Mapping 2: Manipulating geographical data with QGIS

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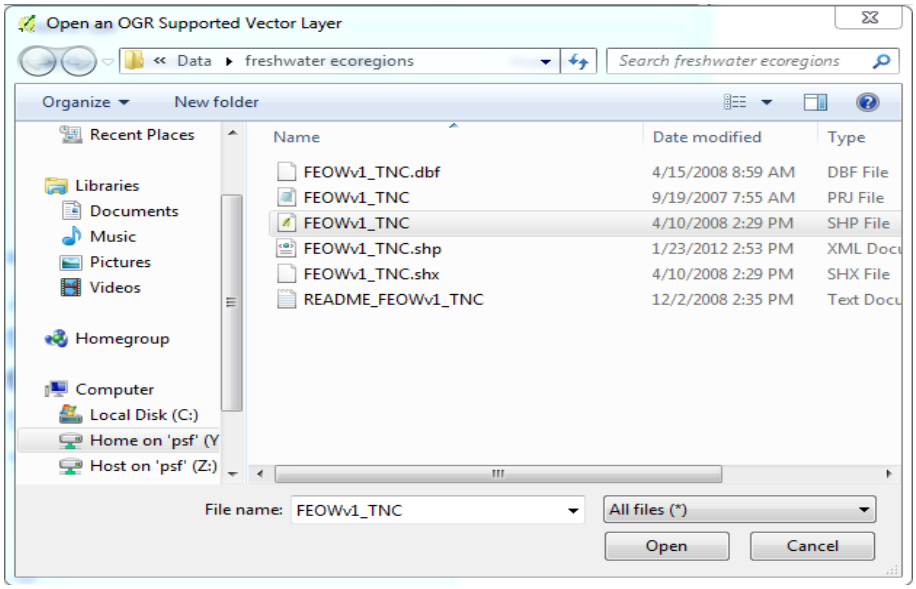
In addition to displaying geographic data, QGIS is a powerful tool for processing data for use by other mapping applications. If you want to make online maps, using tools including TileMill and Leaflet, for instance, QGIS can help get your data into the right shape.

In this class we'll explore some useful QGIS data processing functions, including joining tables of data to existing shapefiles, simplifying geographic features so that online maps will render quickly, and how to save data in formats commonly used for web mapping. We'll also learn how to edit geographic data, and how to process data consisting of hundreds or thousands of closely spaced or overlapping points to give a more meaningful summary display.

Joining data to a shapefile

Launch **QGIS Desktop**, and import this shapefile:



(During this class, we're not going to set a specific projection, and will work throughout with the WGS84 lat-long default. So whenever you're prompted, accept this option.)

The imported shapefile contains the boundary data for the world's freshwater ecoregions, to which were going to join the data on threatened amphibians that we mapped in the previous class. If you open the attribute table, you'll see that it lacks the **THREAT_AMP** column that we used to create the thematic map.

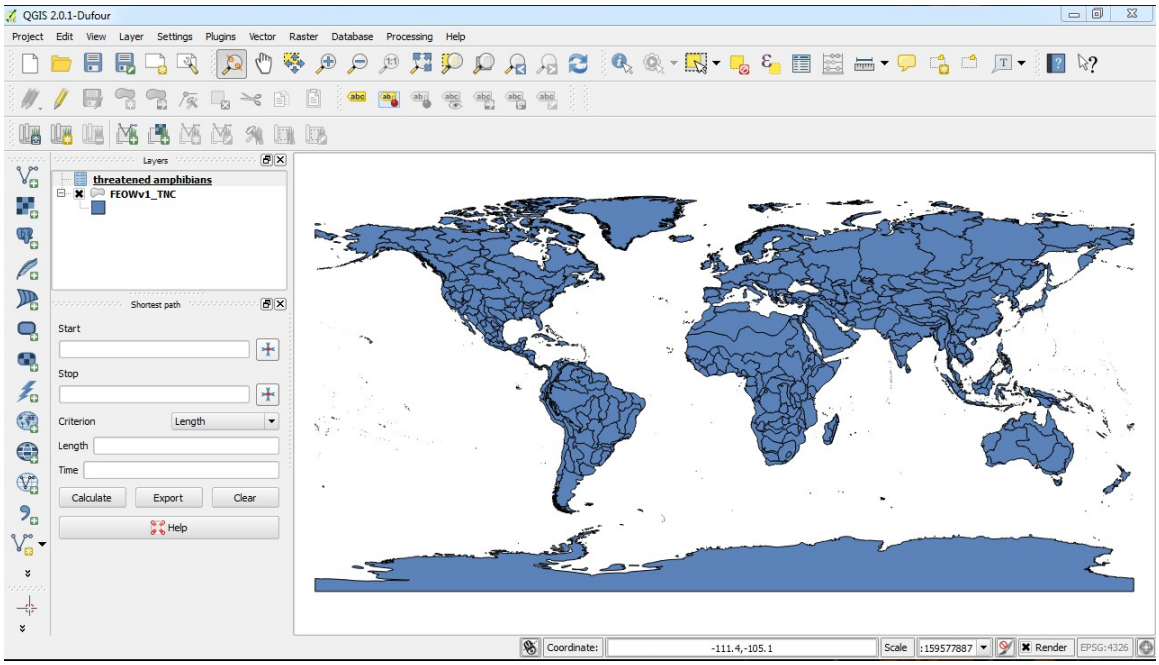
The data is in this file, which I've saved in **DBF** format. You can create DBFs from any spreadsheet – I'd recommend using **Calc**, the free spreadsheet program avilable in LibreOffice. Simply open your spreadsheet in Calc, and select **File>Save As** File Type **dBASE (.dbf)**.

Here's the data, which has two columns, **THREAT_AMP** and **ECO_ID** (you can ignore the letter and numbers after the first comma, which are a description of the data):

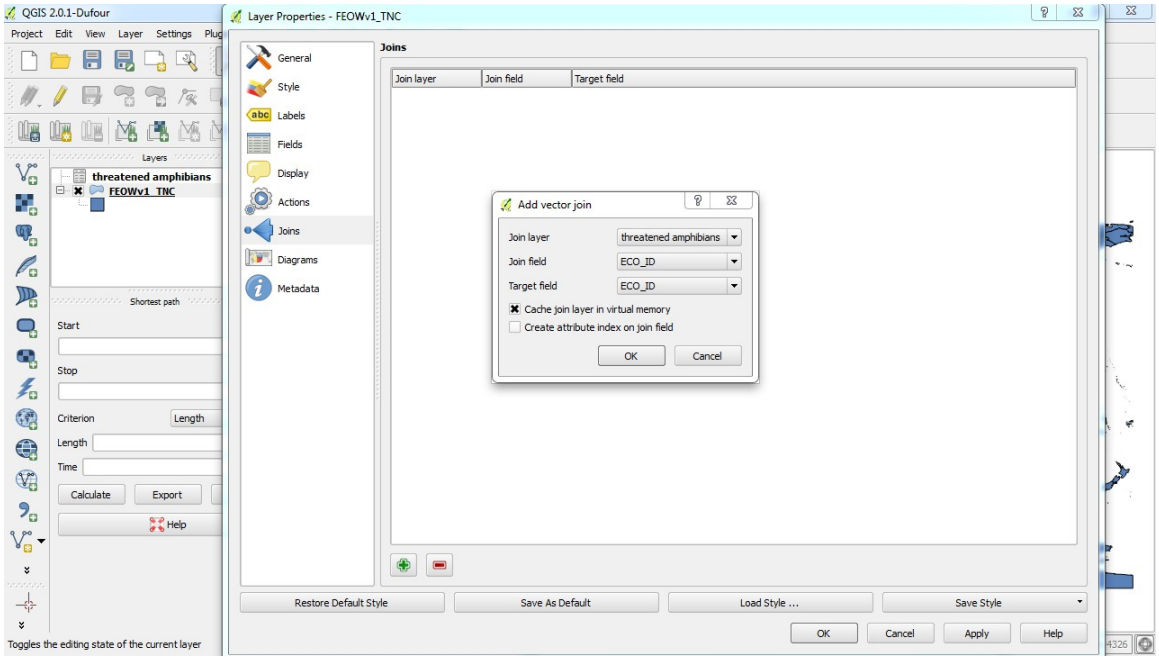
	A	B	C	D
1	ECO_ID,N,6,2	THREAT_AMP,N,5,2		
2	312.00	95.00		
3	301.00	94.00		
4	302.00	68.00		
5	765.00	43.00		
6	715.00	37.00		
7	518.00	37.00		
8	201.00	35.00		
9	203.00	33.00		
10	305.00	33.00		
11	519.00	33.00		
12	202.00	32.00		
13	171.00	29.00		
14	304.00	29.00		
15	807.00	29.00		
16	505.00	28.00		
17	173.00	26.00		
18	206.00	26.00		
19	205.00	25.00		
20	581.00	25.00		
21	204.00	23.00		
22	174.00	23.00		
23	763.00	23.00		
24	165.00	22.00		

The shapefile contains the column **ECO_ID**, too, so we can use this field to join the threatened amphibian data to each ecoregion. If you've used relational databases, this is conceptually the same as an “inner join” query, which pulls together data from different tables where they match for a selected field.

First we need to add the DBF to the project, using **Layer>Add vector layer**. Notice how it appears in the **Layers** panel with an attribute table icon:

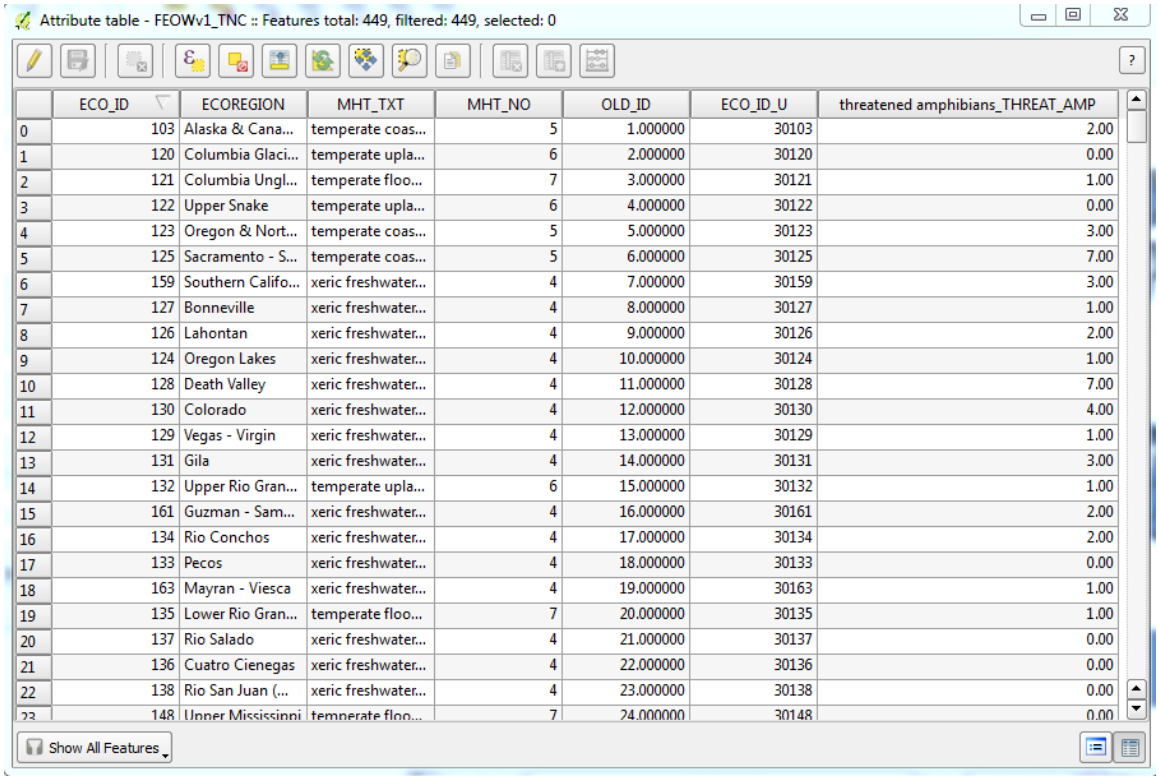


Right click on the shapefile in the **Layers** panel, select **Properties>Joins**, click  and fill in the dialog box as follows:



Click **Apply** and **OK** to complete the join.

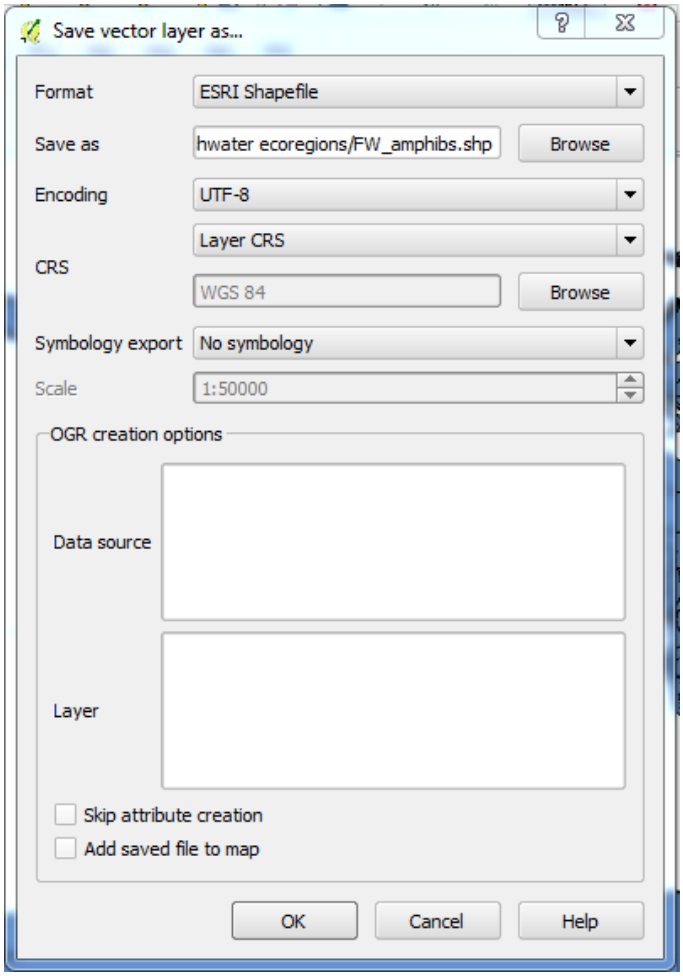
Open the shapefile's attribute table, and see that it contains the joined data on threatened amphibians in a new column at the right:



	ECO_ID	ECOREGION	MHT_TXT	MHT_NO	OLD_ID	ECO_ID_U	threatened amphibians_THREAT_AMP
0	103	Alaska & Cana...	temperate coas...	5	1.000000	30103	2.00
1	120	Columbia Glaci...	temperate upla...	6	2.000000	30120	0.00
2	121	Columbia Ungl...	temperate floo...	7	3.000000	30121	1.00
3	122	Upper Snake	temperate upla...	6	4.000000	30122	0.00
4	123	Oregon & Nort...	temperate coas...	5	5.000000	30123	3.00
5	125	Sacramento - S...	temperate coas...	5	6.000000	30125	7.00
6	159	Southern Califo...	xeric freshwater...	4	7.000000	30159	3.00
7	127	Bonneville	xeric freshwater...	4	8.000000	30127	1.00
8	126	Lahontan	xeric freshwater...	4	9.000000	30126	2.00
9	124	Oregon Lakes	xeric freshwater...	4	10.000000	30124	1.00
10	128	Death Valley	xeric freshwater...	4	11.000000	30128	7.00
11	130	Colorado	xeric freshwater...	4	12.000000	30130	4.00
12	129	Vegas - Virgin	xeric freshwater...	4	13.000000	30129	1.00
13	131	Gila	xeric freshwater...	4	14.000000	30131	3.00
14	132	Upper Rio Gran...	temperate upla...	6	15.000000	30132	1.00
15	161	Guzman - Sam...	xeric freshwater...	4	16.000000	30161	2.00
16	134	Rio Conchos	xeric freshwater...	4	17.000000	30134	2.00
17	133	Pecos	xeric freshwater...	4	18.000000	30133	0.00
18	163	Mayran - Viesca	xeric freshwater...	4	19.000000	30163	1.00
19	135	Lower Rio Gran...	temperate floo...	7	20.000000	30135	1.00
20	137	Rio Salado	xeric freshwater...	4	21.000000	30137	0.00
21	136	Cuatro Cienegas	xeric freshwater...	4	22.000000	30136	0.00
22	138	Rio San Juan (...	xeric freshwater...	4	23.000000	30138	0.00
23	148	Upper Mississippi	temperate floo...	7	24.000000	30148	0.00

Here are [further instructions] on joining data to shapefiles, including from CSV files.

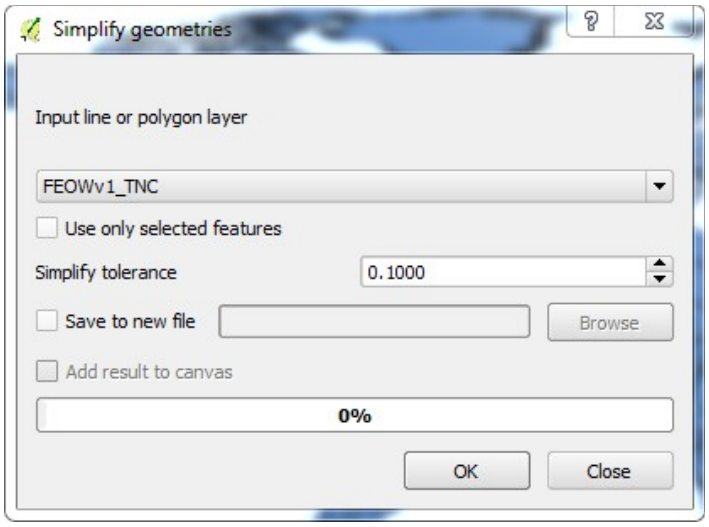
Now is a good time to save the joined shapefile. Right click on it in the **Layers** panel, and **Save as** an **ESRI Shapefile** with a suitable name:



We can also use the same dialog box to export the data in formats commonly used for web mapping, such as geoJSON or KML. But there's one problem: The boundary data is highly detailed, which will make the exported data file huge and sluggish to load.

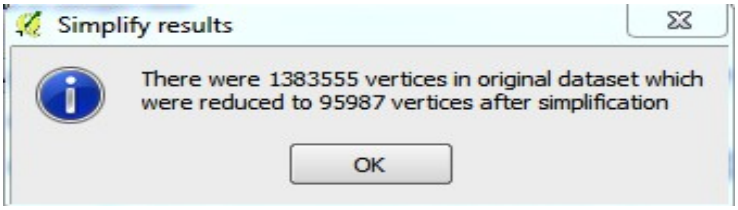
Simplifying the geometry of your data

To solve that problem, select **Vector>Geometry Tools>Simplify geometries**, fill in the dialog box as follows, and click **OK**:



In practice, you will probably want to check the **Save to new file** option, and experiment with different numbers for **Simplify tolerance**, to get a visually acceptable result that will export as a file of reasonable size. (Your web developers may be able to advise on that.)

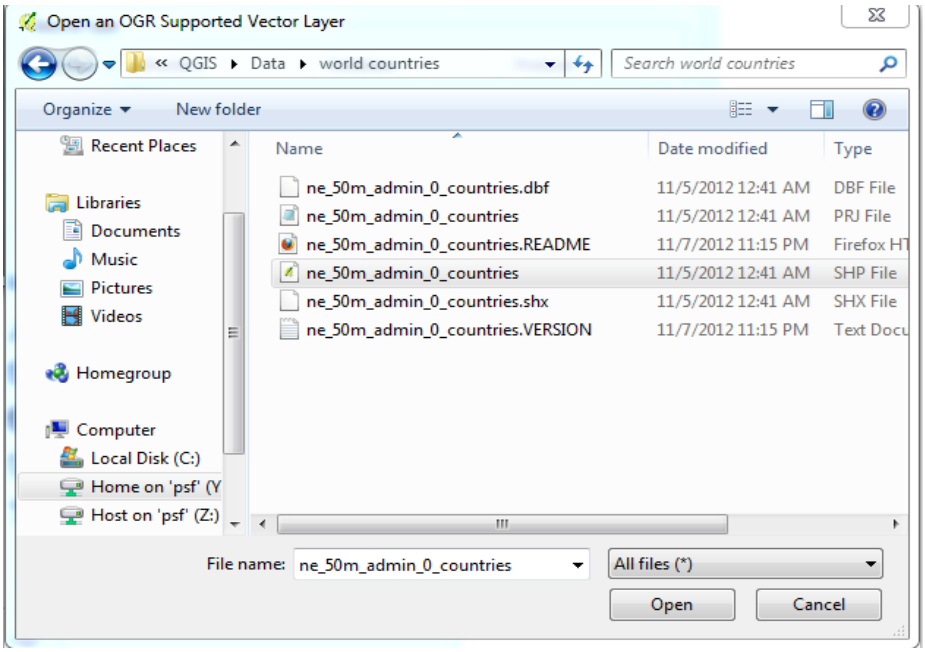
You should see a result like this, which will greatly reduce the size of an exported geoJSON or KML file:



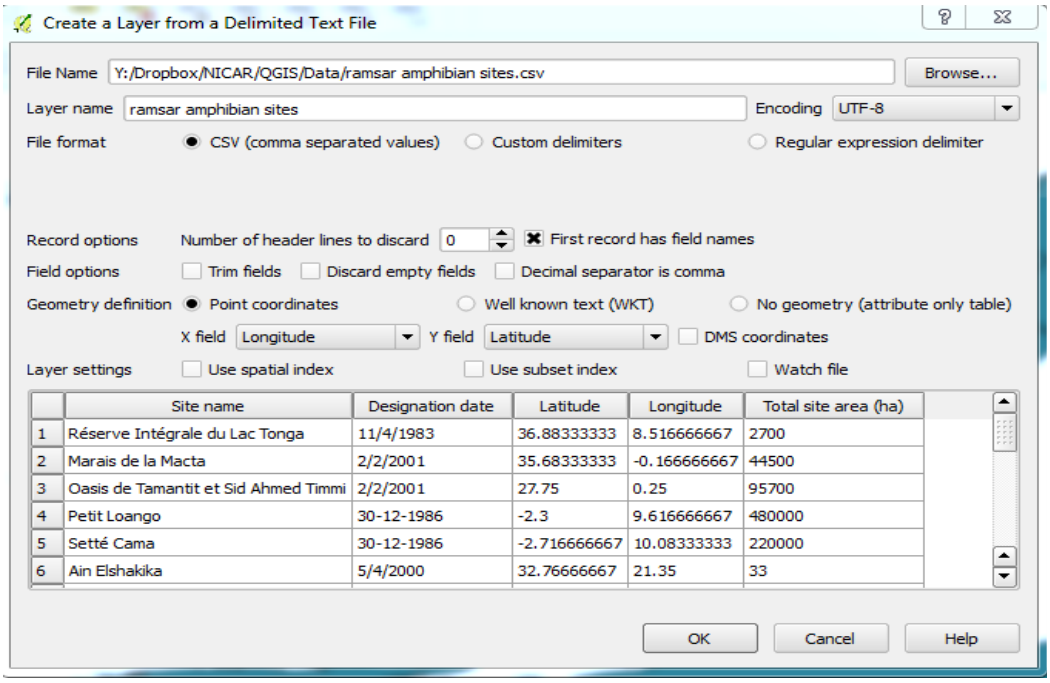
We're finished with this data, so select **Project>New** and **Discard** the current project to start again with a fresh screen.

Editing geographical data

Now we're going to explore some of QGIS's data editing functions. First import this shapefile of the countries of the world by selecting **Vector>Add Vector Layer**:



Next add this CSV file of points showing Ramsar Convention sites deemed important for amphibian conservation, from the previous class, using **Layer>Add Delimited Text Layer**:

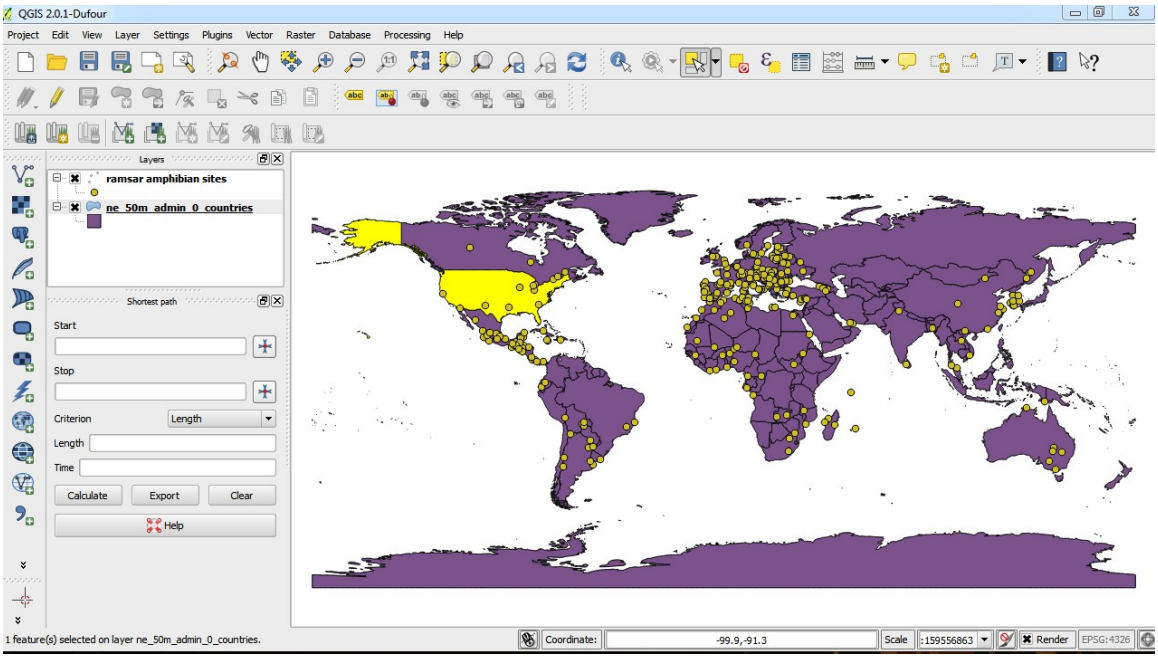


	Site name	Designation date	Latitude	Longitude	Total site area (ha)
1	Réserve Intégrale du Lac Tonga	11/4/1983	36.88333333	8.516666667	2700
2	Marais de la Macta	2/2/2001	35.68333333	-0.166666667	44500
3	Oasis de Tamantit et Sid Ahmed Timmi	2/2/2001	27.75	0.25	95700
4	Petit Loango	30-12-1986	-2.3	9.616666667	480000
5	Setté Cama	30-12-1986	-2.716666667	10.08333333	220000
6	Ain Elshakika	5/4/2000	32.76666667	21.35	33

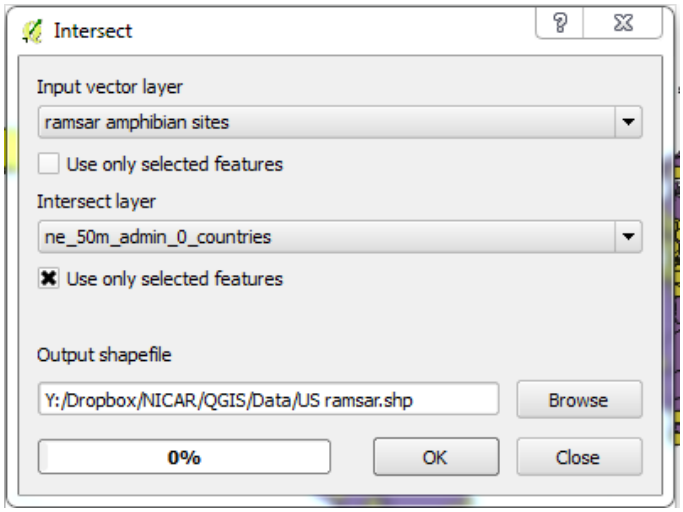
We're going to edit the points to make a shapefile containing only sites in the United States. The CSV file contains no information on country, but we can use the countries shapefile to select the points within the US.

With the countries shapefile highlighted in the **Layers** panel, click the **Select Single Feature** icon: 

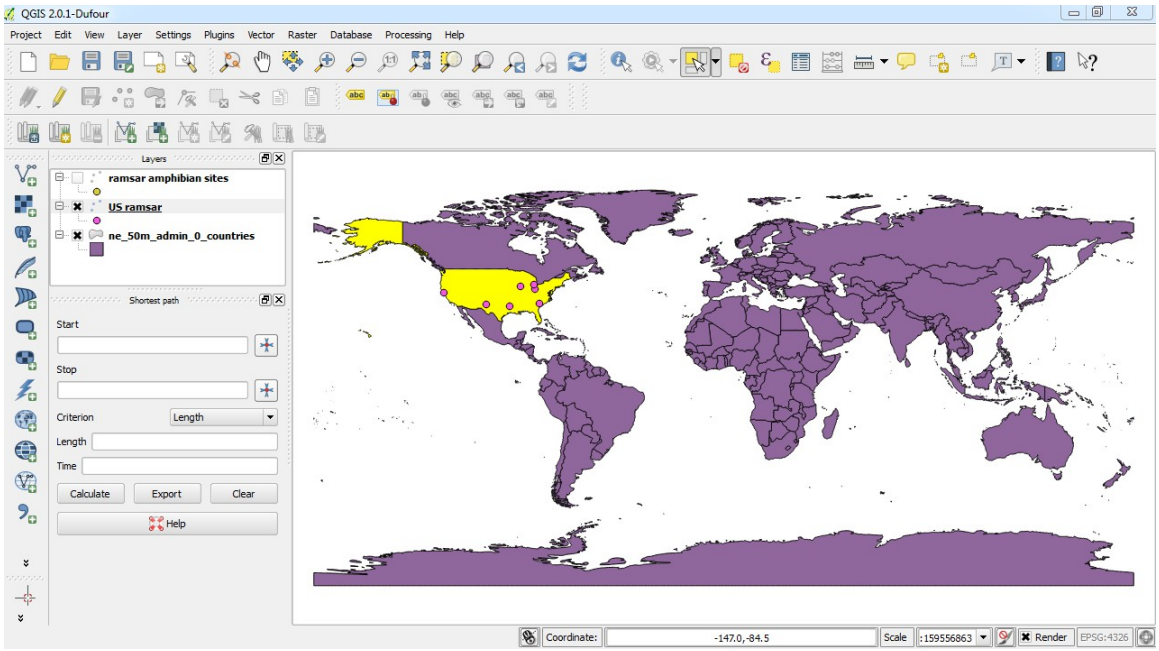
Then click anywhere within the borders of the US, and you should see a screen like this:



Now select **Vector>Geoprocessing Tools>Intersect** and fill in the dialog box as follows, selecting a suitable name for the output shapefile:



Click **OK**, then accept the option to add it to map. Hide the full Ramsar sites layer by unchecking it, and you should see a screen like this, showing our new shapefile:



The **Vector** menu in QGIS offers a rich set of tools for manipulating geographical data. Our **Intersect** option created a new shapefile with fields from both shapefiles in its attribute table. **Clip** is similar, but would not have added fields from the countries shapefile to the new shapefile's attribute table. **Buffer** creates a new shapefile bounding a zone a defined distance from a set features of interest – you might use this, for instance, to see which parts of your city lie within a mile of a park, or a library. Find out more about the options from the QGIS manual, and explore their functions for yourself.

We can also edit data in QGIS directly. With the countries shapefile selected in the layers panel, click the **Toggle Editing** icon:

Then open the attribute table for the countries shapefile and click the **Invert Selection** icon:

This will select all countries apart from the US, which we can then delete from the shapefile by clicking the **Delete Selected Features** icon:

Click **OK**, close the attribute table, then click the **Toggle Editing** icon once more to exit editing mode. Save your changes, and you should now have a map showing just the US.

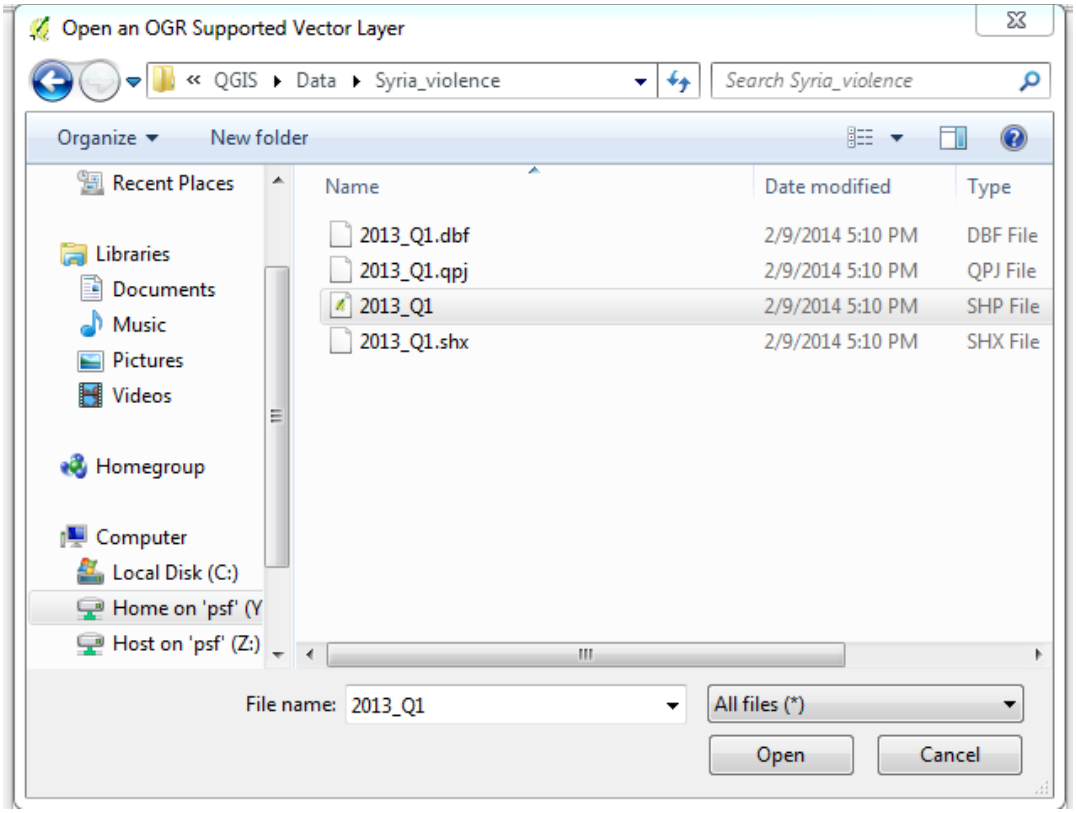
This is just a brief intoduction to QGIS's data editing functions – see the manual for more possibilities.

We're now finished with this data, so select **Project>New** and **Discard** the current project to start again with a fresh screen.

Hexagonal binning: a better option than throwing many points at a map

In the final part of this class, we'll explore how to make a sensible map display from data that consists of hundreds or even thousands of closely spaced or overlaid points. I used this option to make these maps of the Syrian civil war.

Open this shapefile, showing the location of distinct violent events in Syria from the first quarter of 2013:

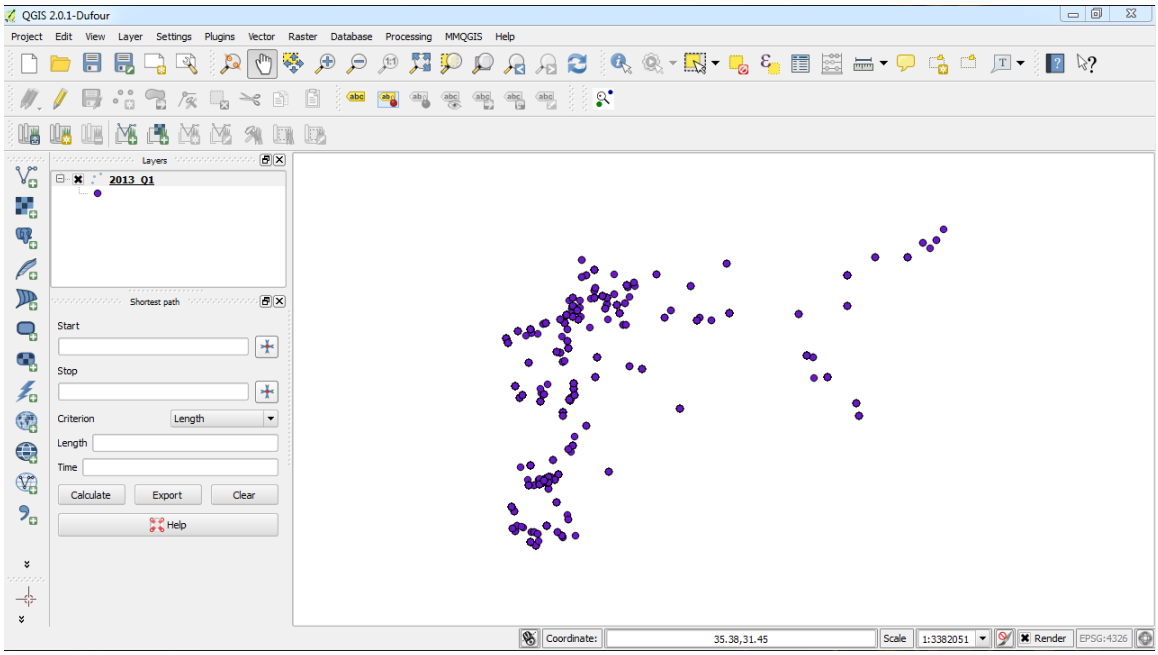


If you open the shapefile's atribute table, you'll see that it contains more than 10,000 points, many of which overlay one another. We're going to create a hexagonal grid covering the same area, and then count the points in each cell in the grid.

One of the strengths of QGIS is that it has an active community of open-source software developers producing useful plugins for specific geodata processing tasks. To make our grid, we need to install one of these plugins, called **MMQGIS**.

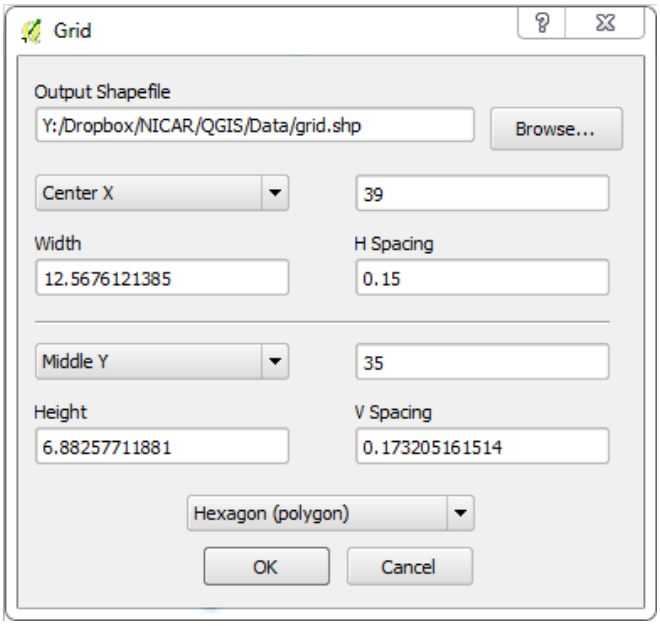
Select **Plugins>Manage and Install Plugins,** then select **Get More** and type **mmqgis** into the **Search** box. Select the result that appears, then click **Install Plugin**. An **MMQGIS** menu should now have appeared.

Next, use the **Zoom In** and **Zoom Out** tools to give some blank space around the points:

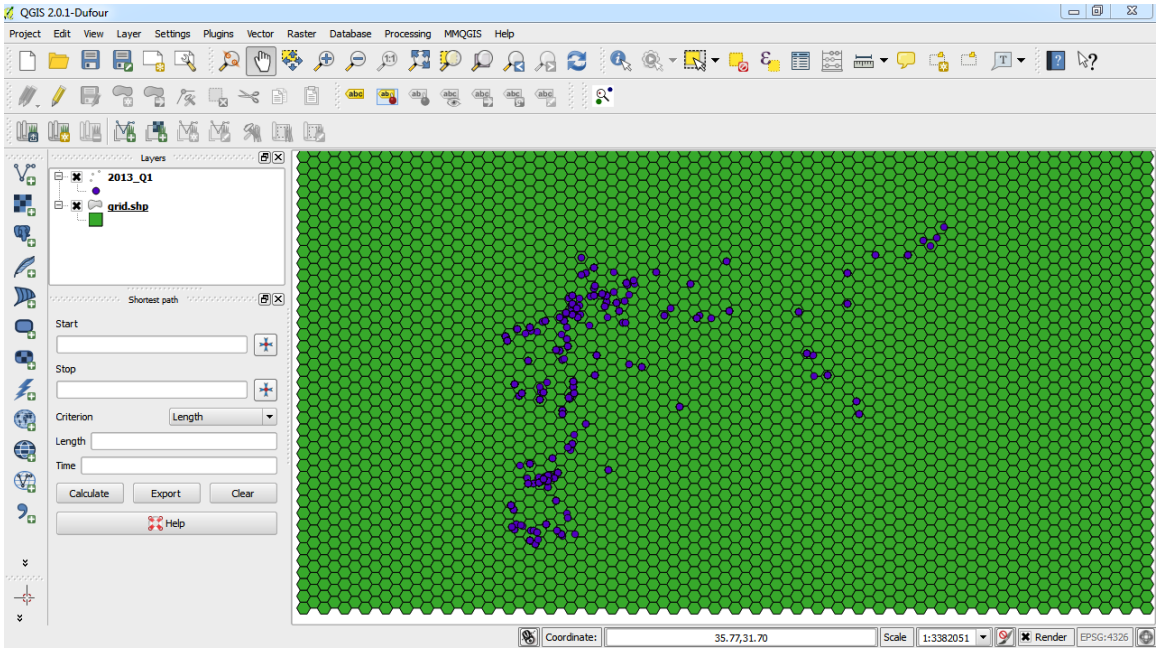


This will ensure that the grid layer will completely cover all the points.

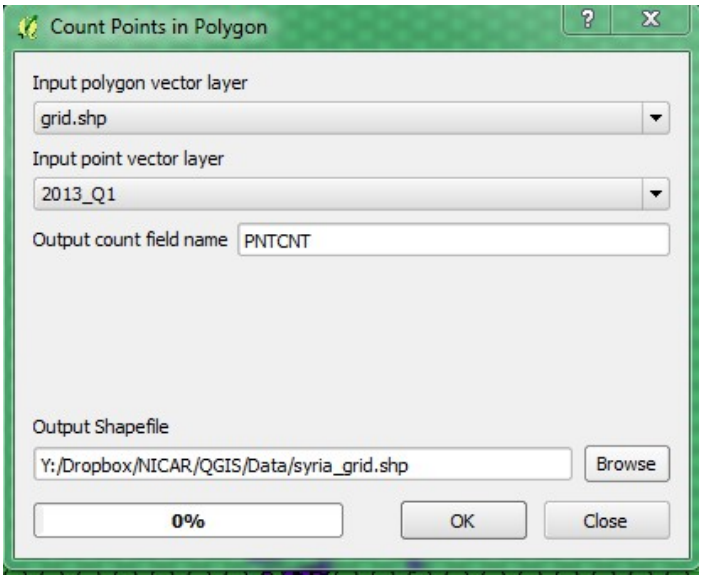
To create the grid layer select **MMQGIS>Create>Create Grid Layer** and fill in the dialog box as follows, selecting an appropriate name for the output shapefile:



In practice, you'll need to experiment with the **H Spacing** value to produce hexagons of a suitable size. The **V spacing** value will adjust automatically.
Once the shapefile has loaded, drag the points shapefile above the grid shapefile in the **Layers** panel, and you should see a screen like this, confirming that all our points are in the grid:



Now we'll make a new shapefile with a count of the points in each cell of the grid. Select **Vector>Analysis Tools>Points in polygon** and fill in the dialog box as follows, selecting an appropriate name for the new shapefile:



Click **OK**, and once the data has processed, accept the option to add the new shapefile to the map. Open its attribute table, and you'll see that there is a column **PNTCNT**, giving the number of violent events in each grid cell. You can now save this new shapefile in whatever format you need for your mapping application of choice.

Next steps

For more on hexagonal binning, and pointers on styling the resulting shapefile in TileMill to make an online map, see this tutorial. For instructions on how to make web maps with Leaflet using data exported as geoJSON, see here and here.