Introduction to using QGIS for Archaeology and History – Workshop by the Empirical Reasoning Center

In this workshop, we will cover the basics of working with spatial data, as well as its main uses for archaeology. Students will learn what data types are common in Geographic Information Systems (GIS), as well as how to begin visualizing maps in QGIS, an open-source GIS software. This workshop has been developed for the Spring 2017 course "Archaeology of the Bronze and Iron Ages in the Southern Levant".

This workshop is the first half of an introduction to mapping and digitizing historic data.

Workshop Objectives:

1. Become familiar with basic GIS data formats.

2. Become familiar with the QGIS software and interface, as well as how to load and visualize layers of vector and tabular data in QGIS.

3. Learn how to create features, adding columns of information to those features, based on satellite imagery and other basemap resources.

4. Learn how to style those features by category, and export a map from QGIS.

Step by Step Walkthrough:

DISCLAIMER: This walkthrough is made using QGIS on a Windows computer. The locations of some tools, as well as the appearance of some of the icons may differ on Apple computers.

To begin, download the zip folder containing the resources for this workshop. Those resources include files for each area designated for students' individual research, as well as a digitized basemap we will be using in this workshop as an example of how to digitize points from a map. The zip folder also includes a list of useful sources of already created GIS data.

Unzip the folder by double-clicking to open it and choosing "Extract All" in the file viewer, and choosing "Browse" on the pop-up, to navigate to a folder where you would like to save your data. This will be referred to as your "Working Folder" and is where you should save all the files you work on and create in this workshop.

Once you have extracted the files, navigate to your Applications or Start Menu, and open QGIS Desktop 2.1x (if you have most recently downloaded QGIS, this may be version 2.16 or higher).

Open QGIS for Desktop. You should see an empty interface that includes icons along the top, and a "Layers" and "Browser" Panel on the right side. The "Layers" panel shows you what layers of data are being displayed on your map view, while the "Browser" panel allows you to navigate to your "Working Folder" and search through your computers files, to add in the GIS layers you want to work with on your map. In this case, those files are all in your "Working Folder" which should be the ERC_QGISWORKSHOP folder you just downloaded and unzipped.
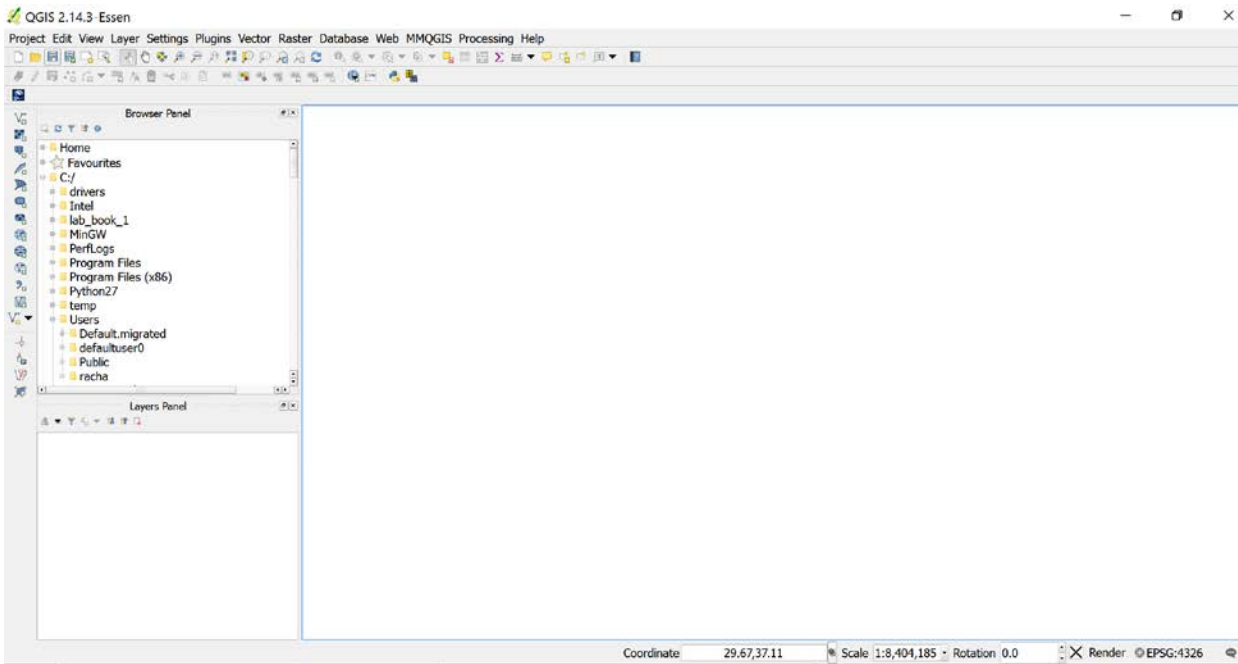
Your main QGIS interface includes toolbars on the left and top sides, as well as a "Layers" and "Browser" panel on the left.

If we wanted to add our first layer of information, in the "Browser" panel, choose your folder, which will be different depending on where you are working (whether you saved that working folder on your Desktop, or in your Documents folder, etc.). Find that Working Folder ERC_QGISWORKSHOP, and open it up by clicking the plus sign next to the folder name.
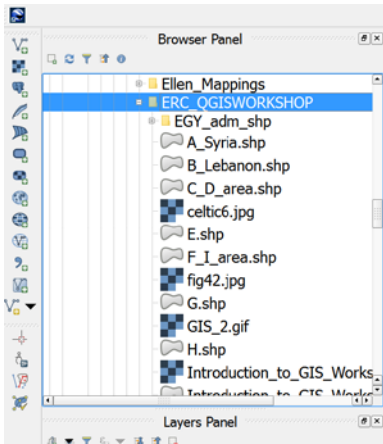
You should see multiple files with different icons next to them. These icons tell you what kind of data format your GIS layers are in, and also it lets you know which files are compatible GIS layers, and which are not. For example, we can see the .shp files have a little polygon icon next to them. These are SHAPEFILES, and they are GIS vector layers, which we discussed in the presentation portion of the workshop.

The polygon icon indicates that they are polygon vectors, and in this case they represent country or region boundaries. This workshop uses Lebanon as an example region, so we will choose B_Lebanon.shp as the file we want to show on our map. Click B_Lebanon.shp and drag it into your "Layers" panel.

You should now see the shape of Lebanon appear on your map main page, and the listing of the file appear in your "Layers" panel, alongside a color that corresponds to the color your shape is (the


color is chosen at random).
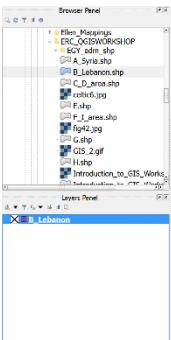
We are now displaying a map of the shape of Lebanon, with no additional information. This is not necessarily a good map because we don't have any reference to where Lebanon is or any additional basemaps.

The nice thing about QGIS is that certain tools and add-in apps have been created by users to add to your map. One add-in allows you to include Google Earth imagery and additional layers. We want to use this app, so we will add it

to our Desktop software. These apps are called "Plug-ins" in QGIS. At the top of your QGIS window, click on the tab that says "Plug-Ins" and choose "Manage and Install Plug-Ins".

There are a few plug-ins that may be useful to us. Once you choose "Manage and Install Plug-ins" a pop-up should appear which allows you to search for plug-ins to add to your toolset. The plug-ins you should search for and add are:
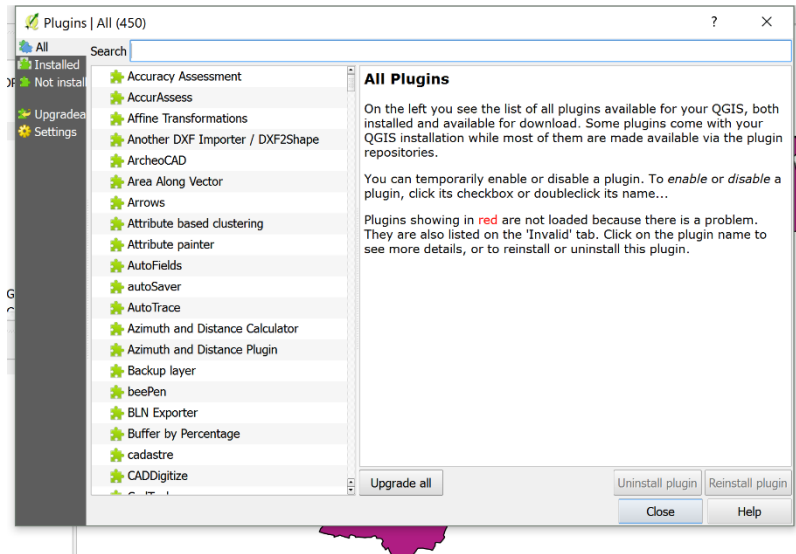
"OpenLayers" – when you find the OpenLayers plug-in, click "Install" and wait for the plug-in to be installed.

Next, search for "QuickMapServices" a plug-in which allows you to add different image data layers, such as contour lines and hillshade. Add this plug-in by clicking "Install".

After adding these two plug-ins, close the Manage and Install Plug-ins pop-up.

You will be able to find the plug-in tools in the "Web" tab at the top of the page.

In the "Web" tab, navigate to the OpenLayers option, then choose "Google Maps" – "Google Satellite" which will add Google Satellite Imagery to your map.

Once you've chosen Google Satellite, you should notice an addition of the Google Satellite layer to your "Layers" panel. This works the same as your data layers that you added yourself. You can choose to turn on and off the layers by checking the box off next to the layers, and the order in which they are listed in the "Layers" panel is the way they appear on your map, so if the Google Satellite is listed first, it will appear on top of your other layers.

If you want, add and play around with the layers from OpenLayers and QuickMapServices. These layers are useful as basemaps.

Next, we will add in a digitized map that we will be using as reference to add points to our GIS map, that we can then symbolize. This map has been **georeferenced** and we will learn more about that in the second workshop.

Navigate in the "Browser" panel to your ERC_QGISWORKSHOP folder, and find the layer file called plate111.tif. This file is in TIFF format, and is actually an image file, but it has been given geographic *metadata* so that QGIS can know where it should be layered on the map.

Drag the plate111.tif to the "Layers" panel. A map should appear on top of your satellite imagery; this map is an image layer that we've added as a layer, and which we can use as a basemap, or to create new features from information it displays. Recall that images are read as RASTER data, while things like the polygon we have of Lebanon is an example of VECTOR data. In order to style and symbolize the points on the map we just added, we must turn the information it has on it into VECTOR points.

So, we are creating a layer for the points on this map. To do so click on the tab at the top of the QGIS page, "Layers" and choose "Create Layer" – "New Shapefile Layer". A pop-up will appear.
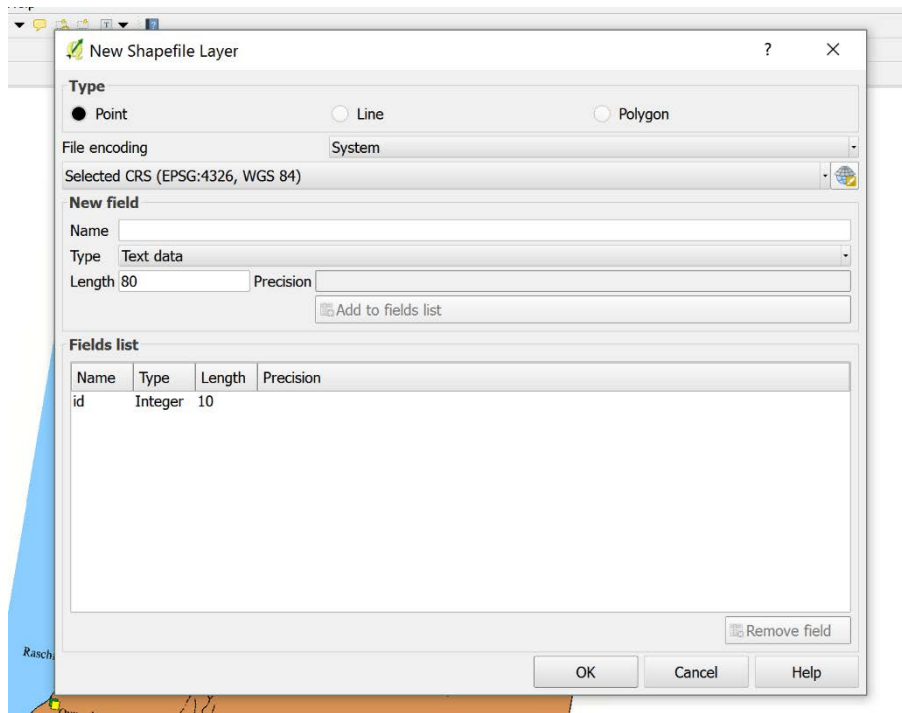
Fill out the pop-up as such:

-We want to create points, so make sure "Point" is selected.

-Don't worry about the CRS, or Coordinate Reference System. We will be using the same one as is used for our other layers, which we specificed to QGIS when we gave it that first Lebanon file.

-Now, we must tell it what columns we want to add to the **attribute table** of our GIS vector point file. This attribute table is the tabular information with our layer, which will let us symbolize our points based on categories we label them, like tomb, cultic, settlement, etc.

So, first fill out the "Name" for the first column (also called field). This first column can be called "name" so fill out Name = name. Then, the "Type" should be "Text data" because we will be filling out this column with the names of the sites we are digitizing. When you've chosen, click "Add to fields list" and you should see this new column appear in the list below.

-We also want to add a "category" column, so we can label each point by type of site. Thus fill out the "Name" with this next column, which we will call "type". So Name = type. Also make this column "whole number " by choosing "whole number" from the drop-down. Click "Add to fields list". For this example, we also have time period as our points already are visualized by time period, so fill out another column specification, by writing Name = "period", which will also be "text data" Add that to the field list too.

If you had other specification or information about your sites or points that you are creating, you would continue to add new columns that you can fill out. In this case, we don't have anything else to add, so press "Enter". You should then get a pop-up that asks you to choose the folder where you save your data, and where you can name your file.

Save it in the ERC_QGISWORKSHOP folder, and name it lebanon_sites.shp. You should have no spaces or special characters in your file names!!!!

Once you name the file and press "Save" you should see in your "Layers" panel, your new layer appears. However, nothing changed on your map. Now we actually have to add information to this empty layer we created. But first, check out the attribute table we created, by right-clicking Lebanon_sites in the "Layers" panel, and choosing "Open Attribute Table".

A table should appear, but which has no rows and only lists your columns at the top. This is because have no points to fill the rows yet.

In order to add points to this layer, we much enter "Editing Mode" which allows us to edit, add, and delete layers.

To enter "Editing Mode", right-click the Lebanon_sites in the "Layers" panel, and and choose
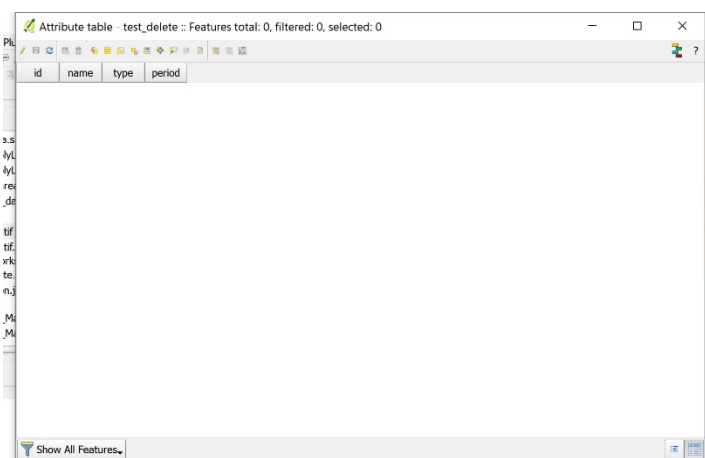
"Toggle Editing" which has a pencil icon. We can also "Toggle Editing" by clicking the pencil icon in the "Attribute Table" we just had opened.

You should now see the icon next to Lebanon_sites change in the "Layers" panel. This lets you know which layer you are editing and working on now.

Now that we are editing, let's add some points. Click on the "Add Feature" tool, in the top panel of the QGIS page. This icon looks like three points with a yellow icon next to it =

This will allow you to drop a new point on your map,   based on whichever point you choose from your image basemap first.

Click on a point on the map that you want to add first. A pop-up should appear, which allows you to fill out those columns of information you created when you created this layer.

Fill out the columns. Automatically, you have an id field added, which is a number column, meaning it takes in only numbers as the data type. Let's give this first point an id of 1. You could randomly give ids, which are just so each point knows it's a unique feature and can be identified as a unique point.

Next, fill out the name of the point you chose. You can find the name from the basemap.

Next, fill out the type. For your own work, you will be categorizing your data as either:

              1. tombs

              2. settlement

              3. cultic site

              4. other

              5. all of the above

              6. tombs and settlement

              7. tombs and cultic site

              8. tombs and other

              9. settlement and cultic site

              10. settlement and other

              11. other and cultic site

              12. tombs, cultic and settlement

In order to make this easier, you will use the numbers to code your categories, as opposed to typing out the category type individually. Then, you can keep track of which category is which based on the numbers you have given it, and it will be easier to group and symbolize your information based on these categories.

Since we are just using these points as an example, they don't show us the type on this map, so we will either leave this blank, or you can give it a value of 0.

Next, fill out period from the actual data on the basemap, just since we already have it and it is shown in the legend on the basemap (although it is not in English). Fill out the point you chose with the corresponding period based on the color it is and the legend of this basemap.

Once you have filled out the columns, click "Ok" and you should see a point in an arbitrary color appear on your map above the point you chose.

Repeat the process with the rest of the points on the map. Clicking where the points are located, and filling out the columns and adding the points. Once you have added all the points, you should save your edits, and turn Editing Mode off. To do so, right click Lebanon_sites in the "Layers" panel, and click "Save Layer Edits" then click "Toggle Editing Mode" which will stop editing.

Now you have digitized data! While we have worked from an example basemap, you can also work from historical maps, images, and satellite images, which will allow you to digitize information and add different categories or additional information to those digitized points.

Now that we created a new GIS layer, let's symbolize it. We gave it some interesting additional information, including time period and in theory type of site (for your actual region not in this workshop).

Let's use some of that information to change what our points are displaying, to do so right-click Lebanon_sites in the "Layers" panel, and click "Properties" which will bring a pop-up that allows you to customize the color, style and additional information your map is showing.
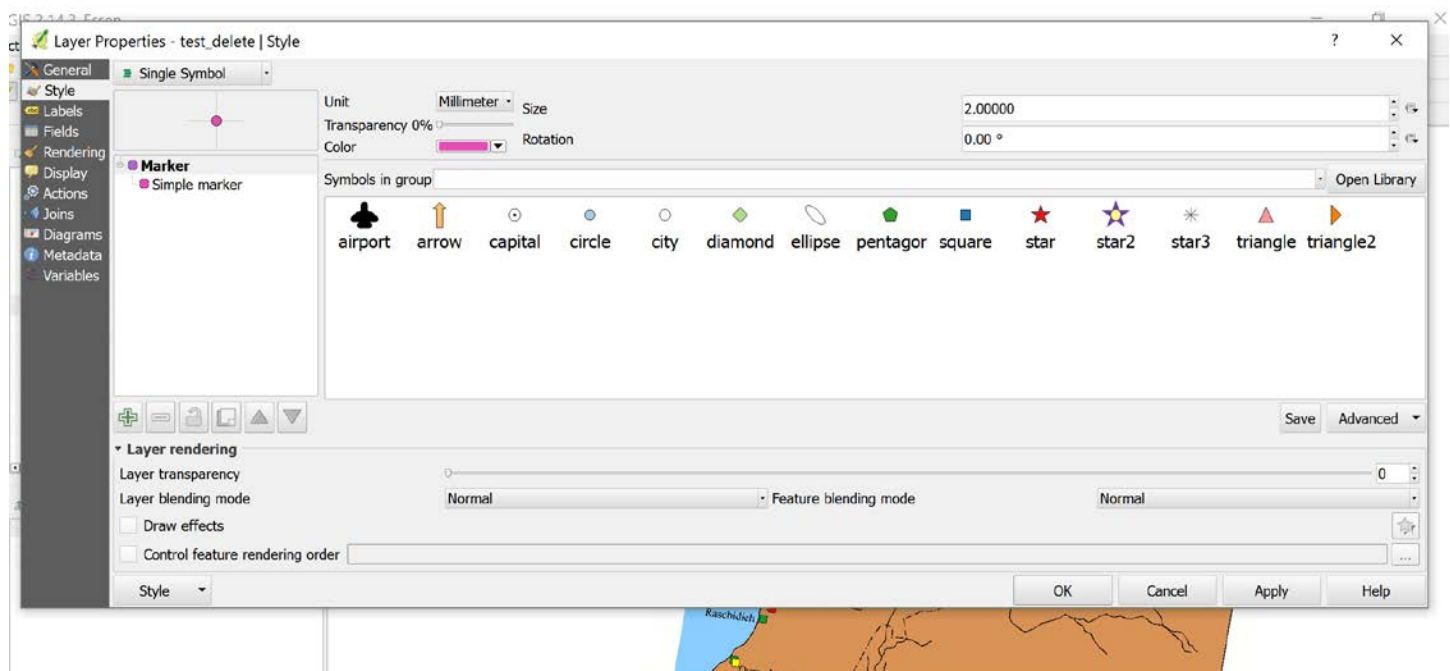

Currently, our points are being styled as a "single symbol". That is, just as a point. They are not being styled based on any data we added, like period or type. These are examples of categories which we could color or style our points by, and we would want to to make our maps convey the information we want them to convey. Right now we are working with one layer of points, with only a few "attributes" or variables that describe those points, but from this we will build on those points over time, by adding additional variables like time period, or changes in settlement or site type, or by adding a column that specifies certain objects found at the site, as well as by overlaying the points with vegetation, elevation or other data. For now, we will focus on symbolizing the points based on the information we digitized, and this will be the same thing you will do for your own region.

In the "Style" tab of the "Properties" pop-up, let's symbolize our points not by "Single Symbol" but by "Categorized". Here we will get to change the points to reflect one of our categories.

Once you choose "Categorized" your pop-up should change:
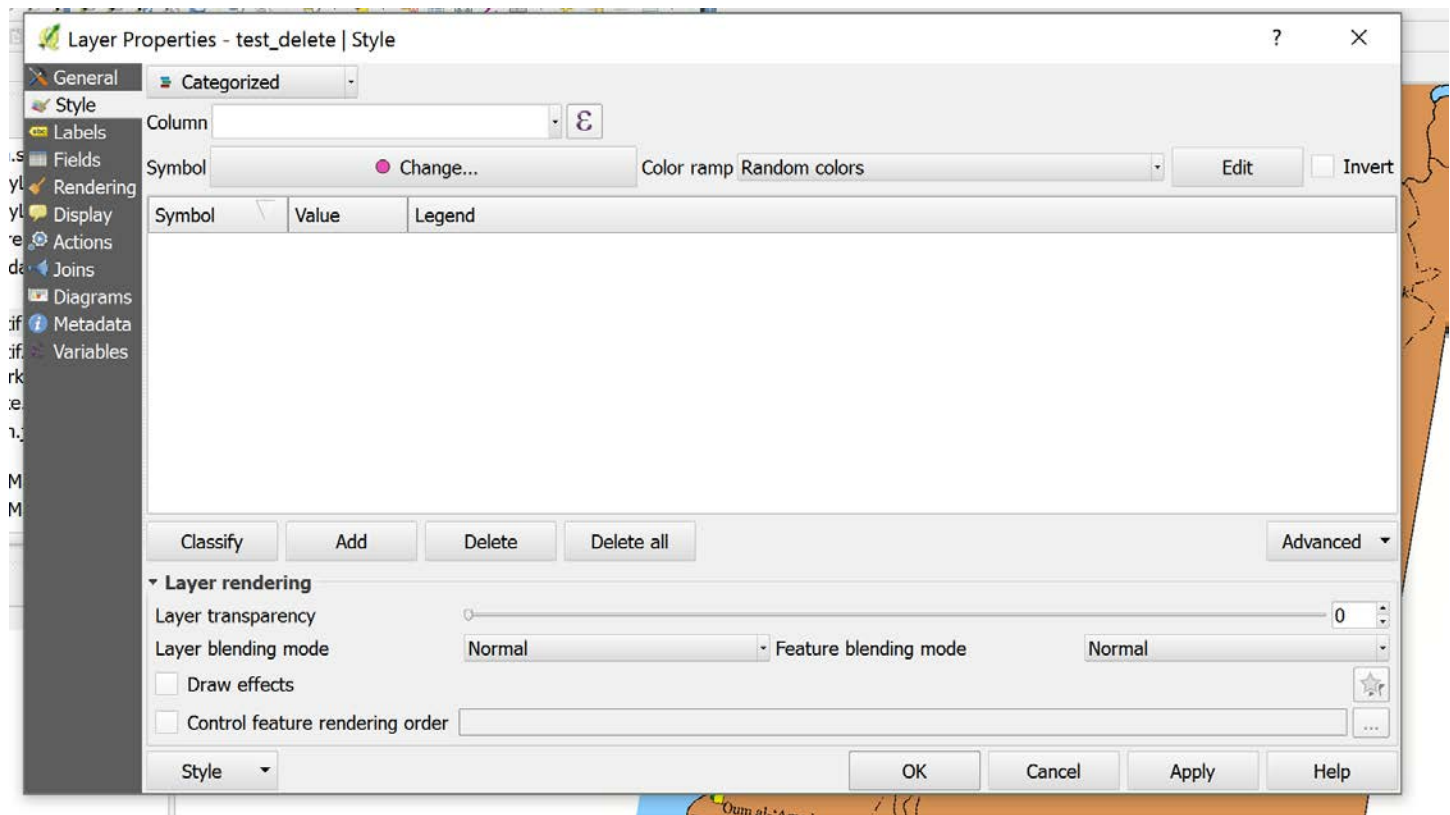
In the "Column" input, choose the "period" column, which is our column that we added from the information on our digitized basemap. Next, click "Classify" at the bottom left side of the pop-up.
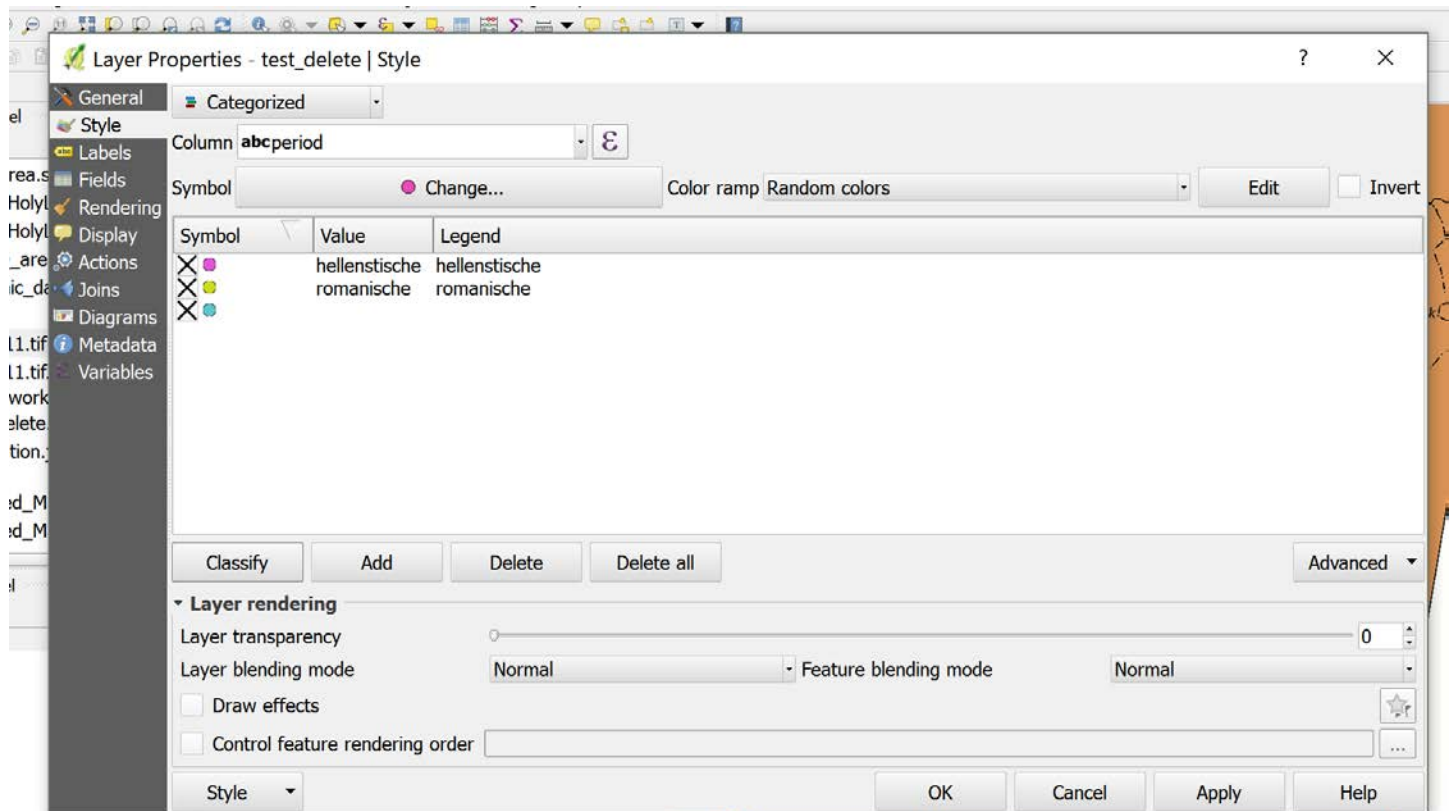
Notice that your categories should now be listed, and they should correspond to different colors for each point of that specific period. The colors have been assigned at random, but you can change it according to whatever decision you make about the color you want to correspond to each period. Double-click the point you want to change, and a pop-up will appear that will allow you to choose a new marker (like a square or triangle instead of a point) or to change the actual color. Play around with your options. You can customize the point however you want.
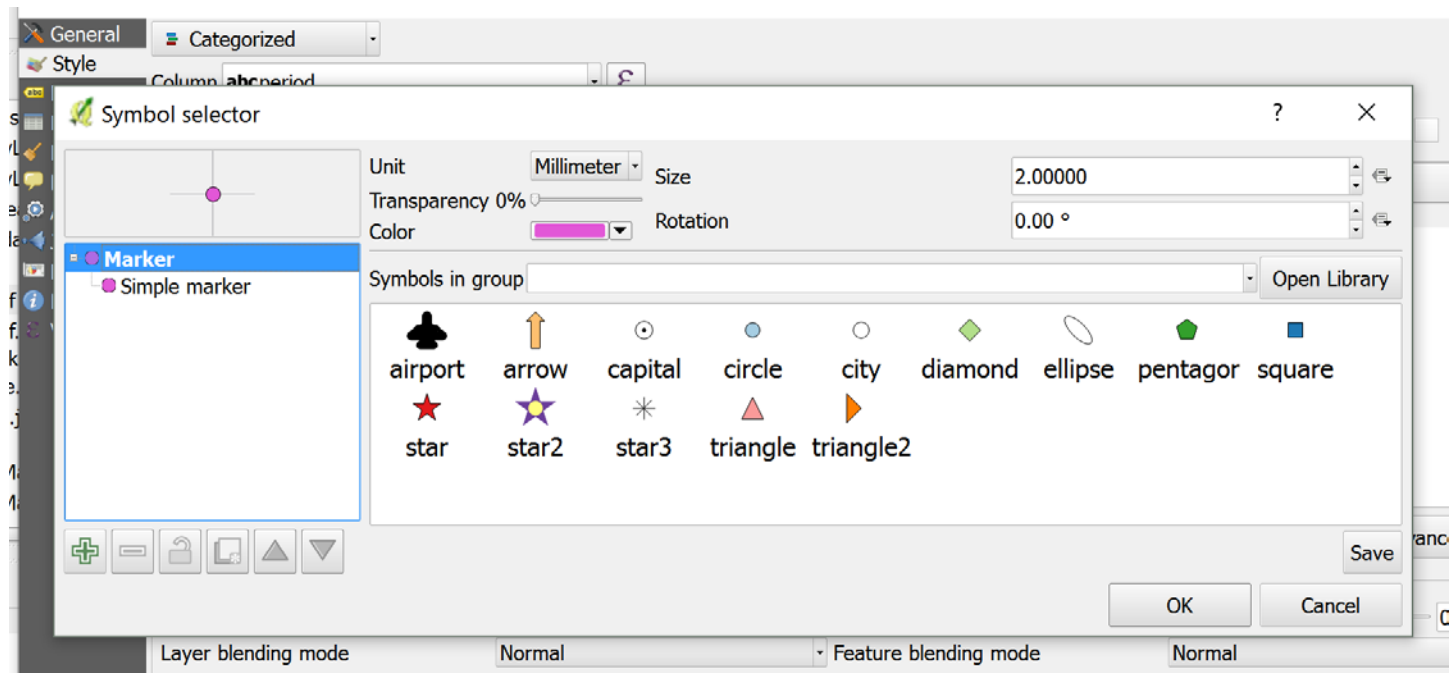

You can also change the point size by adjusting the "Size" input, as well as the rotation. If you click on the "Simple Marker" on the left hand side, you can also change the outline of your symbol.

You can also change all colors for each period at once by clicking out of the "Symbol Selector" pop-up and instead changing the "Color Ramp" from "Random Colors" to some other option.

We may also want to add labels to our points. The labels may be one of the other variables we added, in this case we could use the "name" column we created. For your own data, you may label your points by something else.

Choose the "Labels" tab on the left-hand side.
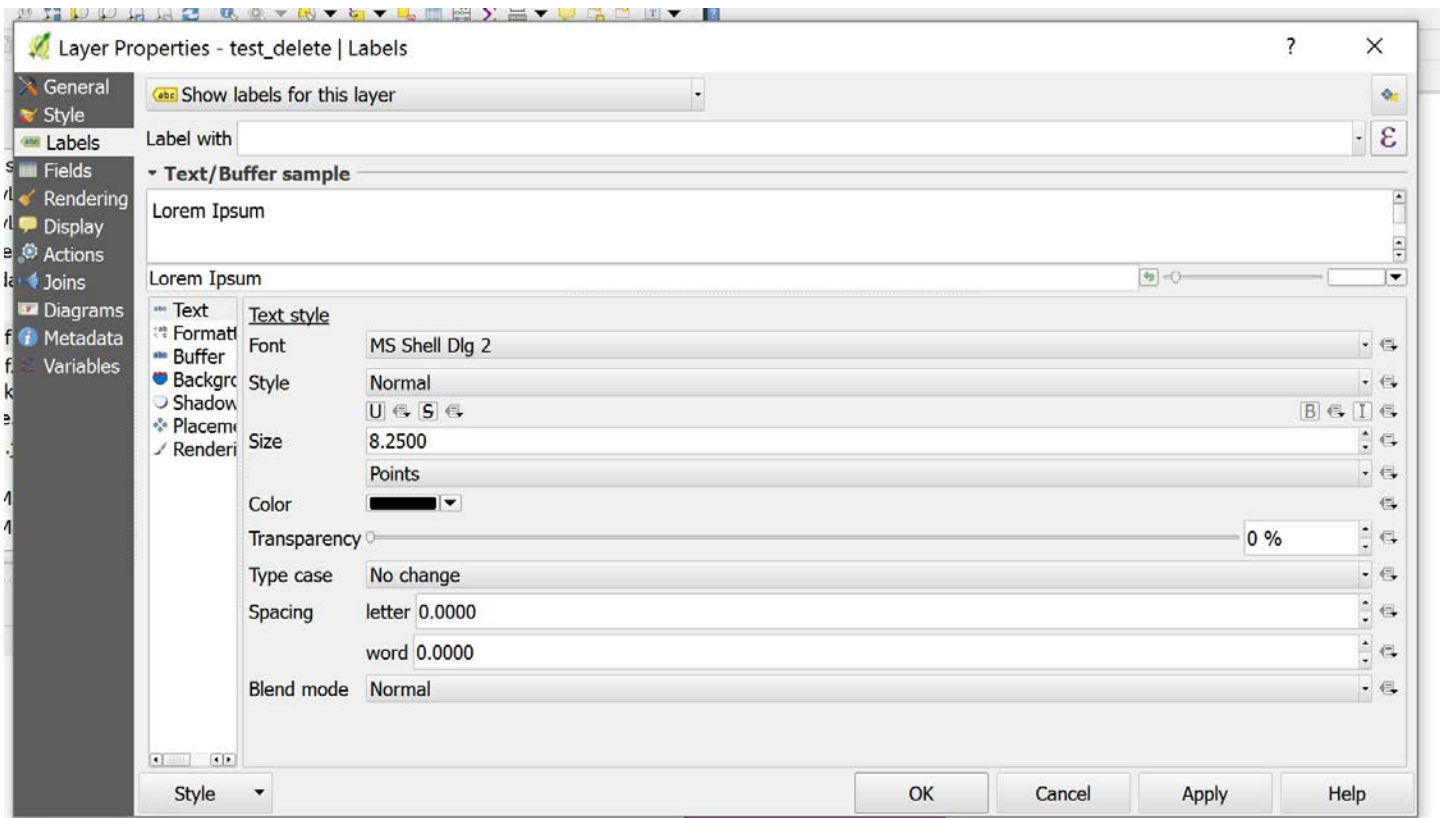
In the top drop-down, choose "Show labels for this layer" and then choose "Label with" as the "name" column you added to your layer.

Then you can customize what your labels look like with the customization options below, including the font, formatting, where the labels are, etc. Click "Apply" when done. And "OK" will add the labels to your map. You may want to change the font color of your labels to a lighter color if they are on top of satellite imagery.

Now, let's make sure you can see the boundary of Lebanon but also our satellite imagery below. In the "Layers" panel, double-click the B_Lebanon boundary file, which will open the "Properties" pop-up. In the pop-up, keep the style as "Single Symbol" but click on the color drop-down and click "Choose Color" and then fill out the box next to "Opacity" to 100%. That will make the inside fill color of the Lebanon boundary clear, and allow you to see the outline without the color, so the satellite imagery can show below. You can also play around with customizing the outline width to make it stand out more.

 You can also customize your basemap, turning off the image we used to digitize the points, and playing around with the QuickWebServices and OpenLayers layers.

Once you have chosen the layers you want to add to your map, we will go through a simple additional data source where you can download already digitized layers from different web sources. Most of them are in a GIS format ready to use in QGIS. Some are not in the format you may be looking for, but can be cleaned up a bit, which will be covered in more depth in the second workshop.

To add a layer of digitized points from the Maps of the Holy Land web-source:

Navigate to the link: https://daahl.ucsd.edu/DAAHL/EsriPiPDigitizer.php

Here you can follow the directions provided on the website, drawing a polygon or a shape on their map interface to select a region which you can then download data from. Follow the website instructions, choosing a time period, type of site or feature, and your region of interest. Here we will choose just for example in the workshop:

-Draw a polygon around Lebanon

-Choose "Neolithic" as the time period

-Do not fill out any specific category, so we will download all possible points of that specific period just for this example

*For your own work, you may want to specify other information and play around with what's available. Unfortunately you cannot see how many points or features are available when you choose your specifications. You have to wait to download the data to see.

Next, click fill out the "KML Layer Name" with for this example with Neolithic_lebanon_sites since that's what we chose.

Click "Submit"

A file with a .kml extension will download. Once it downloads, move it to your working folder "ERC_QGISWORKSHOP" so that it is with the rest of your data.

Now, navigate back to your QGIS Desktop, and in the "Browser" panel, find the .kml file in your ERC_QGISWORKSHOP folder. Drag the file into your "Layers" panel.

A pop-up should appear, asking you which of the layers in this .kml file you want to add to your map:
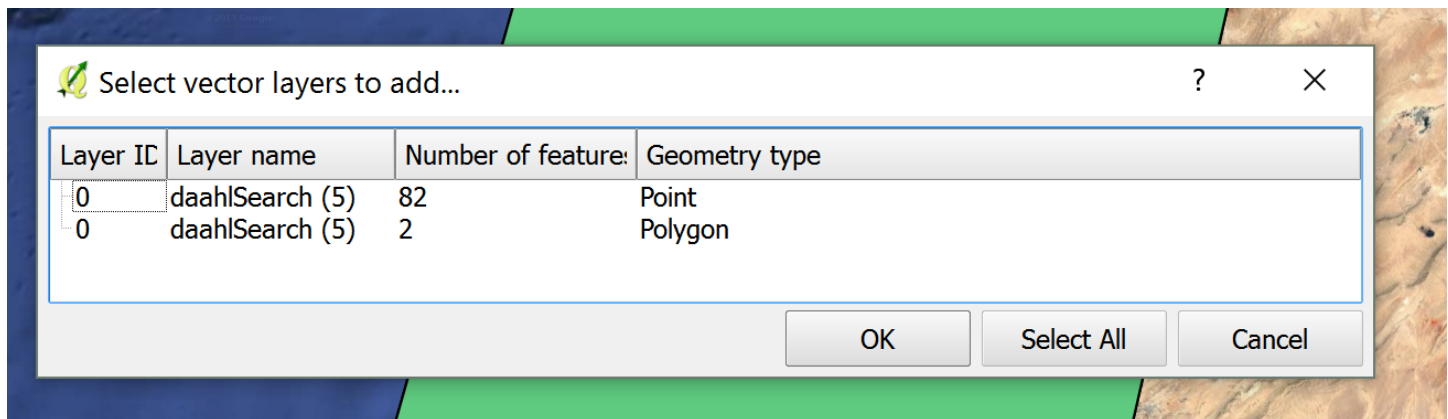
In this case, we just want to add the 82 points we have selected, not the polygon. The polygon is just the boundary you drew on the site to select things within it. So choose the "Point" layer, and click "OK" this will add a point file to your map and in the "Layers" panel.
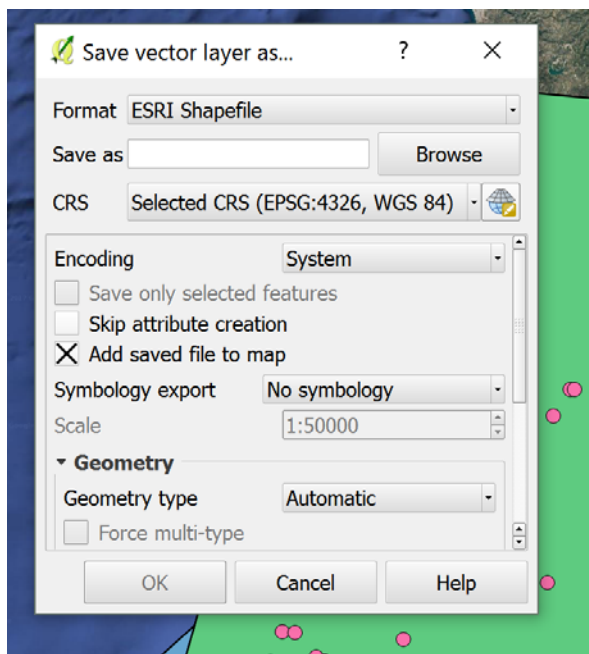
Next, we just want to save the points as a .shp, which is a shapefile. This shapefile format will allow us to use the points we downloaded in the future in QGIS.

Right-click your point layer "daahlSearch" in the "Layers" panel, and click "Save As".

Fill out the pop-up, choose "Browse" to navigate to you working folder, and keep the CRS as is. All other customizations are fine as is, and click "Ok" when you've filled the Save As option out. Make sure your file name makes sense and is organized, and that your file is being saved as a Shapefile.

Now, you can play around with the style of these points, adding labels to them as you did before, and looking at their attributes by opening the Attribute Table.

Exporting your Map:

Once you have displayed the layers you want and customized their style, let's make a map to export. At the top, click "Project" then "New Print Composer" which will prompt you to give a name to your map layout that you will be making. Name it something that is descriptive and specific to the layers you are working with. Once you name the Composer and click "Ok" a new page will open up, which will visualize an 8.5 in x 11 in page where you will customize your map page for export.
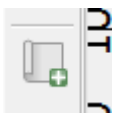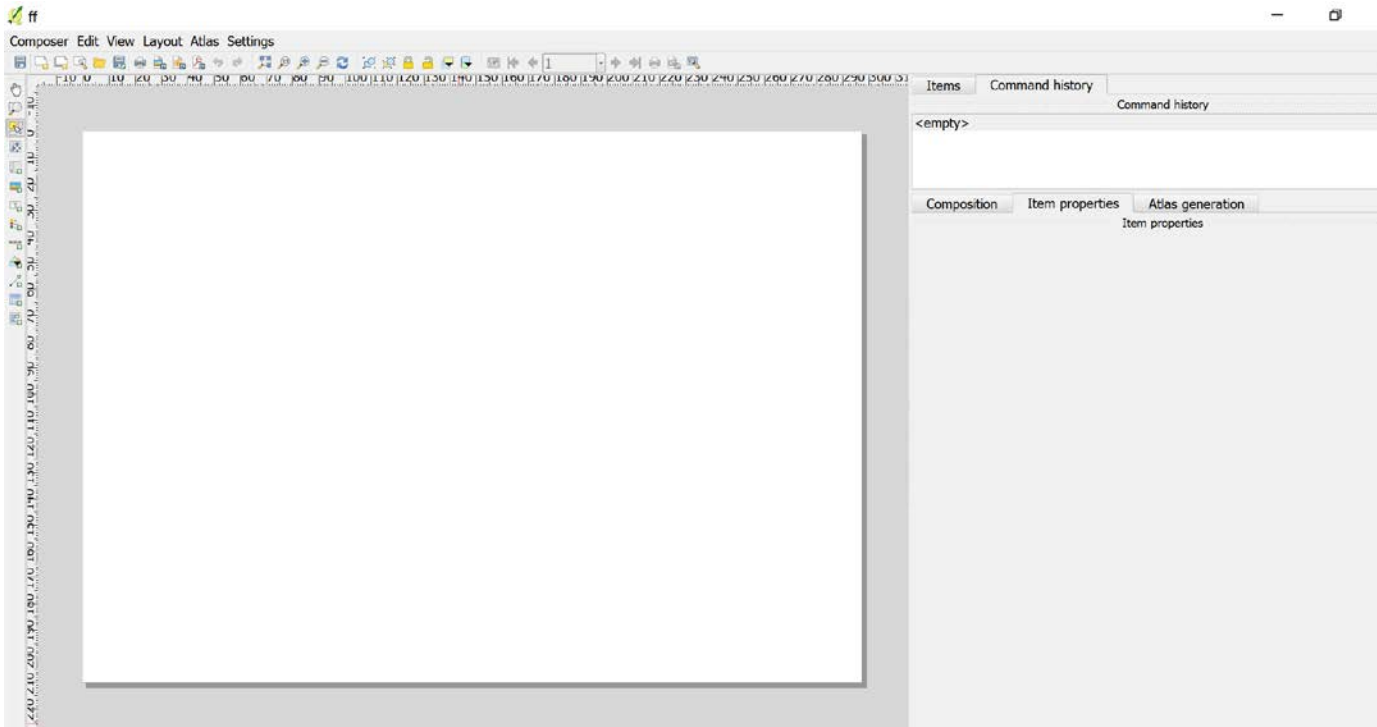
Click on the [icon] icon, then draw a rectangle on the paper, to add a frame for your map. You may want it to take up your whole page, or you may include text or other things on the paper, and thus might want it to take up just part of the page.
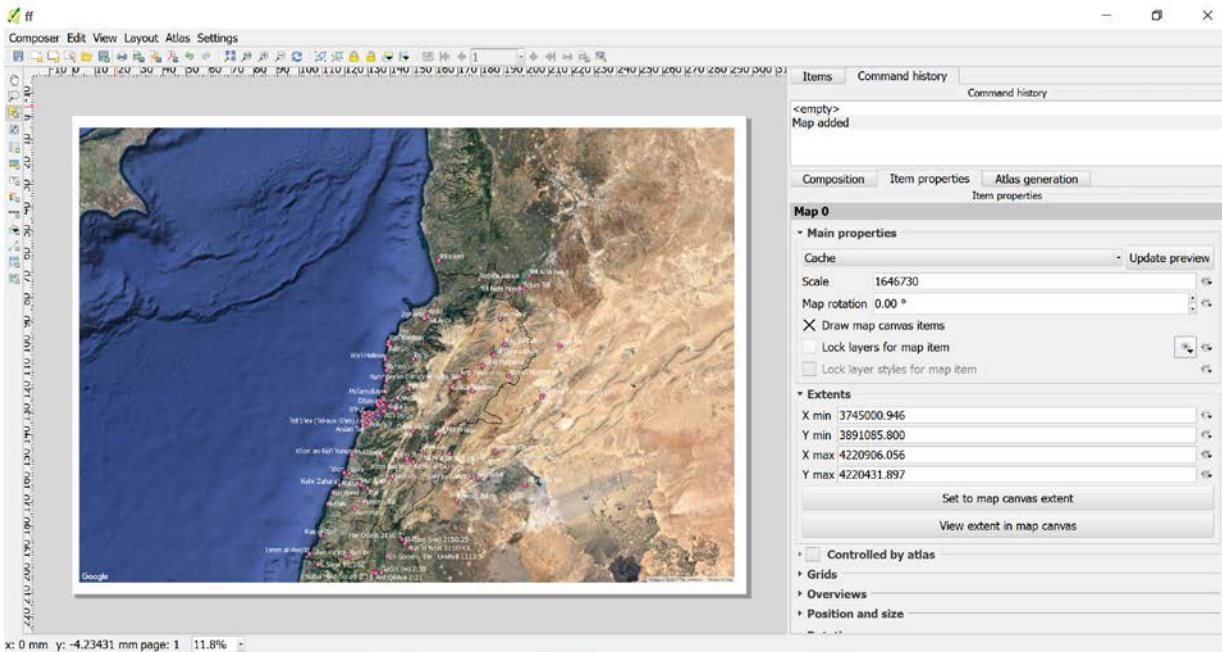
You should see on the right hand side a dialog box of "Item Properties" which will allow you to change things on your map, like the scale (to zoom in or out).

Next, we will want to add the things that are important when sharing a map: title, legend, north arrow, scale bar.

1. Title:

To add a title, click the text icon in the toolbar on the left (shown with a T icon) and draw a box on your map. The "Item Properties" dialog box on the right will change, and give you the text box properties, where you can type in what you want your title to say, and change it's design, font, size, etc.

2. Legend:

To add a legend, click the legend icon on the left side toolbar , and draw a box to add your legend. Once it's added, you will want to customize what is shown in the legend, since some layers may not be on your map, and thus you won't need them on your legend. In the "Item Properties" tab, scroll down to the "Legend Items" and uncheck "Auto Update". This will allow you to add or remove items from the legend.
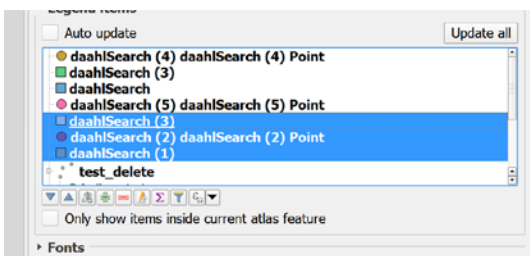
You can select items not shown on your map, and click the red minus sign to remove them from your legend. You may also want to rename the layer name in your legend, by clicking the pencil icon next to the red minus sign. This will prompt you to rename the layer.

You can also change the font, size, and style of your legend in the "Item Properties" dialog.

3. North Arrow:

To add an arrow, click the arrow icon in the toolbar on the left and draw an arrow pointing up. Once the arrow is drawn, you may customize its appearance using the "Item Properties" tab.

4. Scale Bar:

To add a scale bar, click the scale bar icon and drawing a rectangle on your map. You can adjust your scale bar using the "Item Properties". You may want to change the units.

After you have added all these items and customized them appropriately, you can add additional text using the text box, if you want to add explanatory information. Once you have finished designing your map, click "Composer" in the top tab and then "Export as PDF" if you want to export it as a PDF or "Export as Image" if you want to export as an image.

*THIS WILL NOT SAVE YOUR WHOLE MAP PROJECT. Before or after exporting, make sure to save your WHOLE project by clicking "Composer" then "Save Project" as well as choosing to save the project in the original project page, by clicking the "Project" tab at the top, then "Save Project As" and saving it as a .qgs file, which can only be opened in QGIS.

Additional Resources and Further Reading about GIS:

Searchable archaeological layered map of Israel:

http://digitallibrary.usc.edu/cdm/map/collection/p15799coll74

Oriental Institute satellite images and maps of Southern Levant

https://oi-idb.uchicago.edu/#Q/W3siZGF0YXNldCI6IkNNIiwib3BlcmF0b3IiOiIiLCJmaWVsZCI6IktleXdvcmQiLCJ0ZXJtIjoiSXNyYWVsIiwiZmllbGRBbGlhcyI6IktleXdvcmQgKE1BKSJ9XQ==

Stanford Geospatial network model of the Roman World (with main routes of travel)

http://orbis.stanford.edu/

Source for current weather data:

http://www.geog.ox.ac.uk/research/climate/projects/undp-cp/

Source of satellite imagery for Israel:

http://www.livius.org/00israel.html

Source of antique maps and images:

http://www.euratlas.net/antique/index.html

Source of georeferenced maps:

http://www.bl.uk/georeferencer/georeferencingmap.html

Source of ancient maps of Jerusalem:

http://www.jnul.huji.ac.il/dl/maps/jer/index.html

Additional Readings about GIS for archaeology and history:

http://www.slideshare.net/Jo6789/archaeological-applications-of-gis

http://esribulgaria.com/wp-content/uploads/2013/07/archaeology.pdf

http://www.archcalc.cnr.it/indice/PDF22/AC_22_Scianna_Villa.pdf