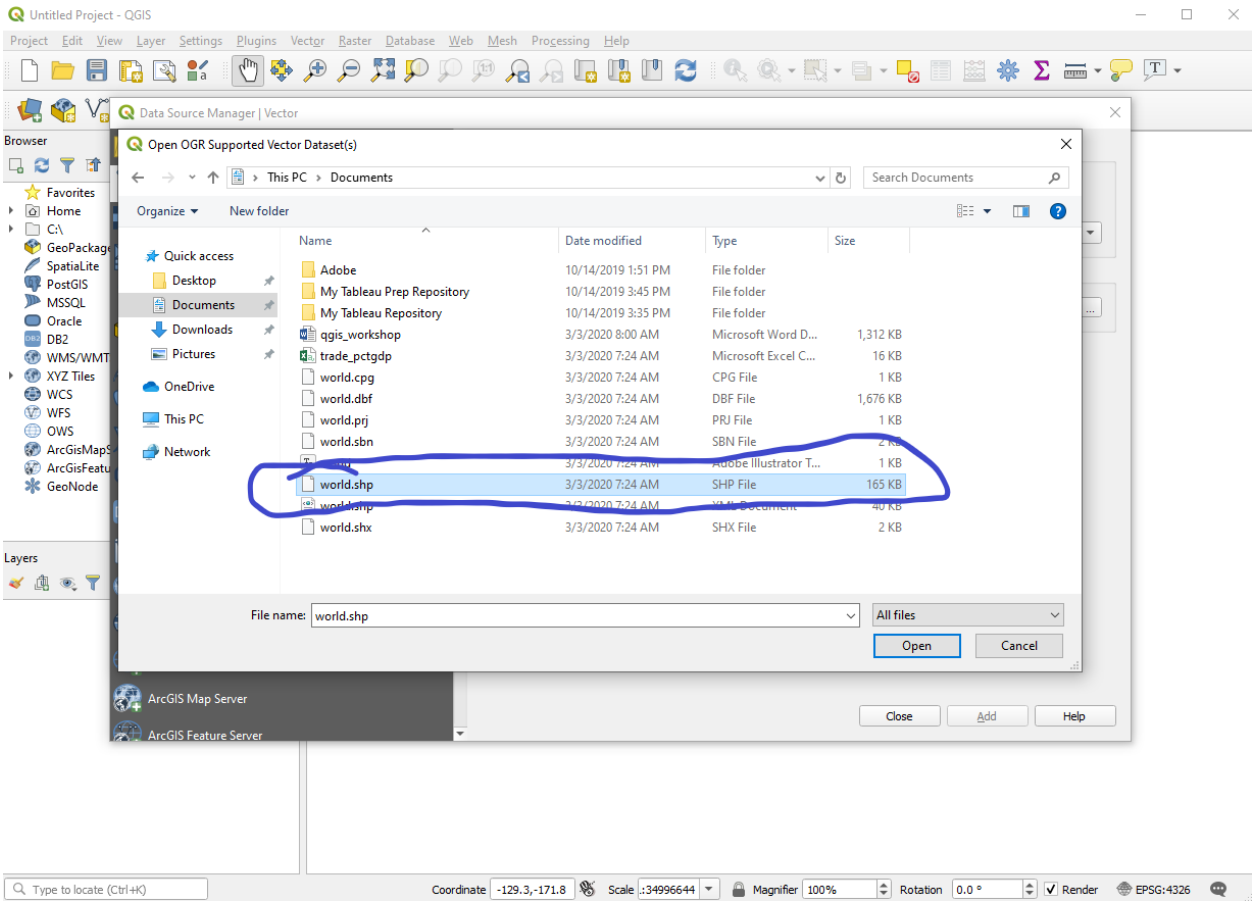
To add the shapefile to this QGIS project, click on the “Layer” heading close to the top of the window, and scroll down to the “Add Layer” button. Then, on your right, click “Add Vector Layer.” As a shortcut, you can also simply press ctrl + shift + v.



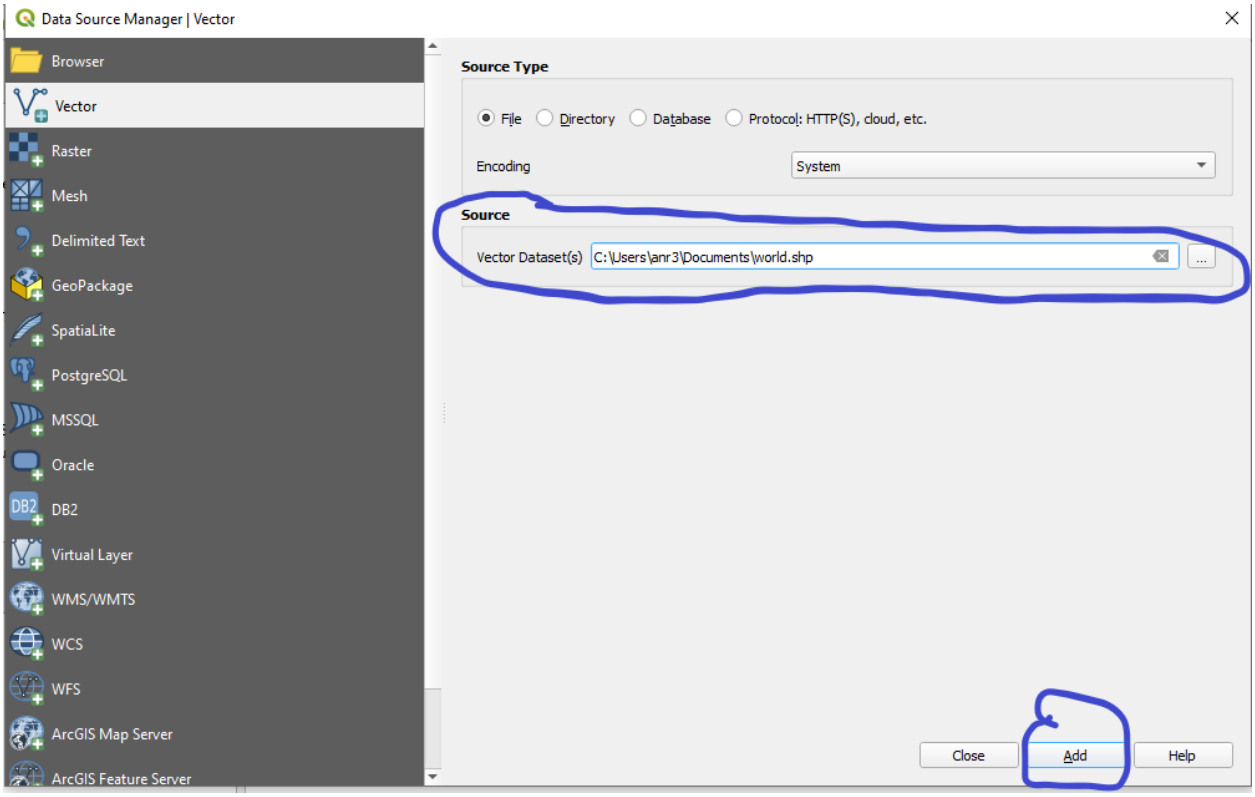
This will open up a window called “Data Source Manager|Vector”; under the “Source” tab, there is a small button with an ellipsis. When you hover over it, a label that says “Browse” will appear. Click on it. Then navigate to the folder in which you have placed the workshop materials, including the downloaded shapefile.



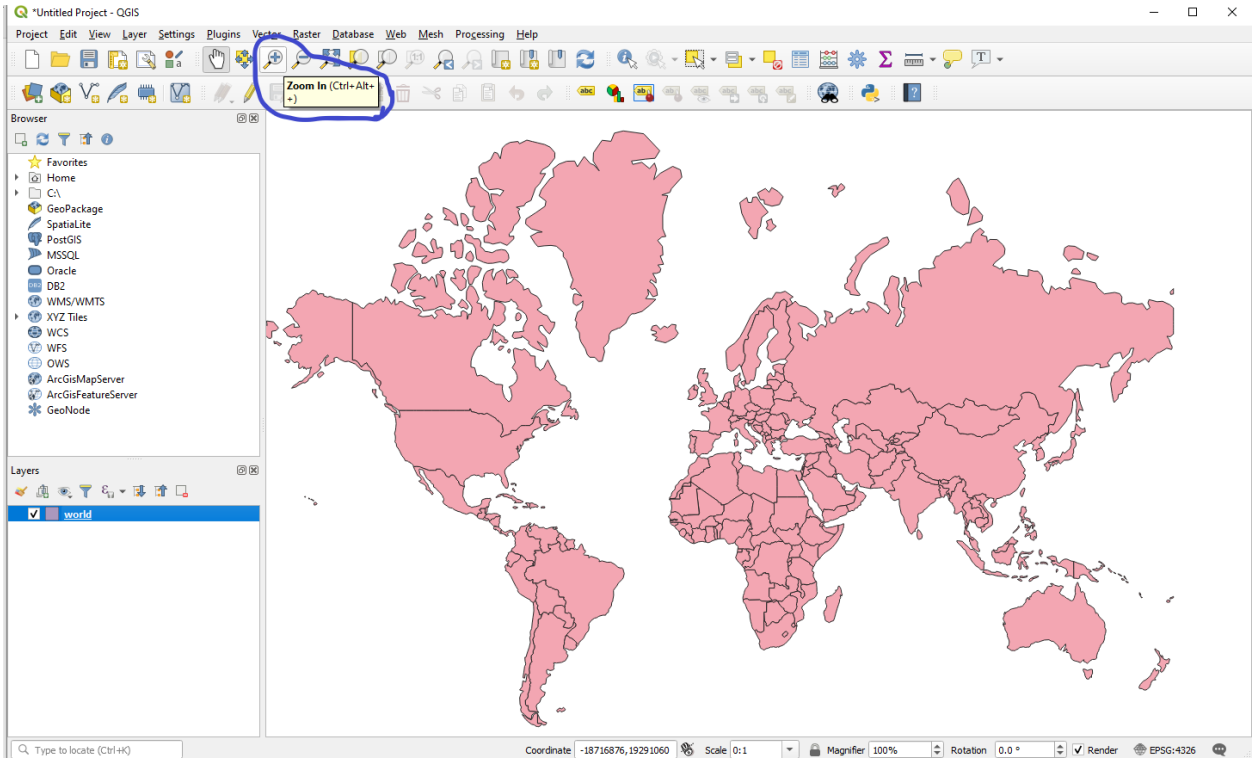
Then, find the “world.shp” file (under the “type” heading, it should say “SHP File”) and double click it, or select it and click “Open.”



At this point, you will be returned to the “Data Source Manager|Vector” window, with the file path of the relevant file filled in. Go ahead and click “add” (Note that you may receive a message about the layer’s coordinate reference system; you can go ahead and dismiss that message, and proceed with loading the shapefile).

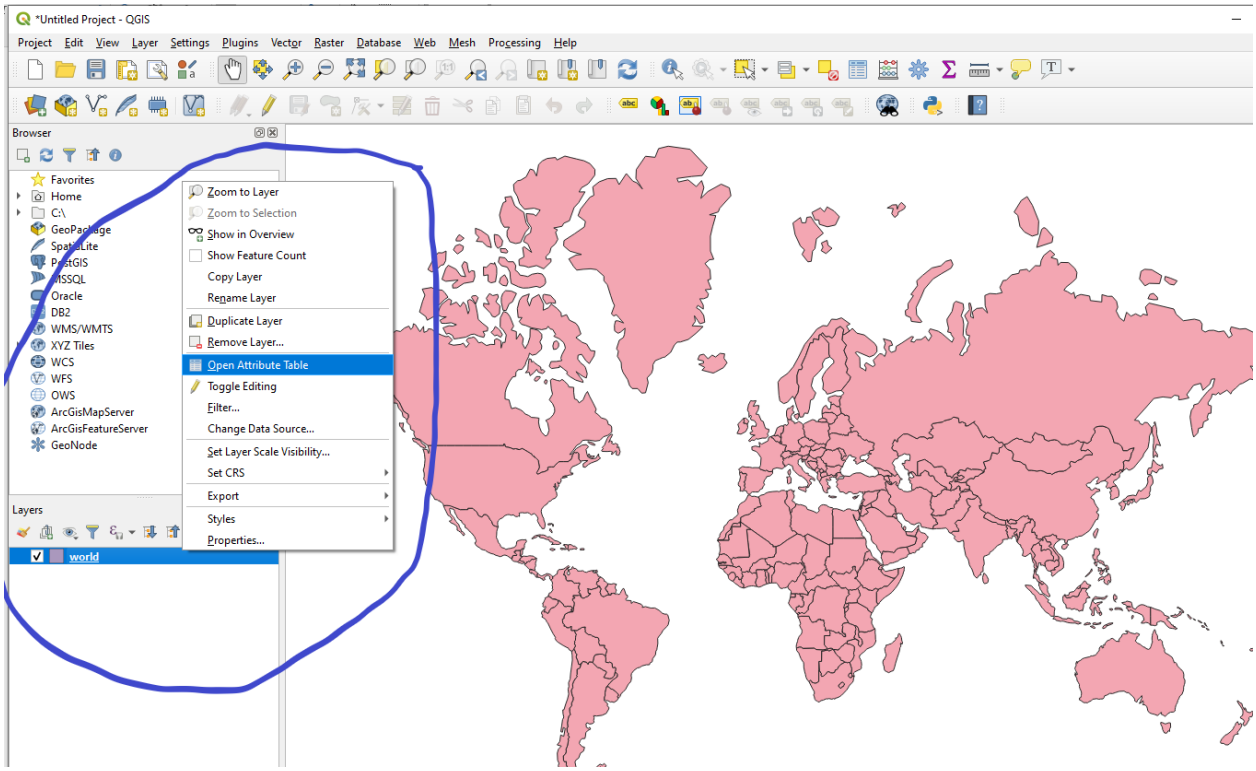


Once you do so, you will see the shapefile in your QGIS project window (Note that the color is arbitrary; we can change this later). You can zoom in and out by scrolling the mouse or pressing the “zoom in” and “zoom out” buttons on the taskbar.

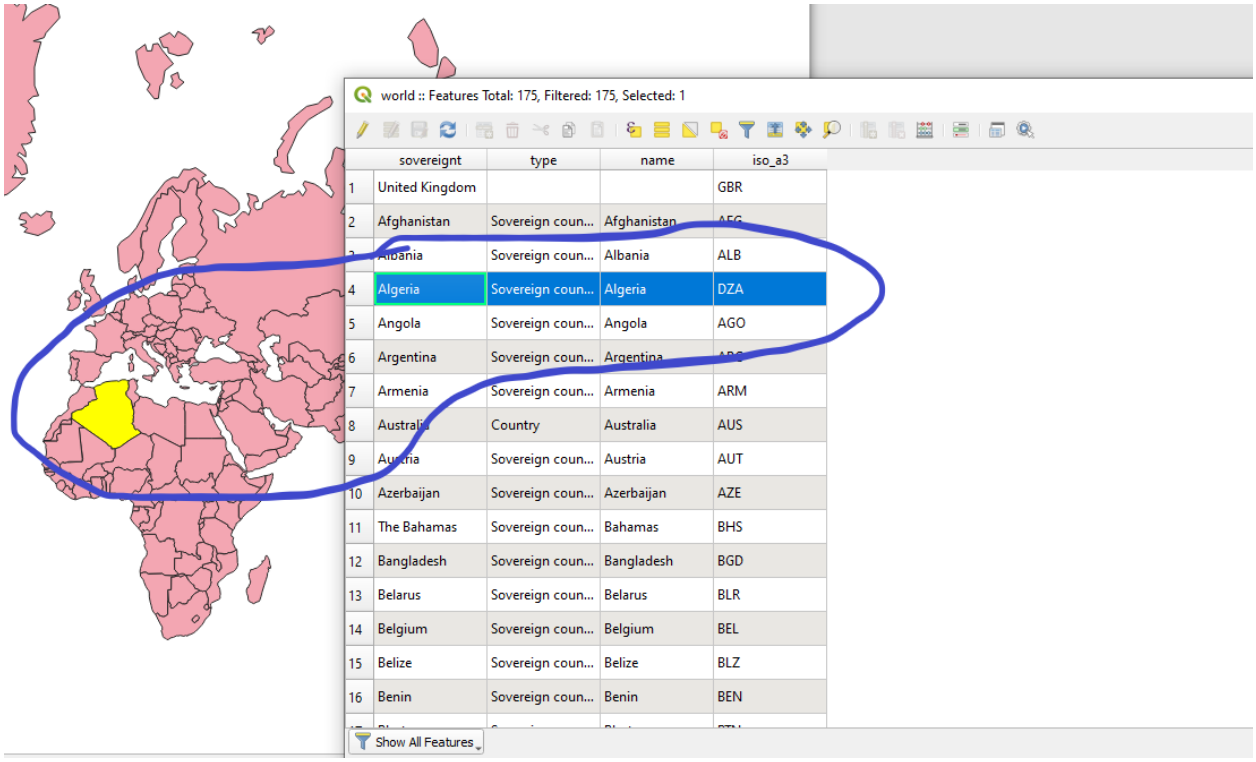


Step Five: Explore the shapefile

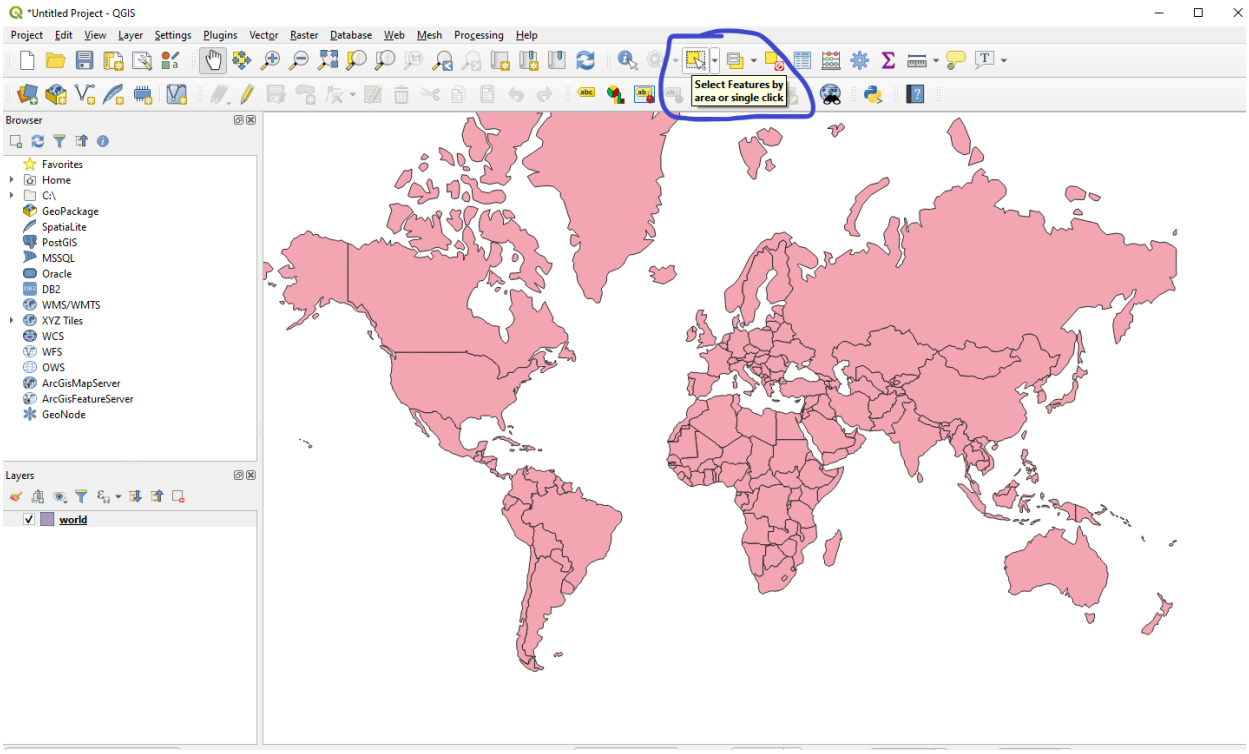
On the bottom-left of the larger QGIS project window, you'll see a smaller window labelled "Layers", which displays the various datasets that are part of the project. Right-click on the "world" shapefile, and select "Open Attribute Table".



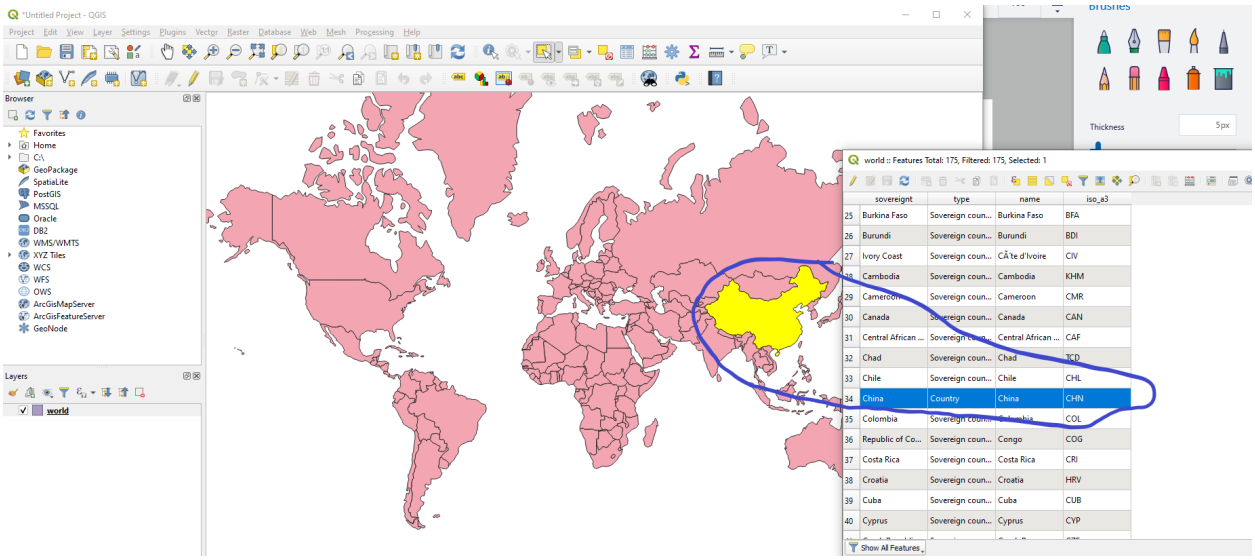
This will open up the attribute table that is associated with the displayed map. If you select a record in the attribute table, it will be highlighted on the map. For instance, if you highlight the record for Algeria in the attribute table (by simply clicking on it), Algeria will be highlighted on your map:



Conversely, you can also click on a country in the map layer, which will in turn highlight the corresponding record in the attribute table. To do so, you must first click on the “Select Features by area or single click” button in the toolbar:

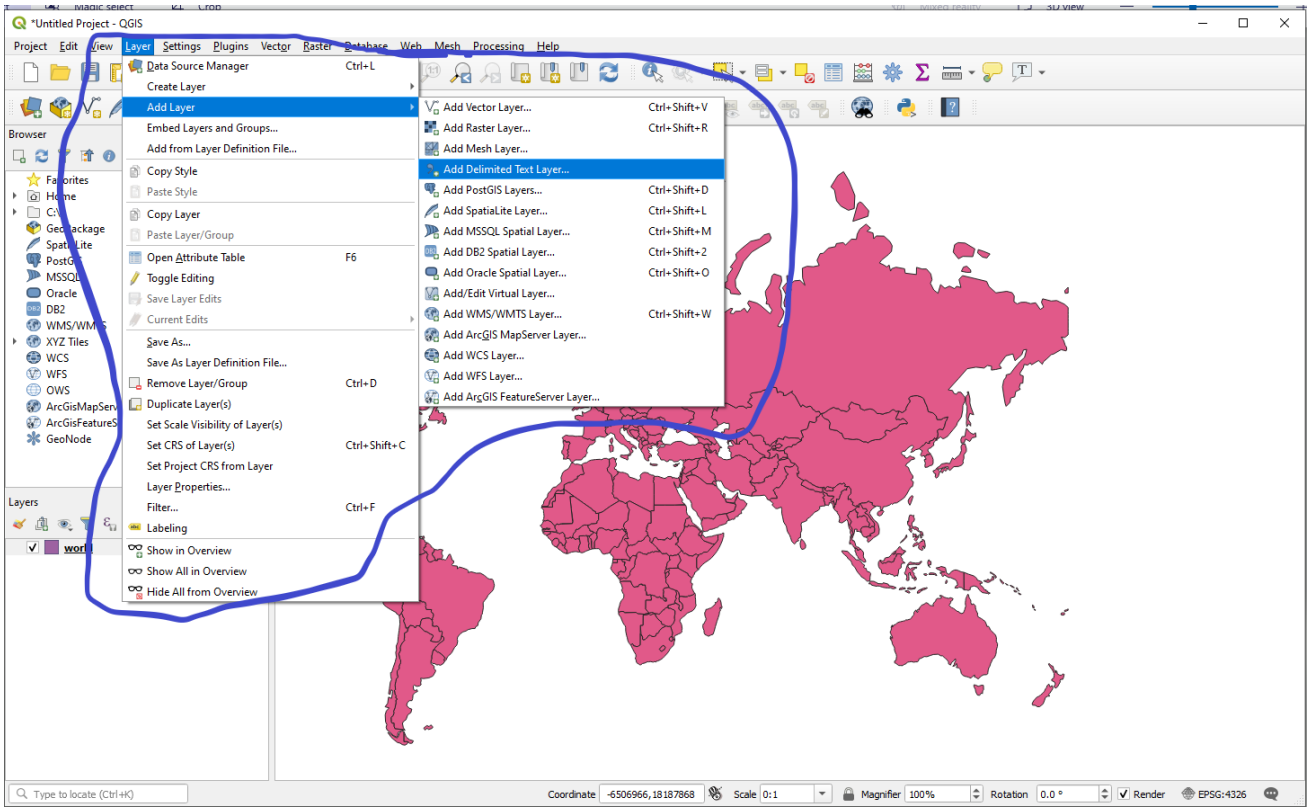


Then, click on a country of your choice on the map. When you do so, the corresponding record in the attribute table will be automatically highlighted. For example, if we click on China, the corresponding record will be highlighted in the attribute table:

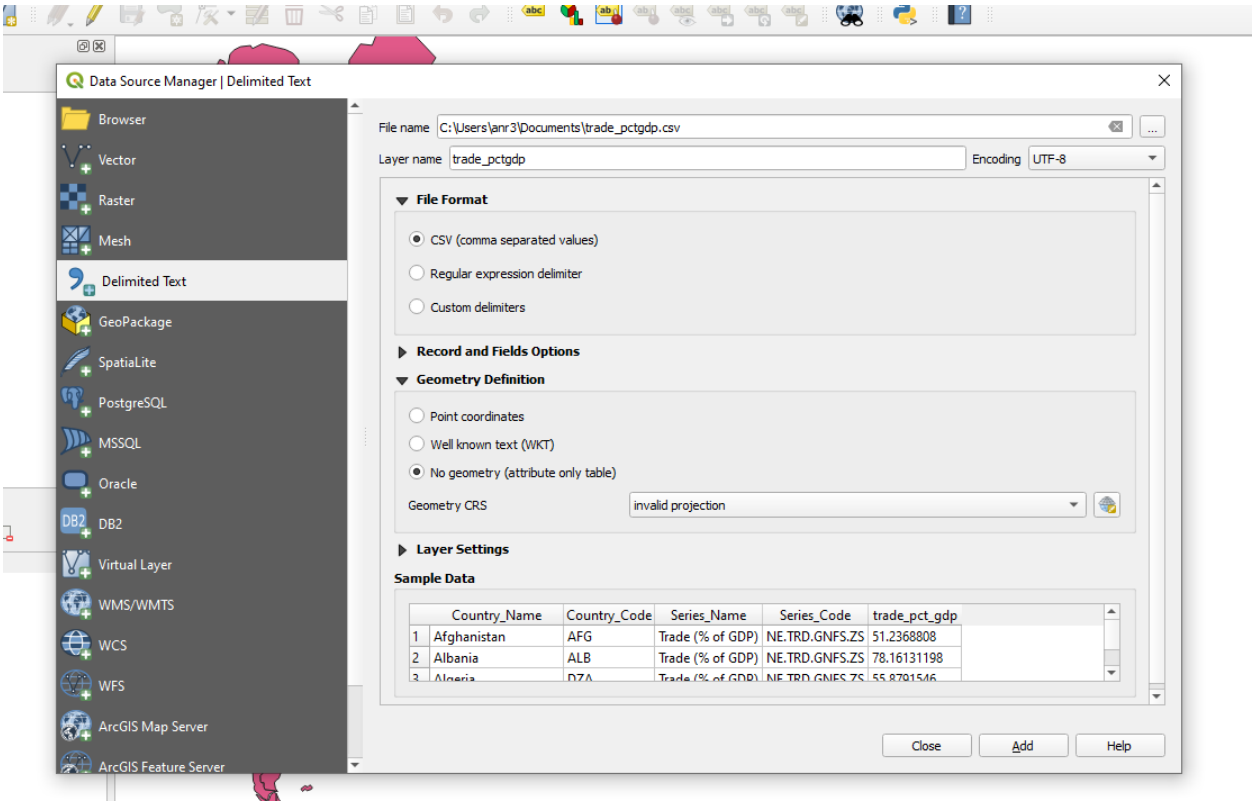


Step Six: Import the cleaned CSV file containing the World Bank data you want to map

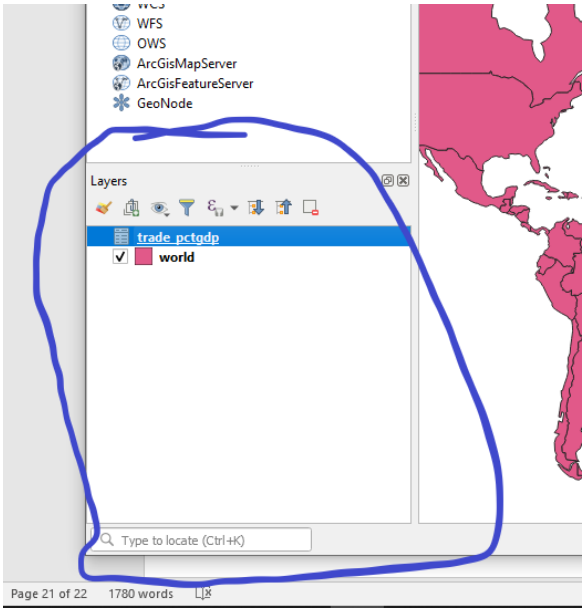
Now, we will begin the process of visualizing our tabular data on this map. To do so, we must bring in our tabular data into QGIS. We do so in much the same way we imported our shapefile of country boundaries into QGIS. However, instead of going from "Layer"→"Add Layer"→"Add Vector Layer" we will instead go from "Layer→"Add Layer"→"Add Delimited Text Layer".



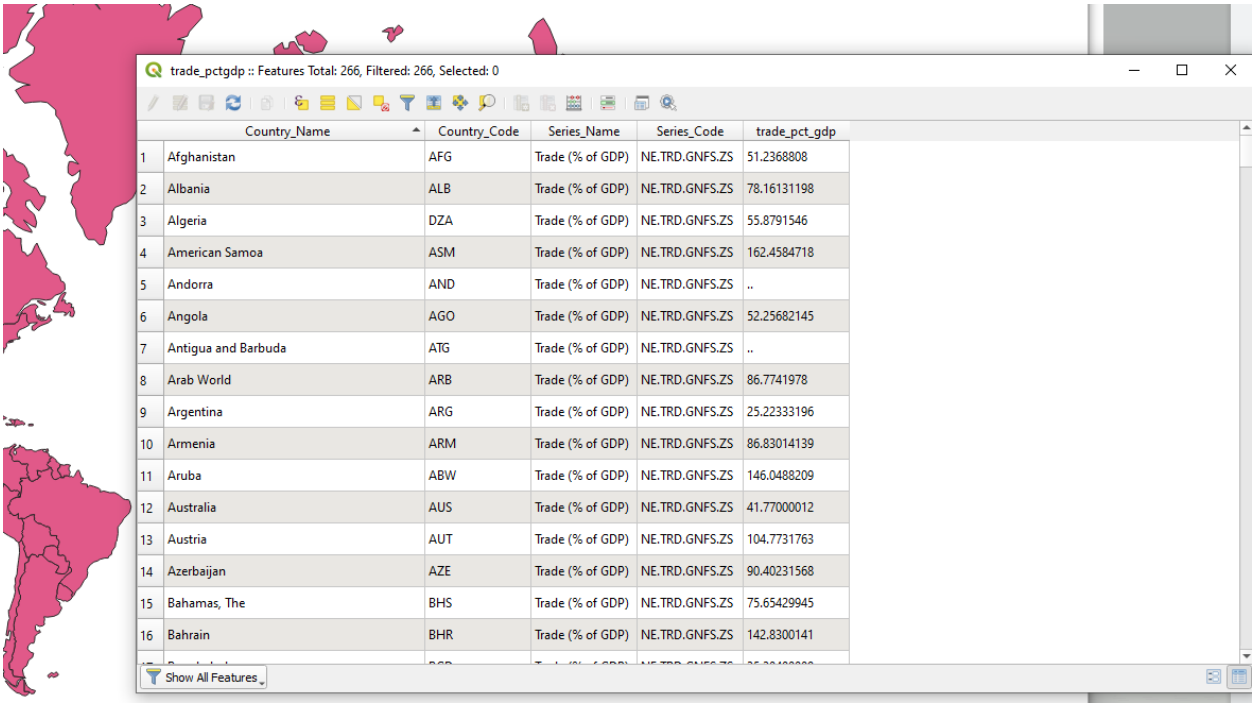
Locate your saved CSV file in your workshop folder and add it; also, under the “Geometry” tab, click the “No geometry (attribute table only)” button to inform QGIS that we are importing a tabular file without explicit geographic information attached to it.



Then, click “Add” and close the window. You should now see the table under the “Layers” window:



Right click on the newly imported table and scroll down to “Open Attribute Table” to open the table containing your World Bank data:



	Country_Name	Country_Code	Series_Name	Series_Code	trade_pct_gdp
1	Afghanistan	AFG	Trade (% of GDP)	NE.TRD.GNFS.ZS	51.2368808
2	Albania	ALB	Trade (% of GDP)	NE.TRD.GNFS.ZS	78.16131198
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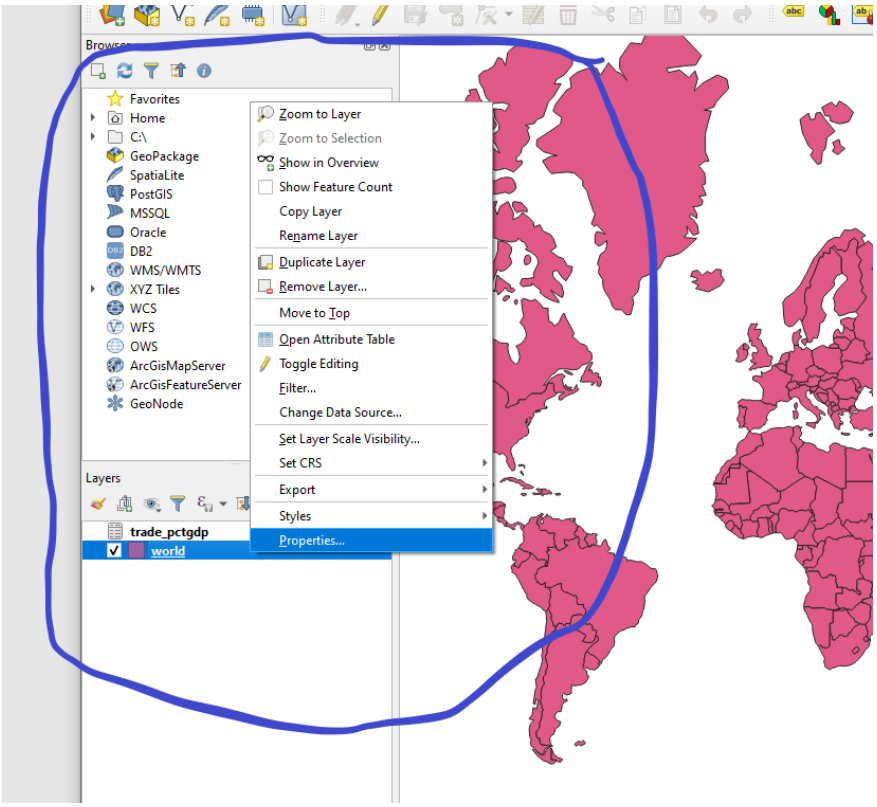
4	American Samoa	ASM	Trade (% of GDP)	NE.TRD.GNFS.ZS	162.4584718
5	Andorra	AND	Trade (% of GDP)	NE.TRD.GNFS.ZS	..
6	Angola	AGO	Trade (% of GDP)	NE.TRD.GNFS.ZS	52.25682145
7	Antigua and Barbuda	ATG	Trade (% of GDP)	NE.TRD.GNFS.ZS	..
8	Arab World	ARB	Trade (% of GDP)	NE.TRD.GNFS.ZS	86.7741978
9	Argentina	ARG	Trade (% of GDP)	NE.TRD.GNFS.ZS	25.22333196
10	Armenia	ARM	Trade (% of GDP)	NE.TRD.GNFS.ZS	86.83014139
11	Aruba	ABW	Trade (% of GDP)	NE.TRD.GNFS.ZS	146.0488209
12	Australia	AUS	Trade (% of GDP)	NE.TRD.GNFS.ZS	41.77000012
13	Austria	AUT	Trade (% of GDP)	NE.TRD.GNFS.ZS	104.7731763
14	Azerbaijan	AZE	Trade (% of GDP)	NE.TRD.GNFS.ZS	90.40231568
15	Bahamas, The	BHS	Trade (% of GDP)	NE.TRD.GNFS.ZS	75.65429945
16	Bahrain	BHR	Trade (% of GDP)	NE.TRD.GNFS.ZS	142.8300141

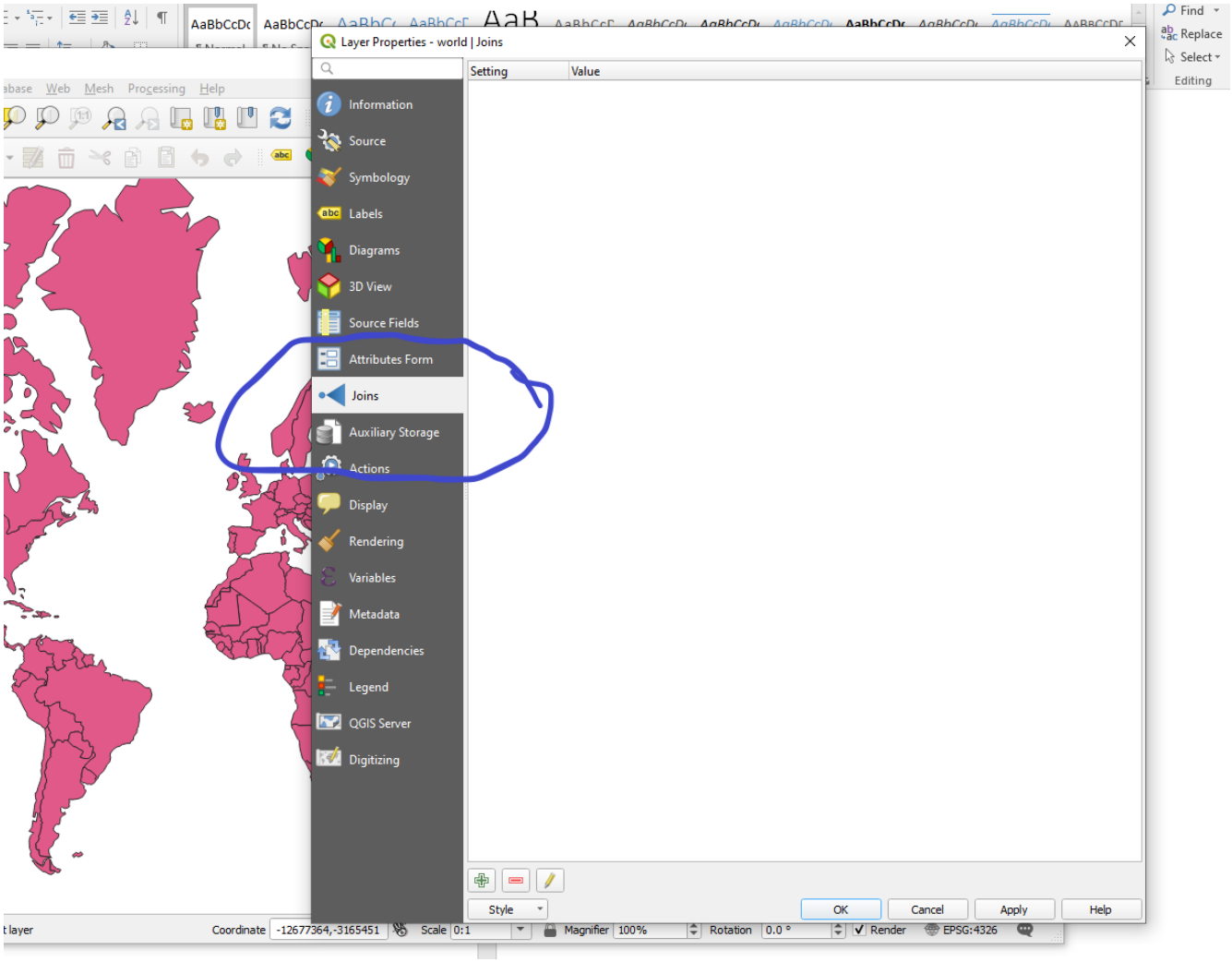
Step Seven: Join the tabular file containing the World Bank data to your shapefile of world countries.

Now, we must join (or merge) the dataset containing our World Bank data to the shapefile of country boundaries; we must do this in order to visualize this tabular data on our map. You may have previous experience merging data; the procedure involved in joining tabular data to spatial data is very similar to the process of joining two tabular (i.e. non-spatial) datasets. Associating two datasets into one larger dataset that can facilitate analysis requires them to have a common field, which we can use to "glue" the datasets together. The International Organization for Standardization provides 3-digit country codes for each country that can be used to identify countries when working with country-level data. Both our shapefile, and our table of World Bank data, contain a field with these standardized 3-digit ISO codes (Country_Code in the tabular dataset, and iso_a3 in the shapefile) and we will therefore use these fields to join the World Bank dataset to our shapefile of world countries.

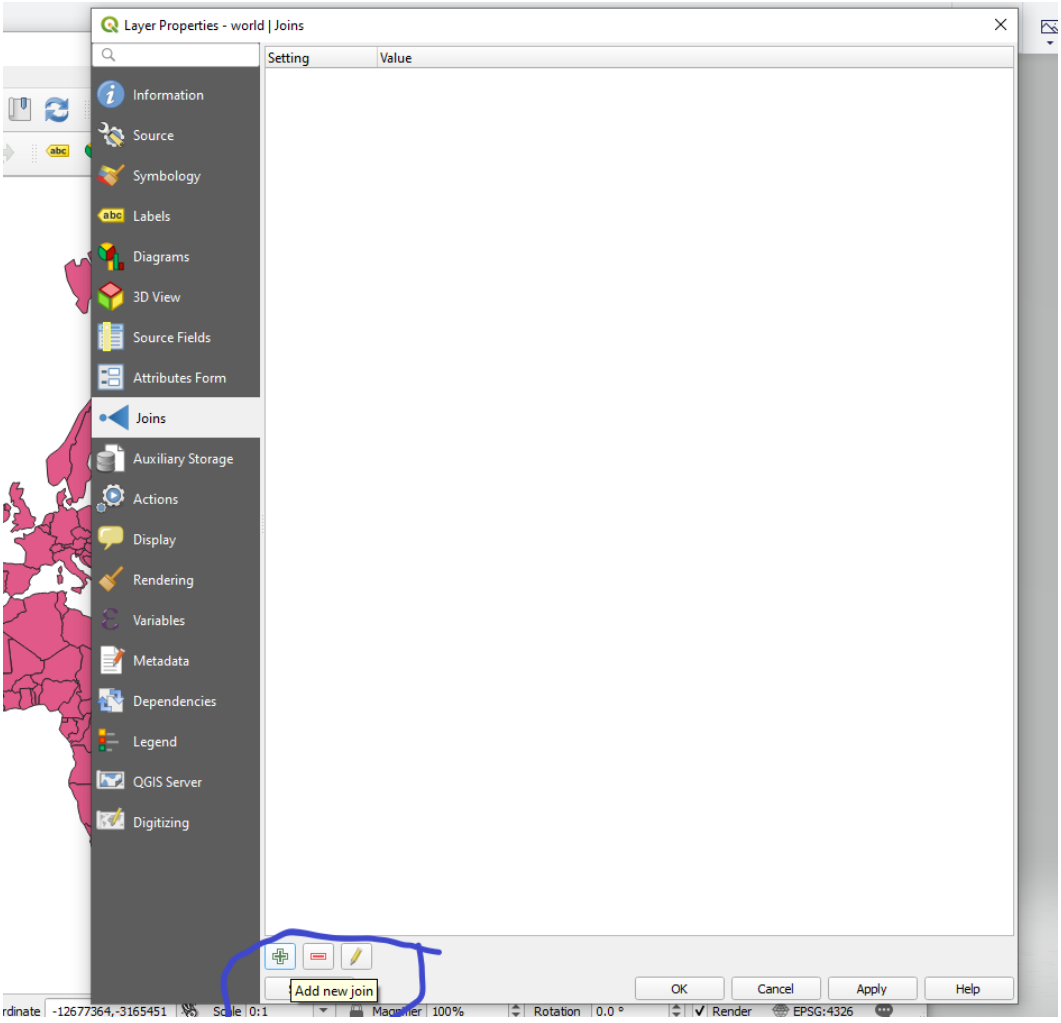
First, right click on the shapefile, and click on "Properties":



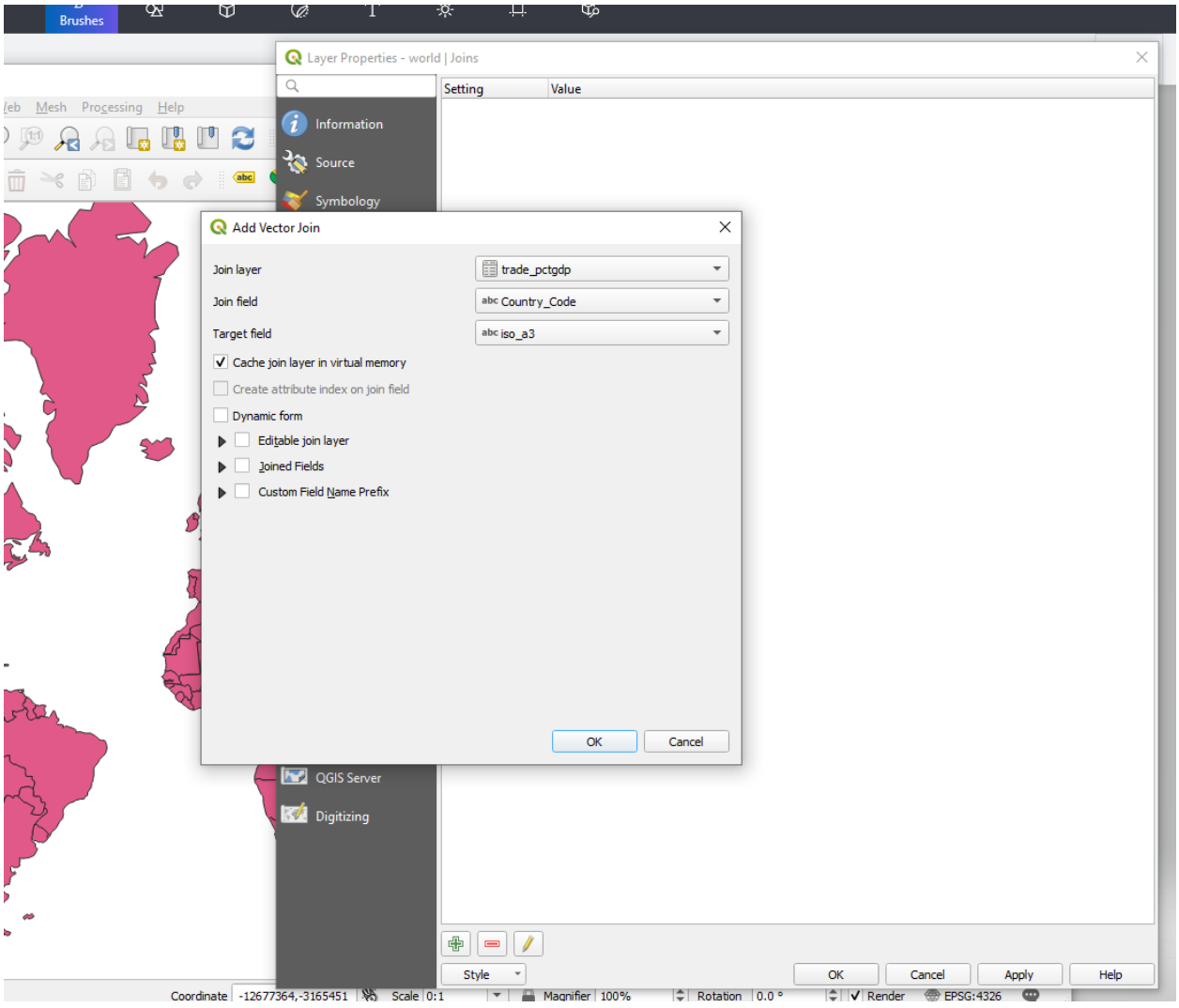
In the “Layer Properties” dialog box that opens up, click the “Joins” tab:



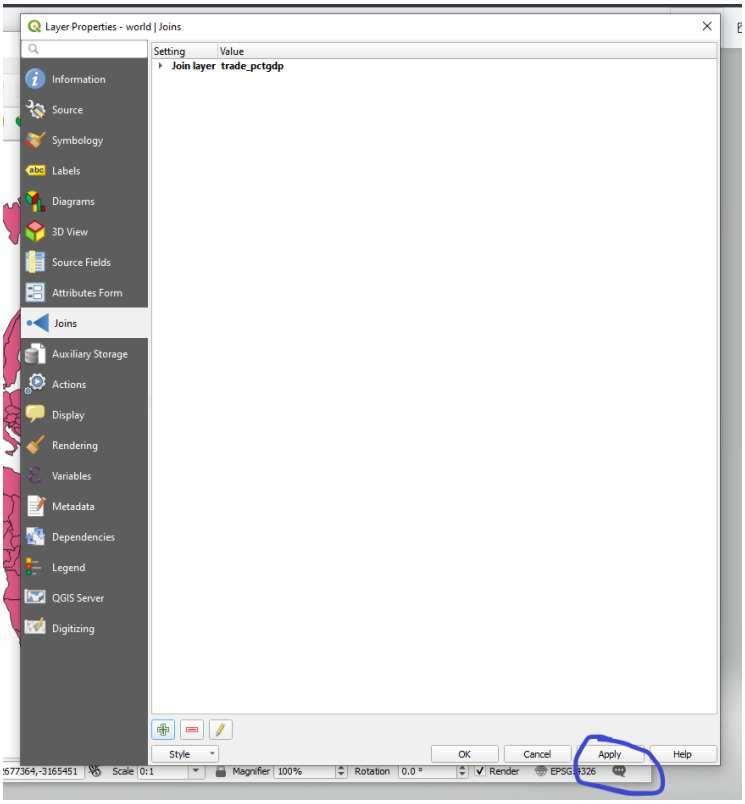
Click on the green cross at the bottom of the “Joins” dialog box; hovering over it will bring up the label “Add new join.”



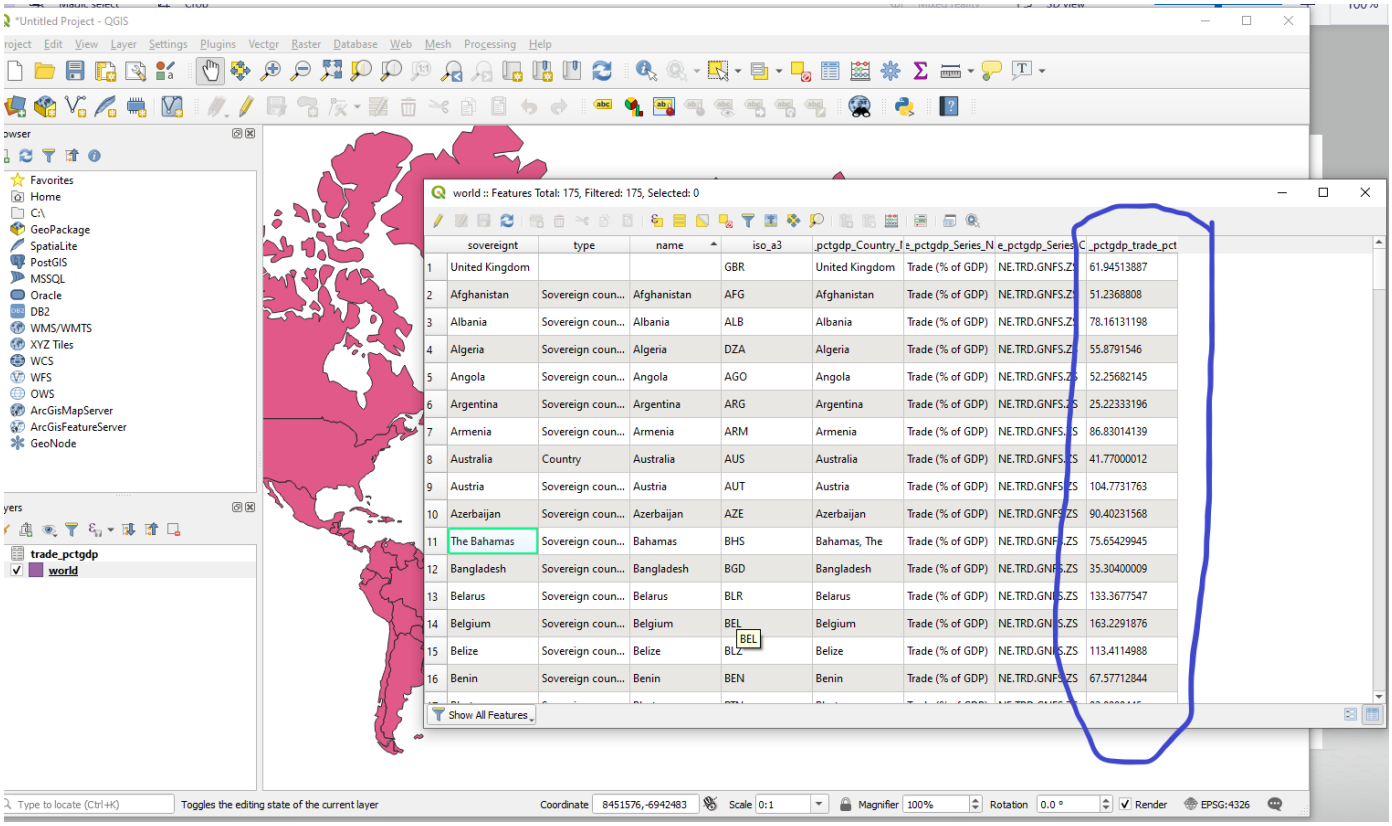
The “Add Vector Join” dialog box will open up. Next to “Join layer” select the name of the tabular file containing the World Bank data (here, “trade_pctgdp”); this informs QGIS that you want to join this tabular file to the world countries shapefile. Next to “Join field”, scroll down to the name of the field that contains the 3-Digit ISO identifier in your tabular World Bank dataset; here, the name of this field is “Country_Code.” Finally, next to “Target field”, select the name of the field containing the 3-Digit ISO identifier in the shapefile; here, it is “iso_a3.” The filled in dialog box should look something like this:



Click “OK” to close the “Add Vector Join” dialog box, then click “Apply” on the main “Join” dialog box. Then click “OK” to close the “Join” dialog box.



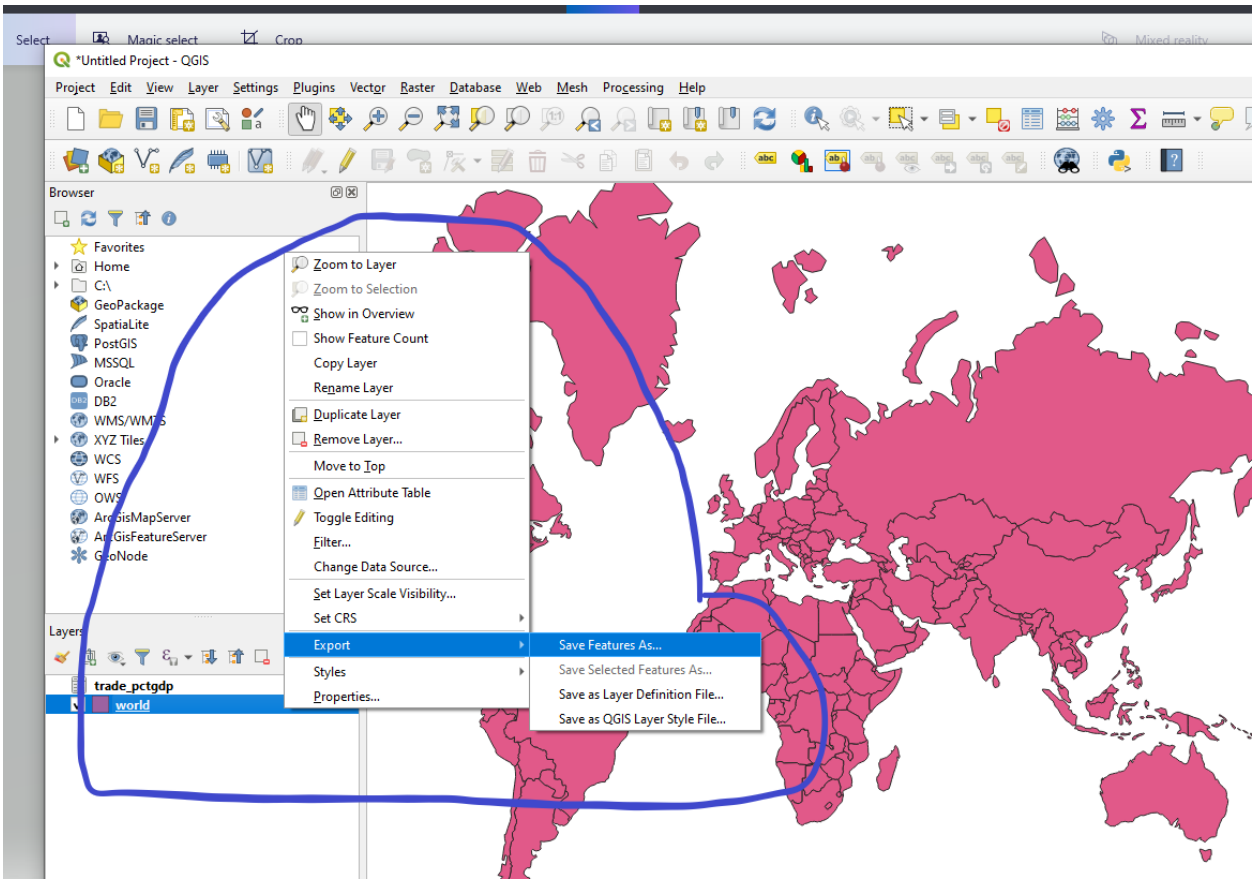
Now, if you open up the attribute table of your shapefile by right-clicking→"Open Attribute Table", you will see the World Bank data attached to the corresponding country records in the shapefile!



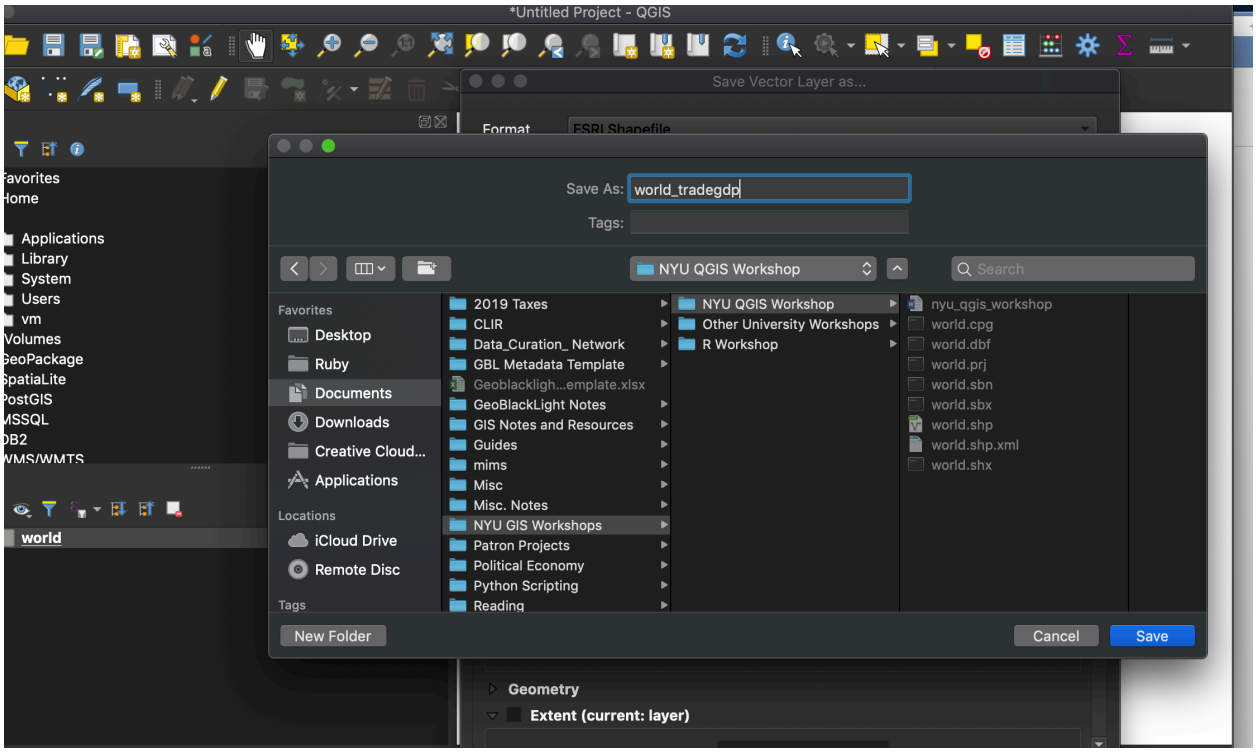
Step Eight: Export the Shapefile and Save a New Layer

Though our World Bank data is now attached to our shapefile layer, we will need to take additional steps to make the joined World Bank data a permanent part of the "world" shapefile's attribute table (unless the joined field is a permanent part of the shapefile, we cannot visualize the data). To make the join permanent, we must export the "world" shapefile as a new shapefile, which we will then proceed to use in lieu of the "world" shapefile we have been using thus far. This is essentially like doing a "save as" in a regular document, whereby you save the changes you have made in an existing document while simultaneously generating an entirely new document. Here, we are "saving as" our "world" shapefile into a new shapefile that contains the changes we have made to the "world" shapefile in the previous step(s).

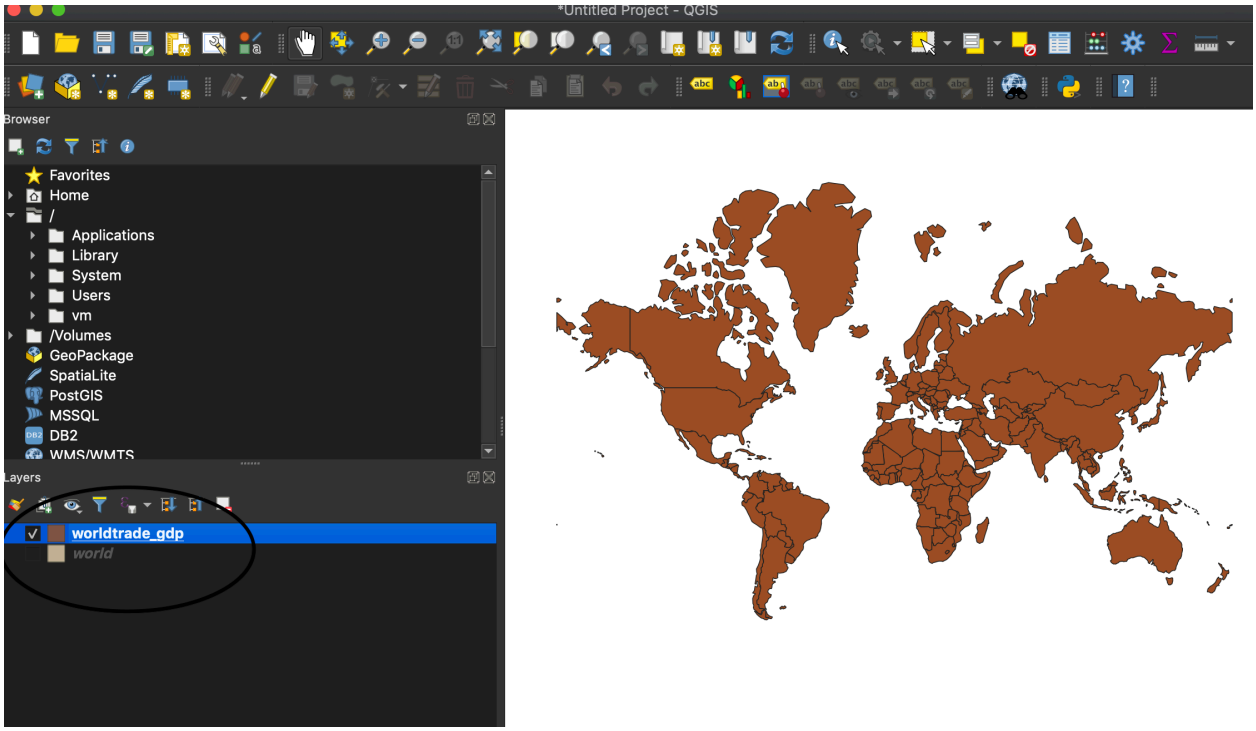
To carry out this process, right-click on the shapefile in the "Layers" window, scroll to "Export", and then click on "Save Features As."



This will open up the “Save Vector Layer as” dialog box. Next to “Format”, select “Esri Shapefile.” Then, next to “File name”, click on the ellipsis button (…) navigate to the folder in which you want to save your new shapefile, and give the new shapefile a descriptive name (different from the name of the original file). Here, we’ll label the shapefile “worldtrade_gdp”, which indicates that this is a new dataset that is the product of our joining of the World Bank data to our initial “world” shapefile.

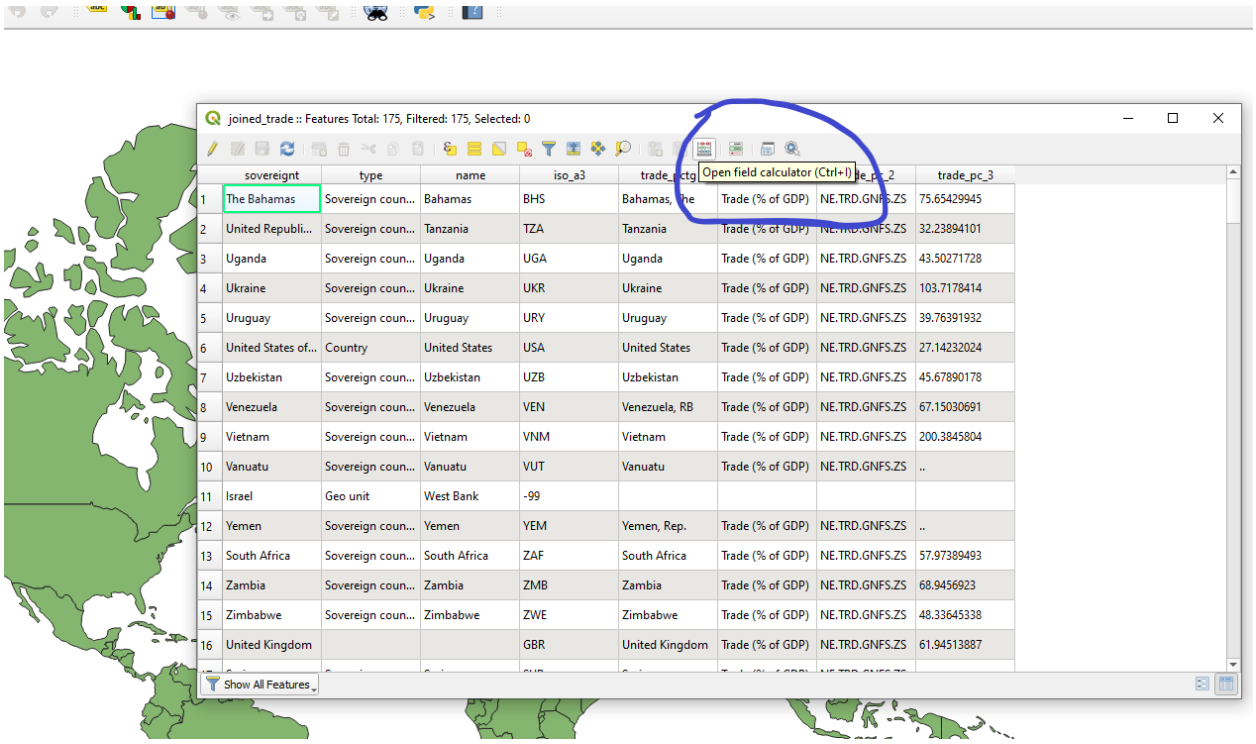


You should see the new layer added to your project. Go ahead and turn off the original “world” layer, and turn on the new “worldtrade_gdp” layer:



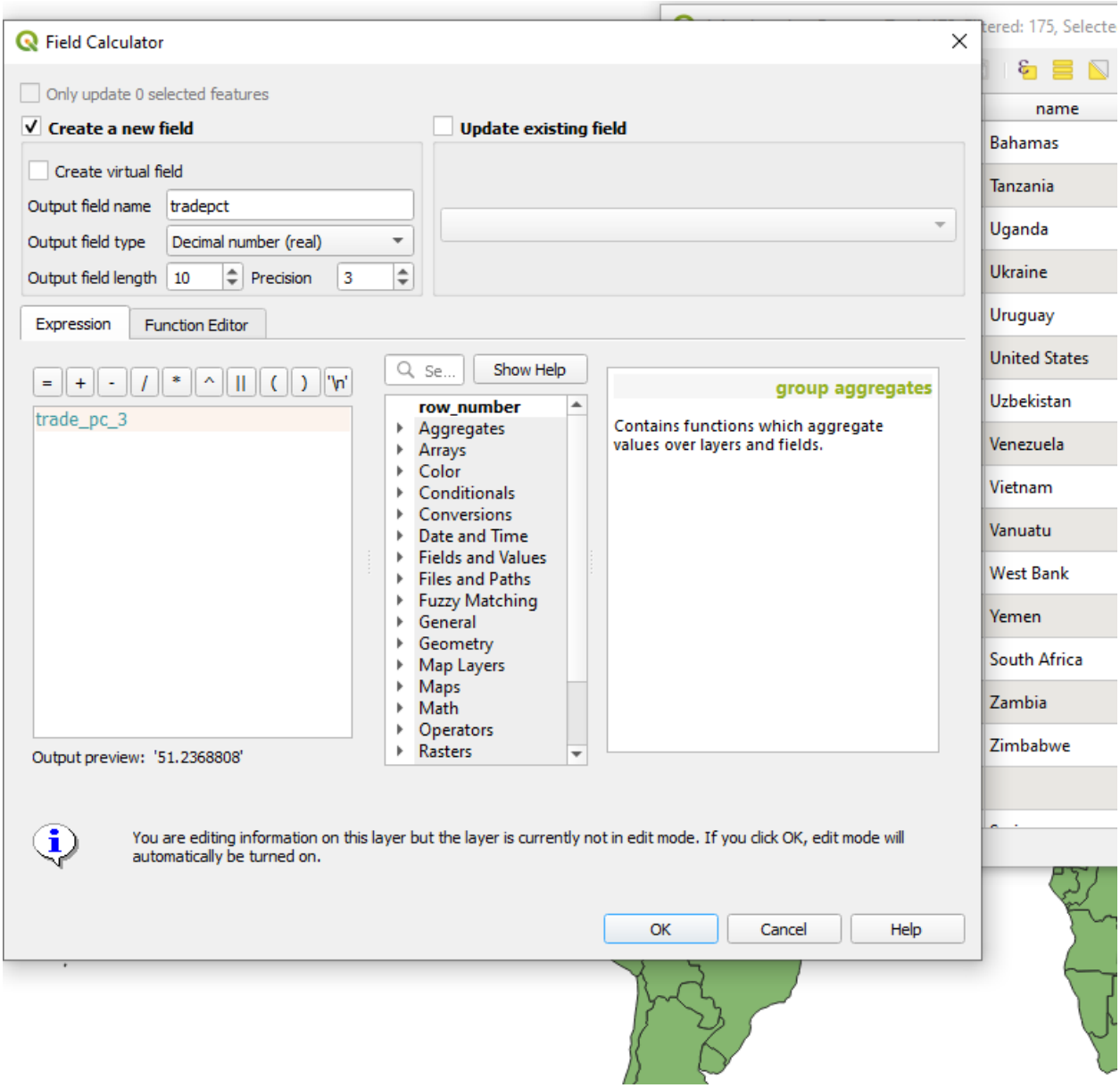
Step Nine: Create a new field to contain the data you want to map

Before mapping the World Bank data, we need to ensure that the data is in a format that QGIS's mapping utilities are able to read. First, open up the Attribute Table of the newly saved shapefile (here, "worldtrade_gdp"). Once you have opened it, click the "Open field calculator" button:

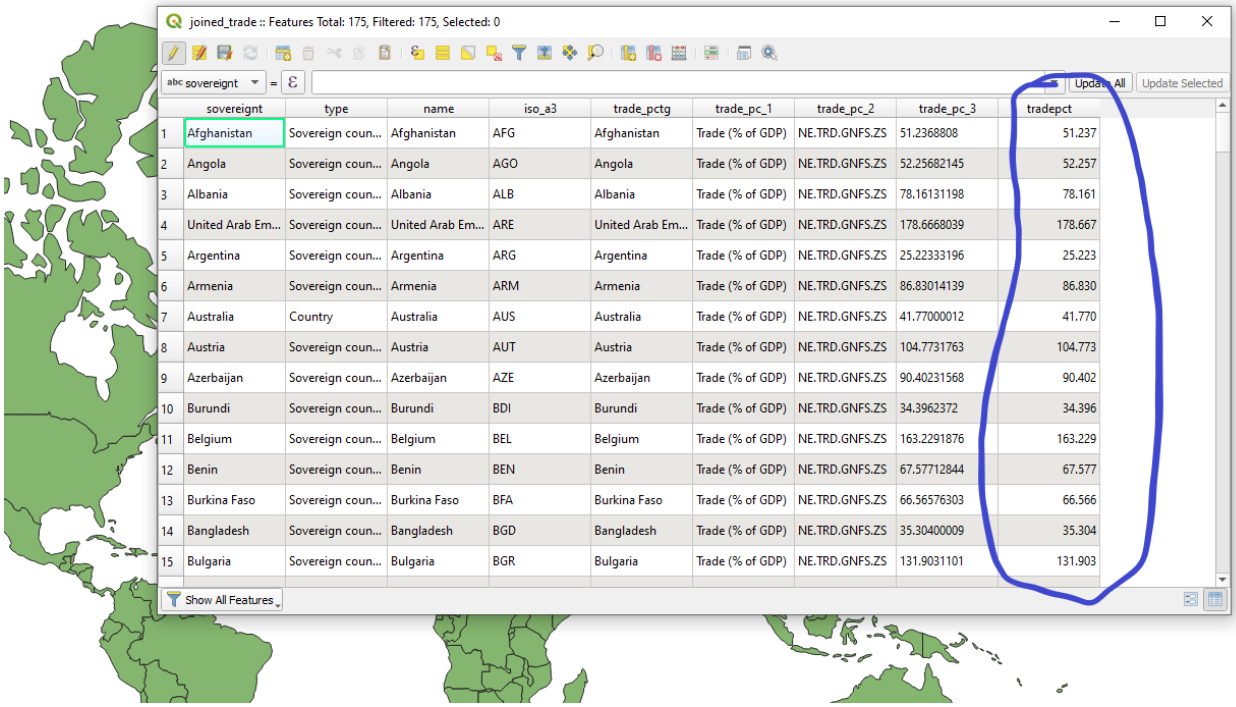


	sovereignt	type	name	iso_a3	trade_pctg			trade_pc_3
1	The Bahamas	Sovereign coun...	Bahamas	BHS	Bahamas, The	Trade (% of GDP)	NE.TRD.GNFS.ZS	75.65429945
2	United Republi...	Sovereign coun...	Tanzania	TZA	Tanzania	Trade (% of GDP)	NE.TRD.GNFS.ZS	32.23894101
3	Uganda	Sovereign coun...	Uganda	UGA	Uganda	Trade (% of GDP)	NE.TRD.GNFS.ZS	43.50271728
4	Ukraine	Sovereign coun...	Ukraine	UKR	Ukraine	Trade (% of GDP)	NE.TRD.GNFS.ZS	103.7178414
5	Uruguay	Sovereign coun...	Uruguay	URY	Uruguay	Trade (% of GDP)	NE.TRD.GNFS.ZS	39.76391932
6	United States of...	Country	United States	USA	United States	Trade (% of GDP)	NE.TRD.GNFS.ZS	27.14232024
7	Uzbekistan	Sovereign coun...	Uzbekistan	UZB	Uzbekistan	Trade (% of GDP)	NE.TRD.GNFS.ZS	45.67890178
8	Venezuela	Sovereign coun...	Venezuela	VEN	Venezuela, RB	Trade (% of GDP)	NE.TRD.GNFS.ZS	67.15030691
9	Vietnam	Sovereign coun...	Vietnam	VNM	Vietnam	Trade (% of GDP)	NE.TRD.GNFS.ZS	200.3845804
10	Vanuatu	Sovereign coun...	Vanuatu	VUT	Vanuatu	Trade (% of GDP)	NE.TRD.GNFS.ZS	..
11	Israel	Geo unit	West Bank	-99				
12	Yemen	Sovereign coun...	Yemen	YEM	Yemen, Rep.	Trade (% of GDP)	NE.TRD.GNFS.ZS	..
13	South Africa	Sovereign coun...	South Africa	ZAF	South Africa	Trade (% of GDP)	NE.TRD.GNFS.ZS	57.97389493
14	Zambia	Sovereign coun...	Zambia	ZMB	Zambia	Trade (% of GDP)	NE.TRD.GNFS.ZS	68.9456923
15	Zimbabwe	Sovereign coun...	Zimbabwe	ZWE	Zimbabwe	Trade (% of GDP)	NE.TRD.GNFS.ZS	48.33645338
16	United Kingdom			GBR	United Kingdom	Trade (% of GDP)	NE.TRD.GNFS.ZS	61.94513887

When the field calculator dialog box opens, we will use it to create a new field that contains the World Bank data, but which is in decimal format (which will allow it to be read by QGIS's mapping utilities). Under "Output field name" type in the name of the field that will contain the World Bank data in decimal format; here, we'll label it "tradepct." Next to "Output field type", select "Decimal number (real)". Then, in the white box at the bottom-left of the Field Calculator, type in the name of the field that contains the World Bank data in your new shapefile (which you exported in a previous step). When you're done, make sure that your filled-in Field Calculator looks something like this, and then click "OK":



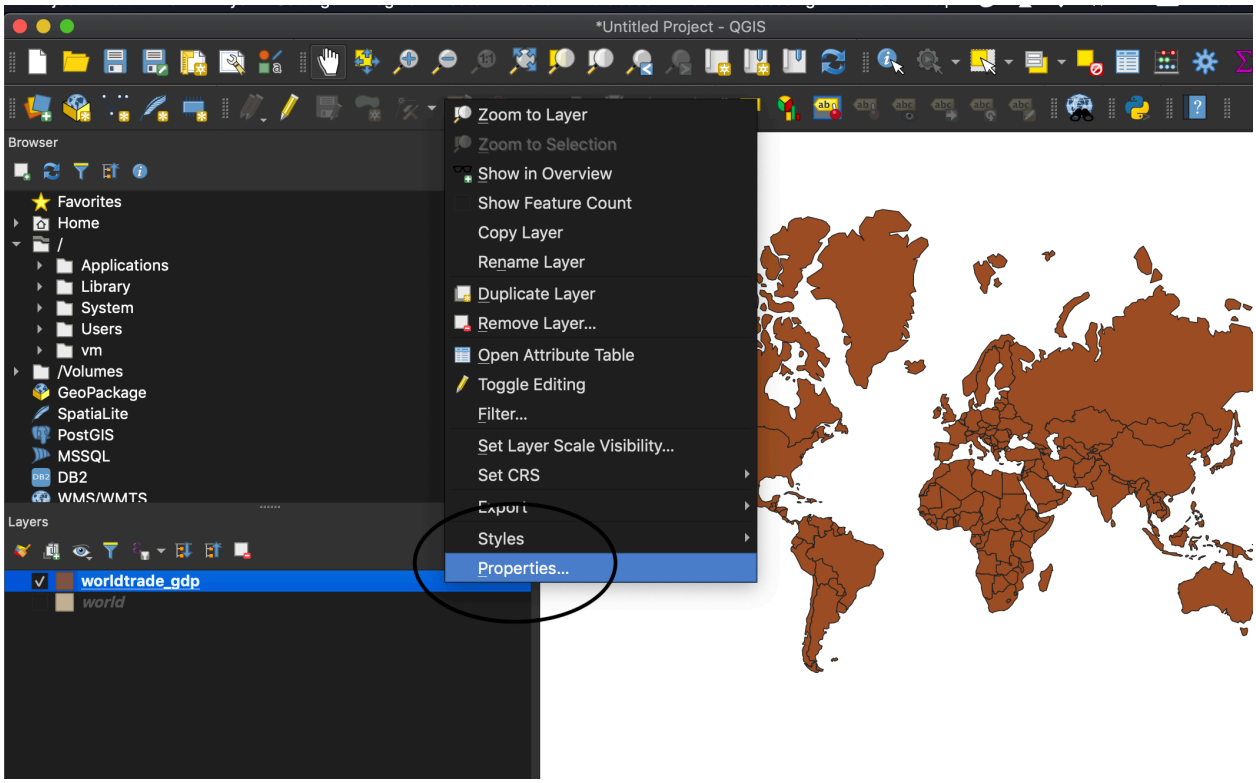
In the shapefile attribute table, you'll see your newly created field; after checking to make sure it appears, go ahead and close the attribute table.



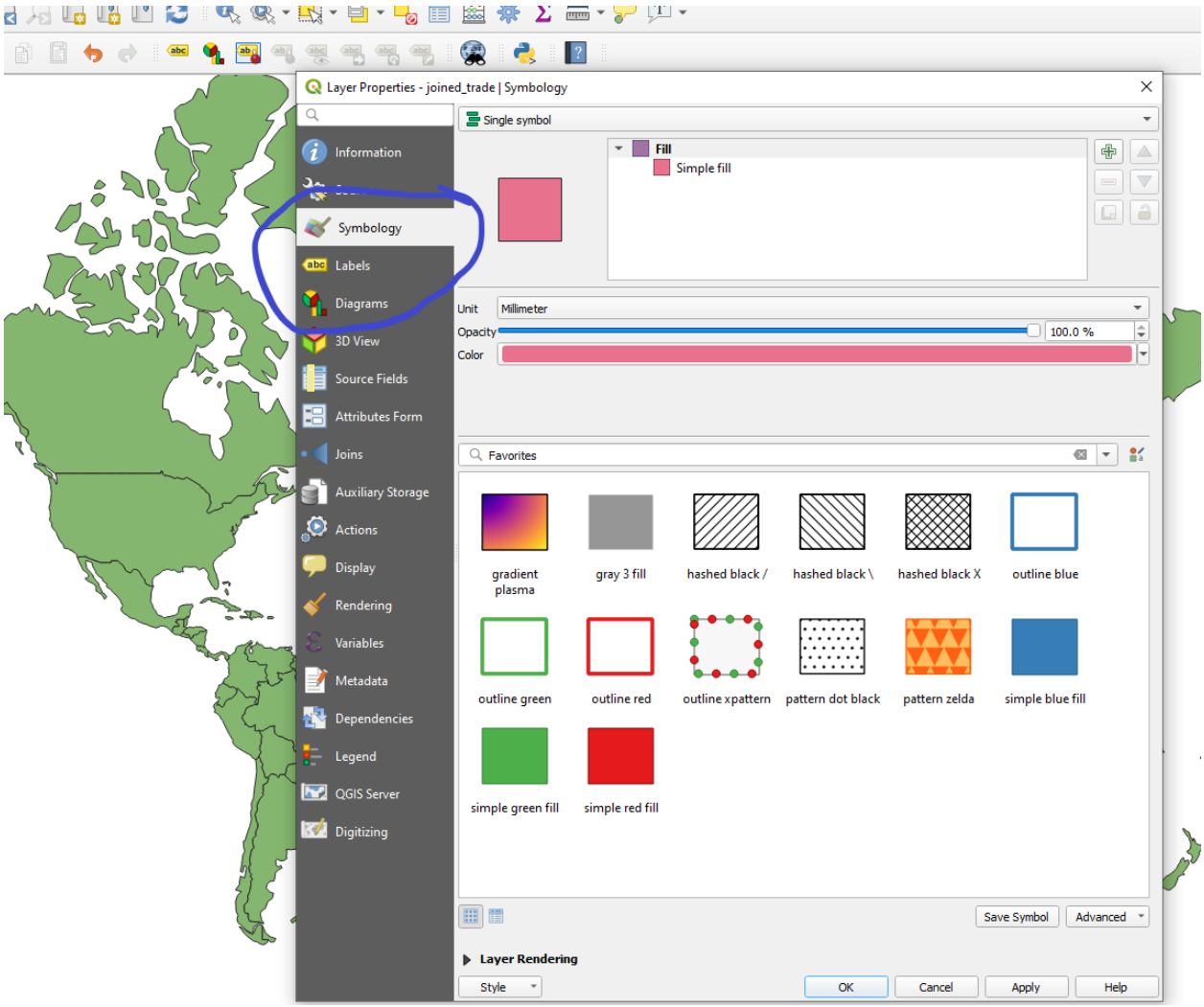
	sovereignt	type	name	iso_a3	trade_pctg	trade_pc_1	trade_pc_2	trade_pc_3	tradepct
1	Afghanistan	Sovereign coun...	Afghanistan	AFG	Afghanistan	Trade (% of GDP)	NE.TRD.GNFS.ZS	51.2368808	51.237
2	Angola	Sovereign coun...	Angola	AGO	Angola	Trade (% of GDP)	NE.TRD.GNFS.ZS	52.25682145	52.257
3	Albania	Sovereign coun...	Albania	ALB	Albania	Trade (% of GDP)	NE.TRD.GNFS.ZS	78.16131198	78.161
4	United Arab Em...	Sovereign coun...	United Arab Em...	ARE	United Arab Em...	Trade (% of GDP)	NE.TRD.GNFS.ZS	178.6668039	178.667
5	Argentina	Sovereign coun...	Argentina	ARG	Argentina	Trade (% of GDP)	NE.TRD.GNFS.ZS	25.22333196	25.223
6	Armenia	Sovereign coun...	Armenia	ARM	Armenia	Trade (% of GDP)	NE.TRD.GNFS.ZS	86.83014139	86.830
7	Australia	Country	Australia	AUS	Australia	Trade (% of GDP)	NE.TRD.GNFS.ZS	41.77000012	41.770
8	Austria	Sovereign coun...	Austria	AUT	Austria	Trade (% of GDP)	NE.TRD.GNFS.ZS	104.7731763	104.773
9	Azerbaijan	Sovereign coun...	Azerbaijan	AZE	Azerbaijan	Trade (% of GDP)	NE.TRD.GNFS.ZS	90.40231568	90.402
10	Burundi	Sovereign coun...	Burundi	BDI	Burundi	Trade (% of GDP)	NE.TRD.GNFS.ZS	34.3962372	34.396
11	Belgium	Sovereign coun...	Belgium	BEL	Belgium	Trade (% of GDP)	NE.TRD.GNFS.ZS	163.2291876	163.229
12	Benin	Sovereign coun...	Benin	BEN	Benin	Trade (% of GDP)	NE.TRD.GNFS.ZS	67.57712844	67.577
13	Burkina Faso	Sovereign coun...	Burkina Faso	BFA	Burkina Faso	Trade (% of GDP)	NE.TRD.GNFS.ZS	66.56576303	66.566
14	Bangladesh	Sovereign coun...	Bangladesh	BGD	Bangladesh	Trade (% of GDP)	NE.TRD.GNFS.ZS	35.30400009	35.304
15	Bulgaria	Sovereign coun...	Bulgaria	BGR	Bulgaria	Trade (% of GDP)	NE.TRD.GNFS.ZS	131.9031101	131.903

Step Ten: Map your variable!

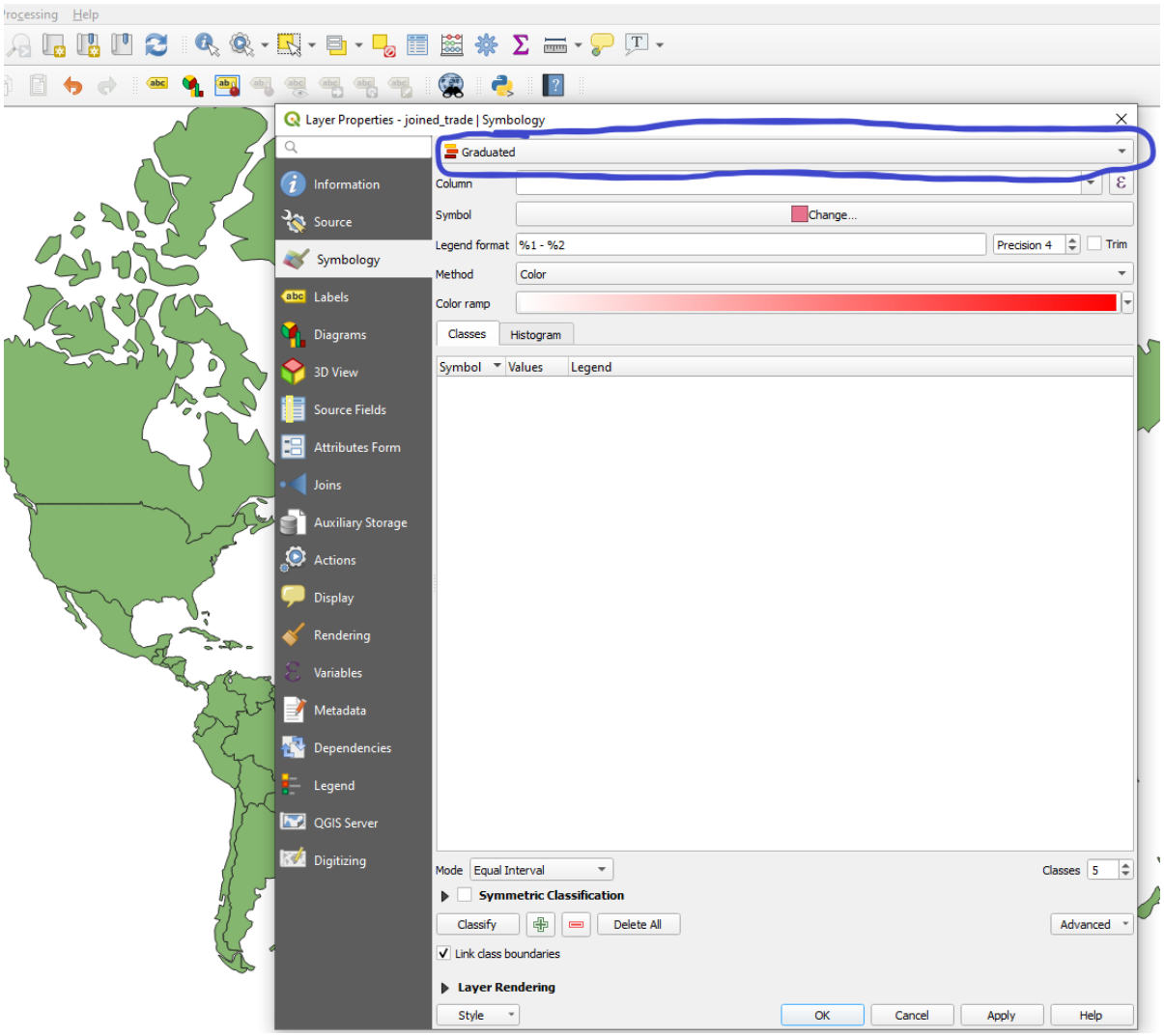
We're finally ready to map our variable of interest. Right click on your new shapefile (here, the "worldtrade_gdp" shapefile) and click "Properties":



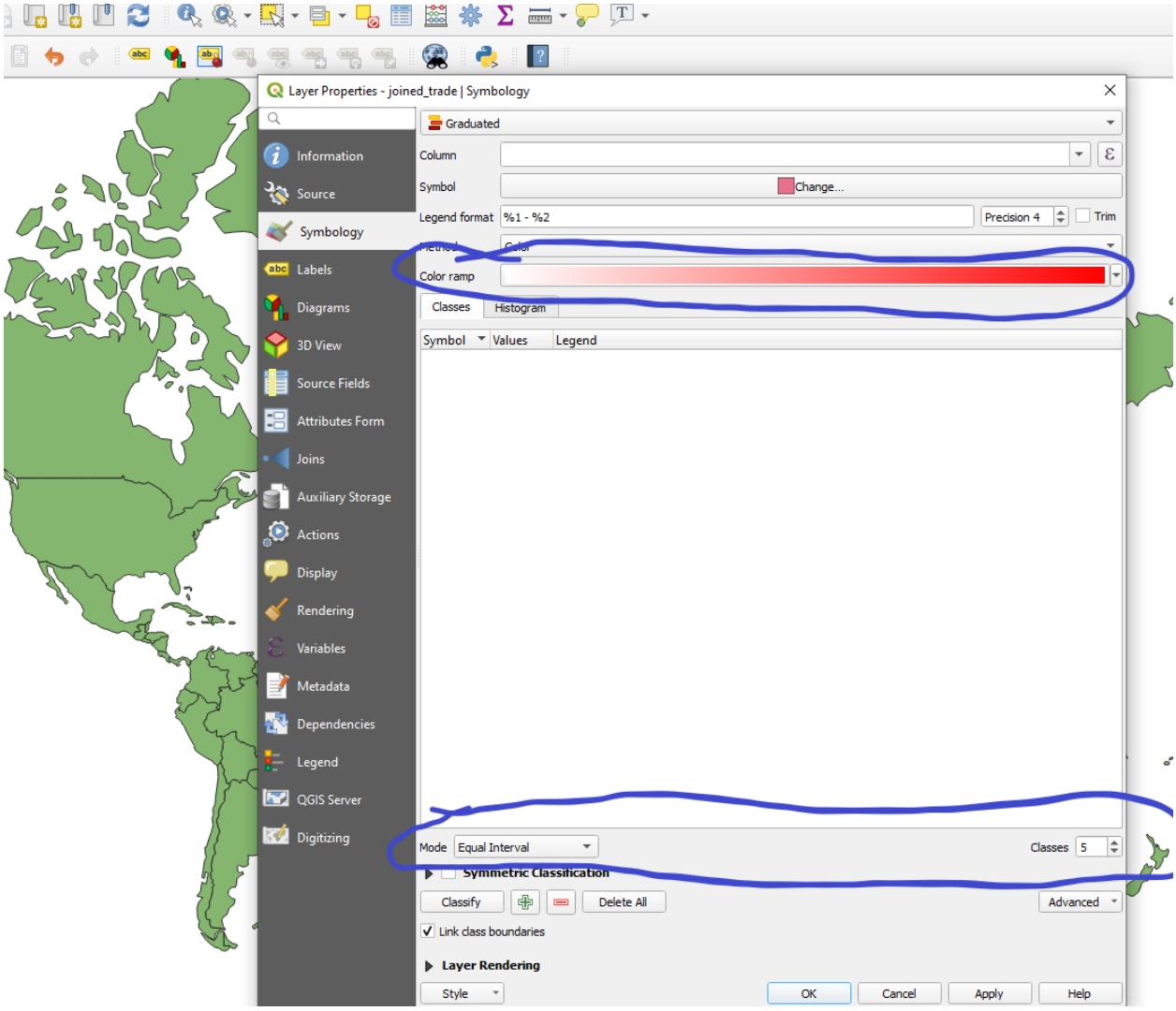
Within the shapefile's "Layer Properties" dialog box, select the "Symbology" tab:



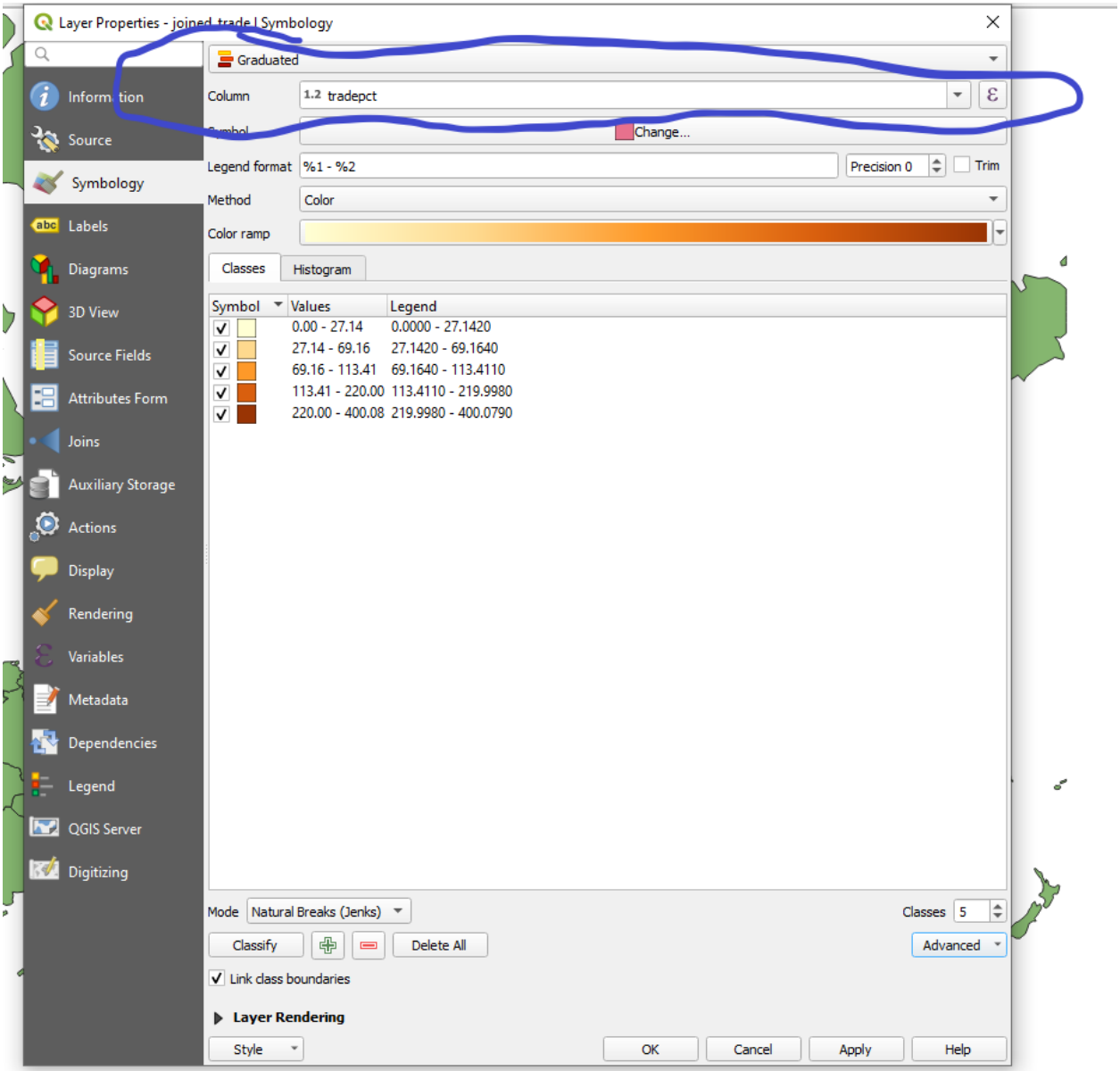
We want to make a choropleth map that shows how our variable of interest varies across our geographic units of interest (i.e. countries). To do so, select “Graduated” from the drag-down menu at the top of the Layer Properties→Symbology dialog box:



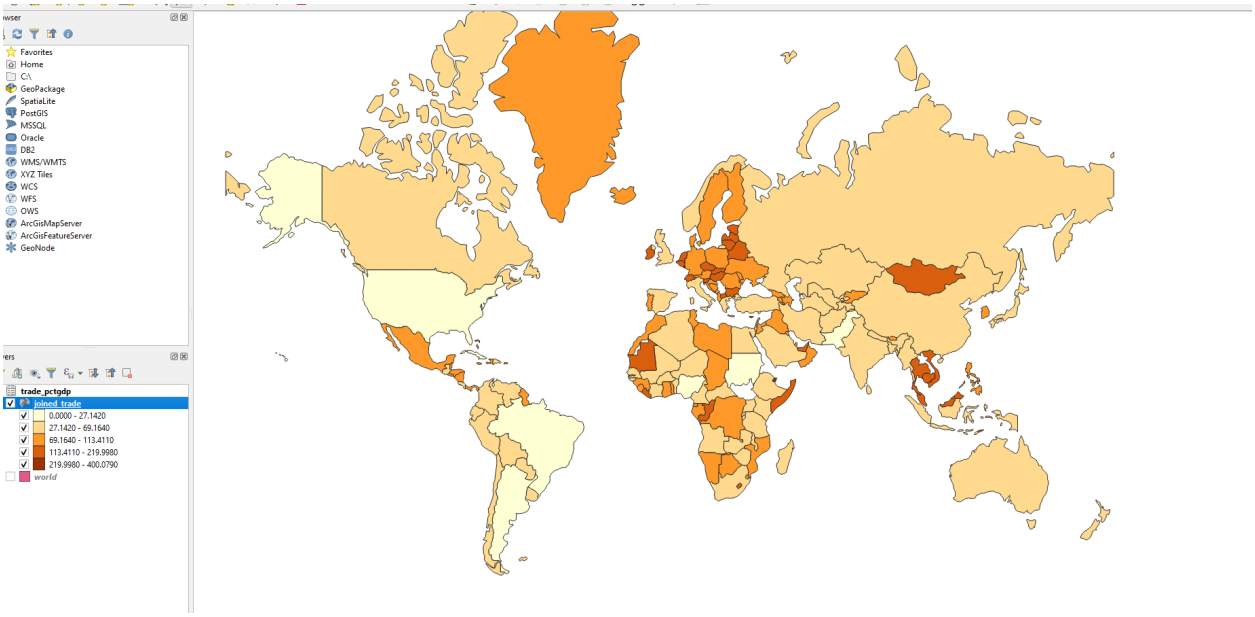
Then, select the color scheme you want to use, as well as the interval scheme you want and the number of intervals you think would be appropriate. It's best to experiment with different possibilities.



Once you've made your selections, hit the "Classify" button. Make sure that under "Column", you've selected the name of the field containing the World Bank variable:



Go ahead and click “Apply”, and then click “OK”. You now have a chloropleth map that shows how your World Bank variable varies geographically with respect to the world’s countries:[1]



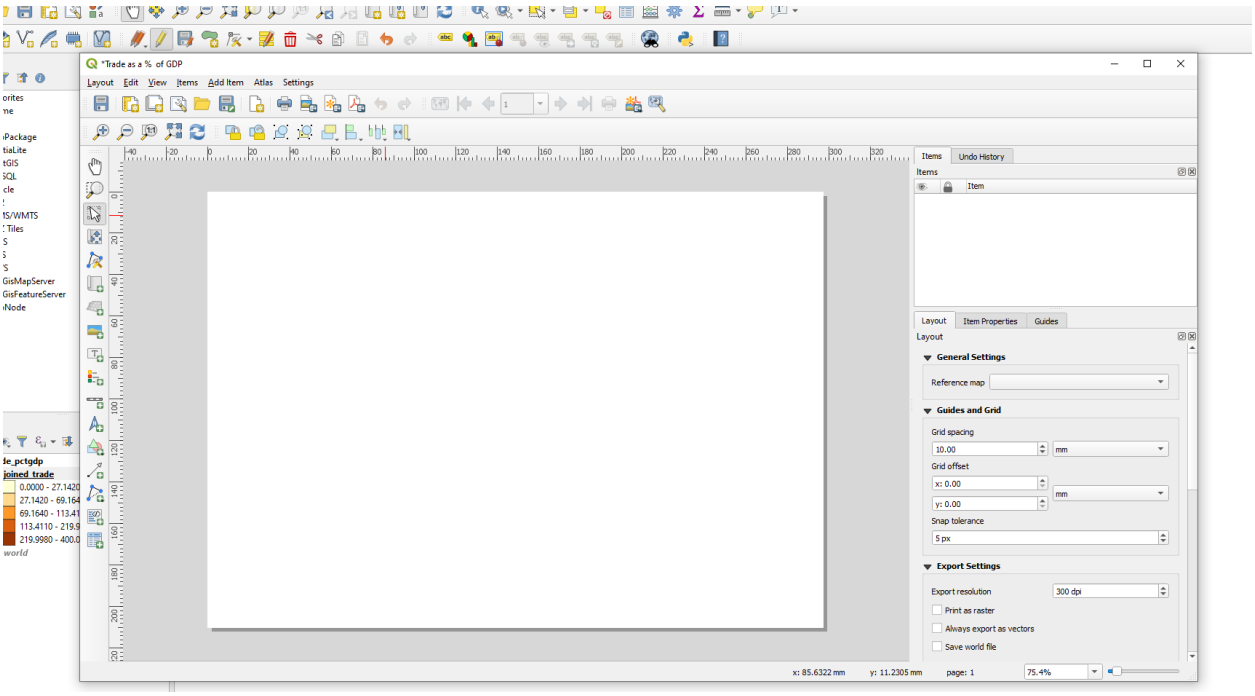
[1] Note that under QGIS’s default settings, geographic units for which there is no data (for the mapped variable) in the attribute table are excluded from the map. If you want to display countries without data in your map, and give these countries a legend entry in the final map to indicate that they do not have data associated with them, you must take some additional steps. These steps are detailed in the appendix.

NYU DataServices

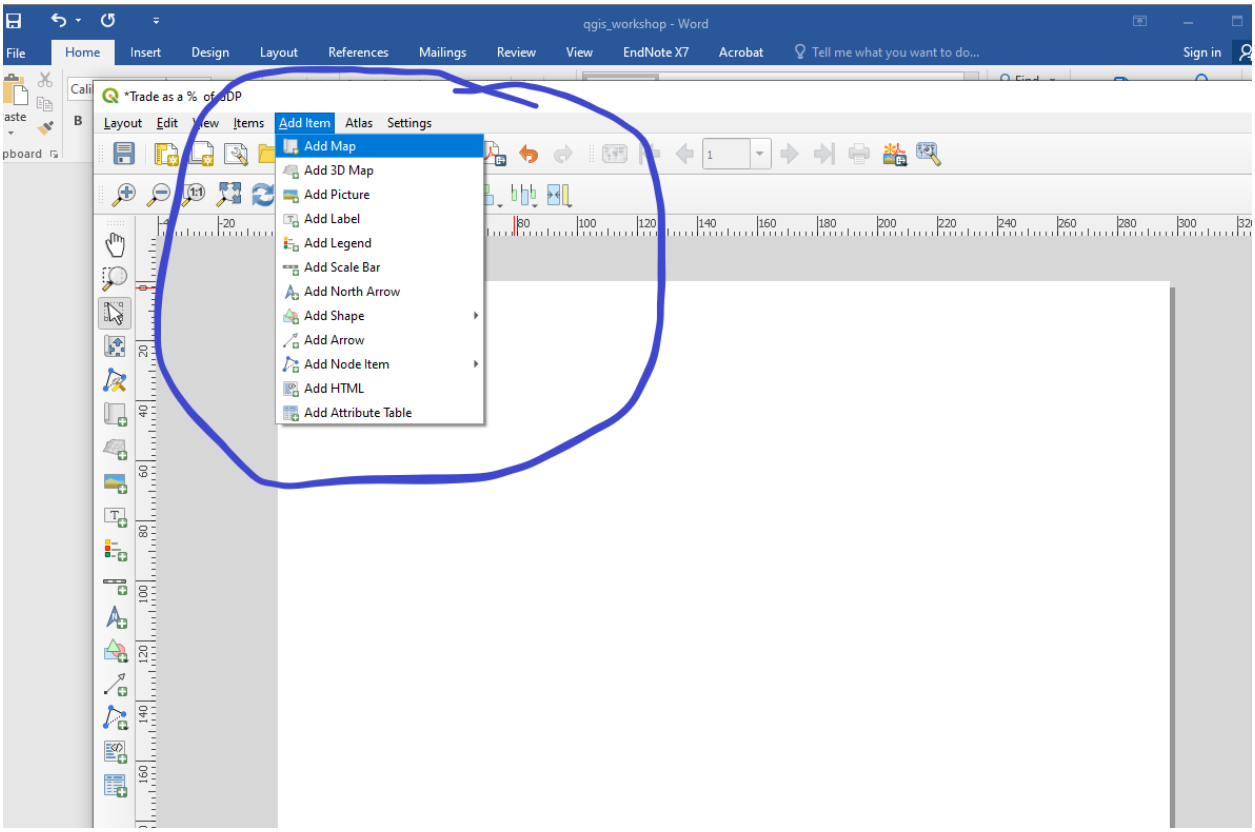
Step 11: Make an Exportable Map

Now that the heavy lifting is done, we will refine and export the map. To bring up QGIS's cartographic utility, go to Project→New Print layout (or alternatively Ctrl + P), and give your layout a name.

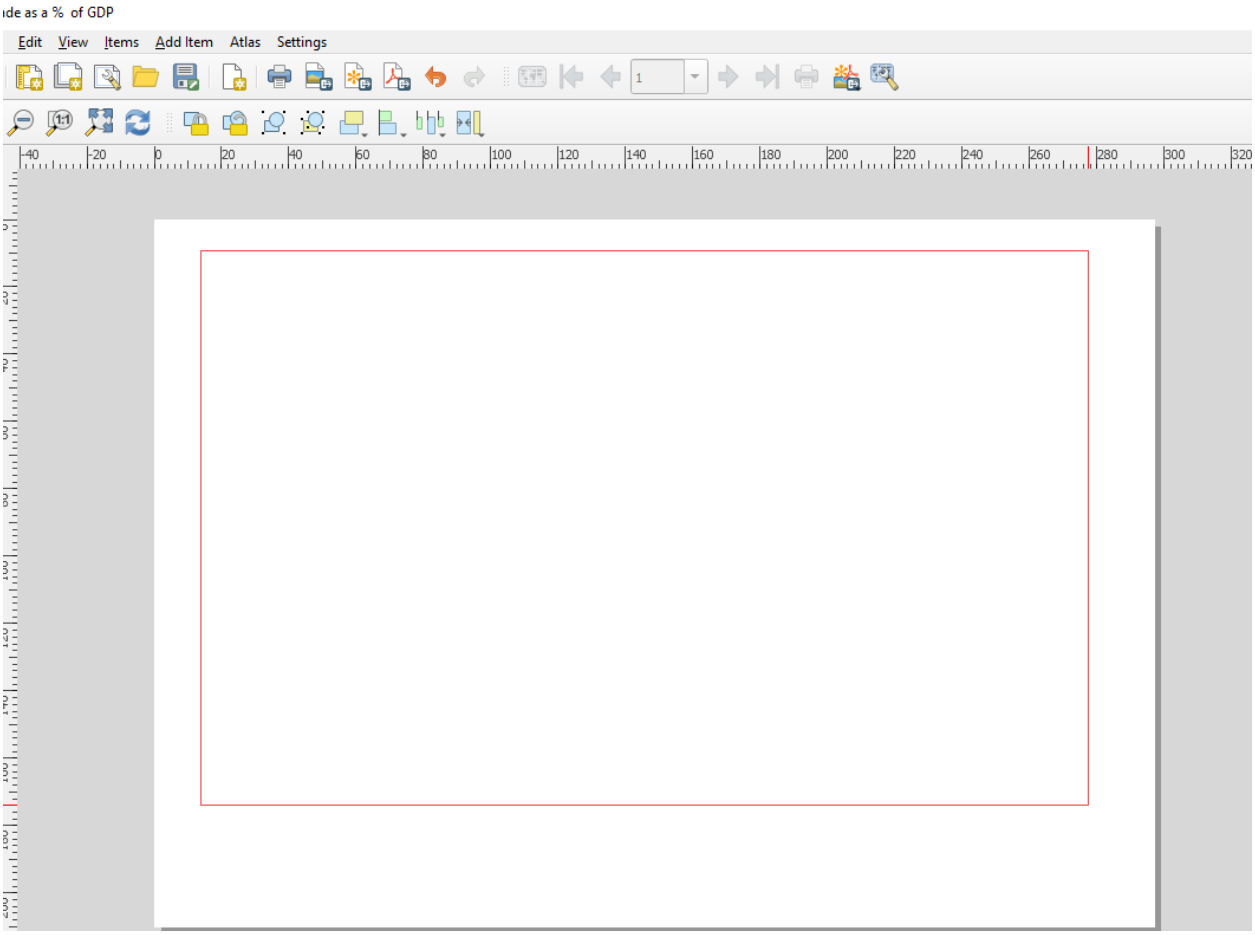
This brings up a window that looks something like this:



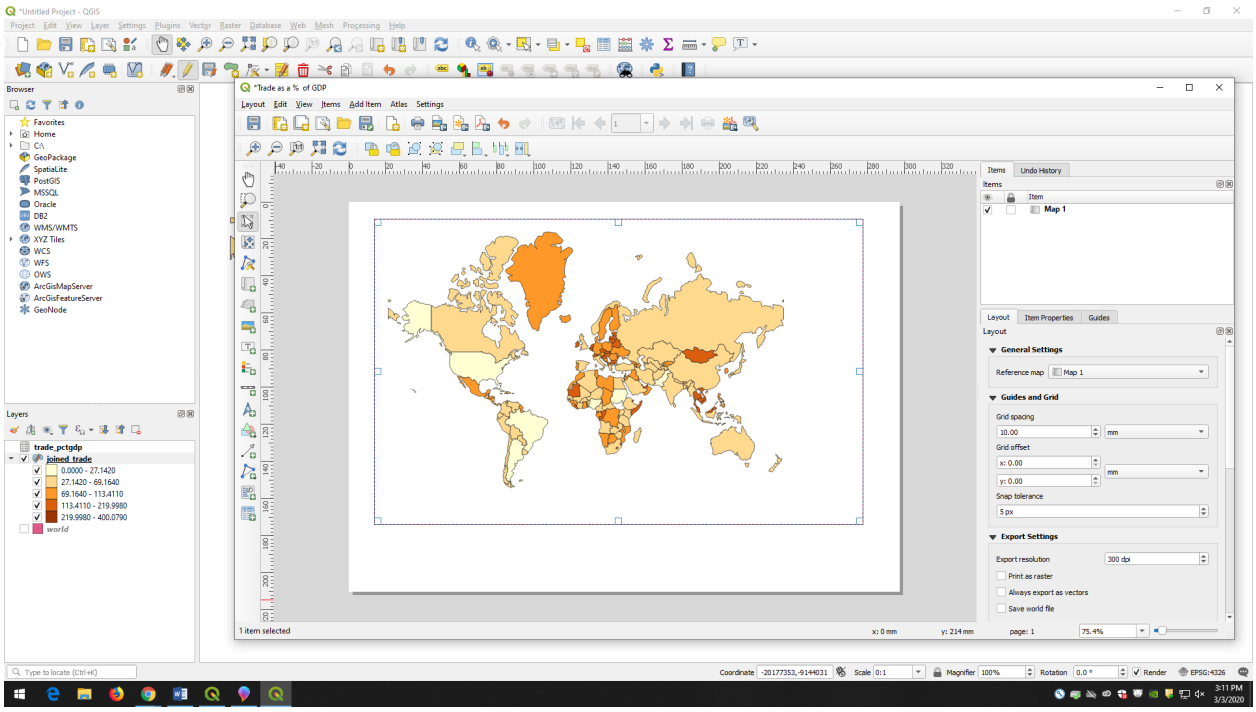
To add your map to QGIS's cartographic utility, click on "Add Item" in the taskbar, and then click add map:



Once you click “Add Map”, a cross-shaped cursor will appear; use it to draw a box in the white window that is the size of your desired map:

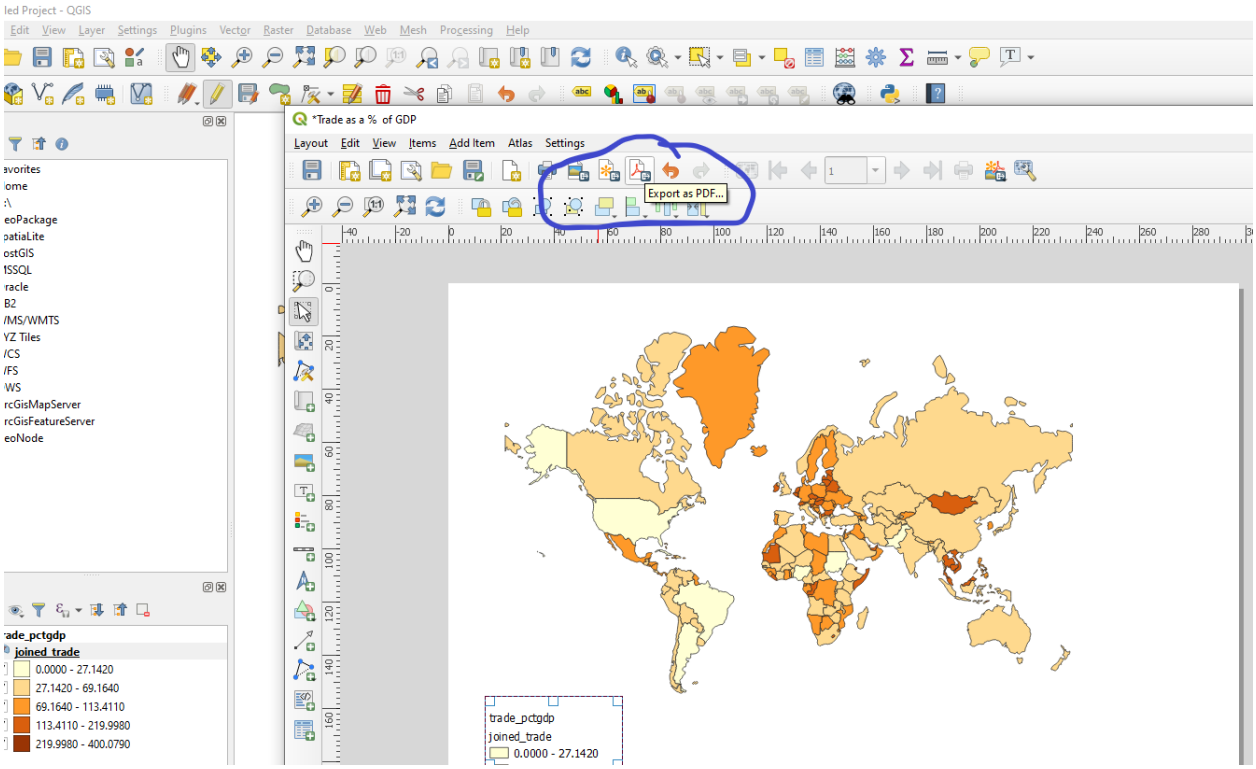


Once you release your mouse, the map will appear within the print layout window:



You can use the “Add Item” tab to add and edit a map legend, title, scale bar, and north arrow. You should add these features and arrange them in a way that is pleasing to you. Feel free to experiment! While doing this, you should also consult the online documentation regarding QGIS’s map-making capabilities; consulting such documentation is an important part of working with open-source software, so this will be good practice.

Once you are satisfied with how your map looks, you can use the toolbar to export the map in a file format of your choice:



Concluding Reflections

Briefly tell us a little bit about your map. Some things you may wish to think about and share:

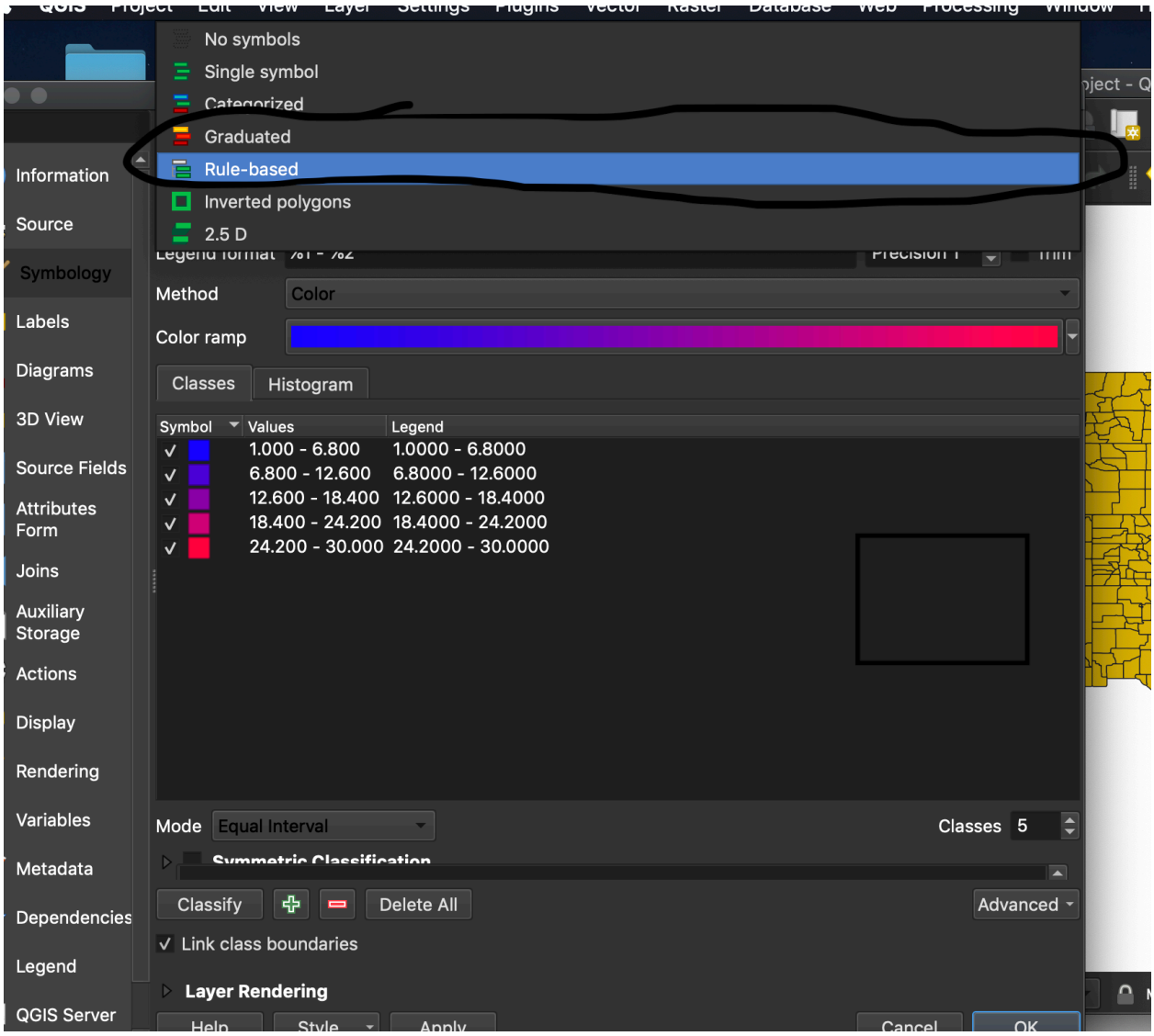
- What spatial patterns do you see and what might explain them?
    - Are there interesting patterns of clustering or dispersion? Are there regional or continent-level effects? Are there noticeable differences between coastal and landlocked countries? Do you notice spatial patterns tied to historical or colonial legacies?
- How might our chosen map projection affect our ability to recognize spatial patterns?
- What patterns can you recognize on your map that you couldn't have seen in your original tabular dataset?
- How might you extend or enrich this simple project using the tools you have already learned. For instance, how might you make a map that displays change over time?

If you're willing to share your final map, please send it to me!

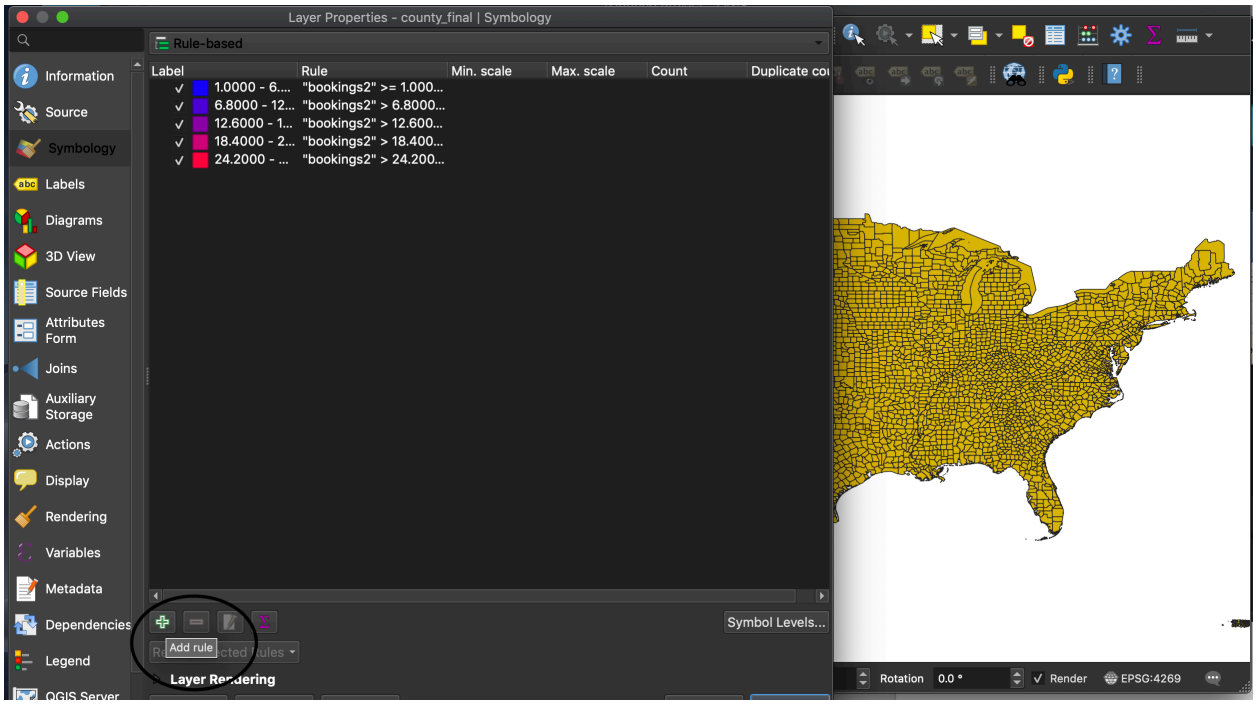
Appendix: Displaying geographic units for which there is no data in QGIS

In order to display countries for which the World Bank does not provide data on your map (and inform the map's viewers of which countries fall into this category), before clicking "OK" to close the symbology tab (see pp. 38-39), you must take the following additional steps:

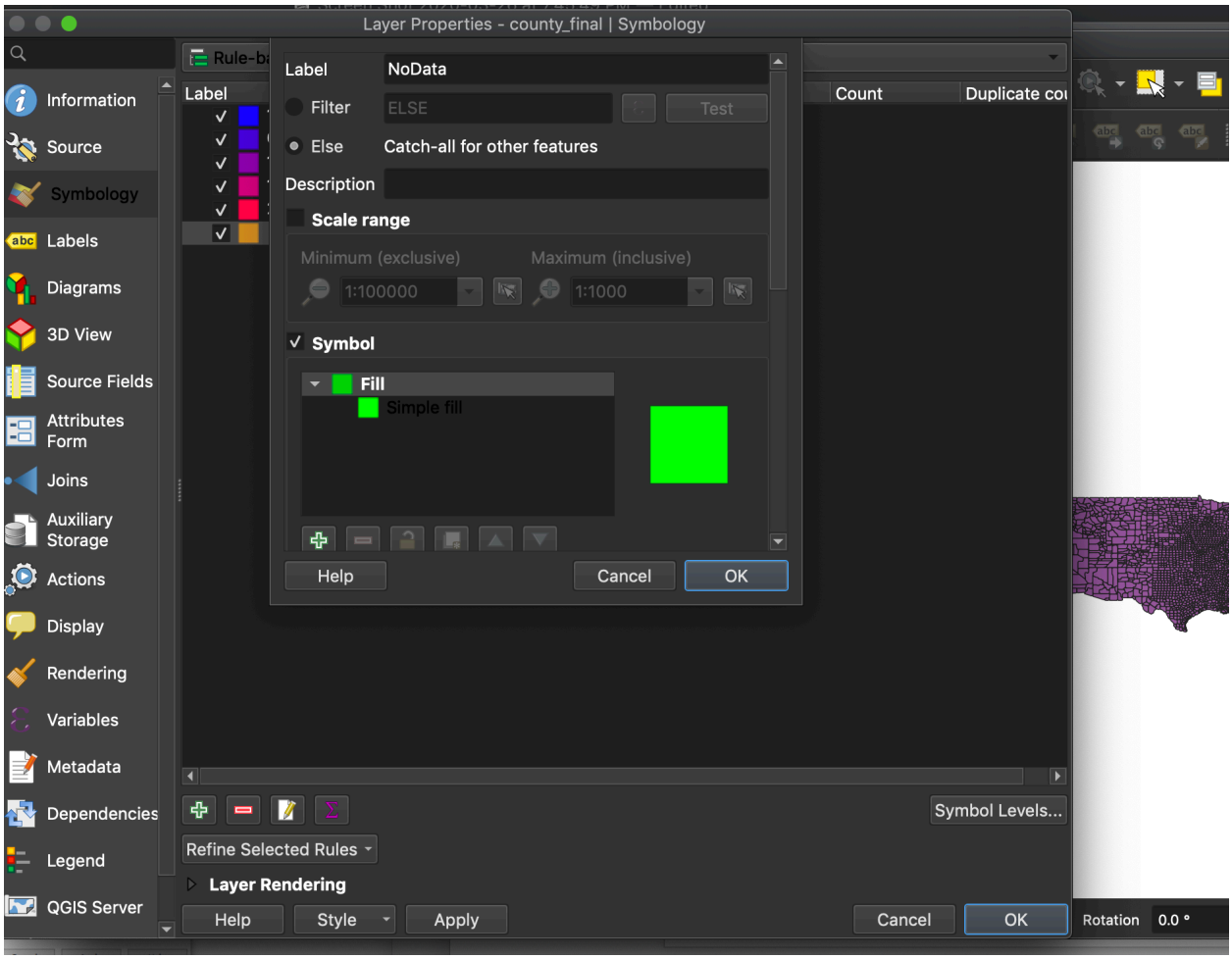
Click on the top drop down in the Symbology menu and select "Rule-Based":



Select the small green “+” icon in the “Rule Based” dialog box (it will say “Add rule” when you hover over it).



In the dialog box that opens up, select “Else” within the “Labels” heading. Next to “Label” enter the name you wish to use to represent areas in your map that do not have data (i.e. something along the lines of “NoData” or “NA”. You can also select the color you would like to use to represent the “NoData” values. When you’re done, the “Rules Based” dialog box would look something like this:



Once you click “OK” you should have a map that represents your bookings data on the map (according to the color and interval scheme you selected), along with “NoData” areas clearly demarcated.