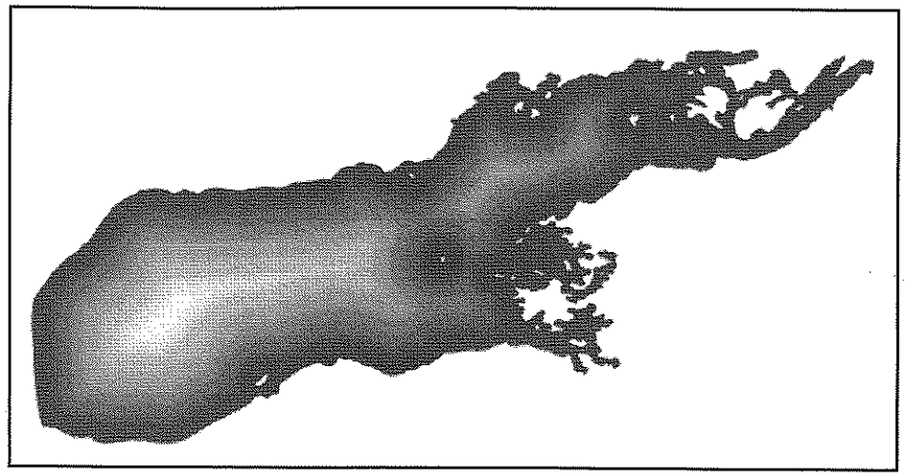
As always, choose the best option to visualize the data that you have, and then save the project.The result of the styling would be as follows:



Result of the styling

Summary

This chapter showed you how to symbolize Raster and Vector data. We have progressed from quickly inspecting our data to presenting it in a way that adds meaning. We have also covered a range of examples, including styling GIS data in Alaska. The focus has been on building a series of layers that complement each other.

In the next chapter, we will look at bringing all of this knowledge together by using the Print Layout to create maps from your data.

4
Creating Great Maps

In this chapter, we will cover some of the important features of QGIS that enable us to create great maps. We will also learn how to label features, which can now be done interactively in QGIS 3. QGIS 3 has improved the way maps are created with new print layout tools. We will look at these in detail in the coming sections, before looking at ways of sharing data at the end of the chapter.

Topics covered in this chapter include the following:

- Communicating with data
- Labeling
- Creating maps
- Loading data
- Map outputs

QGIS 3 is used on a worldwide basis to produce stunning maps. To get an idea of the maps that QGIS is capable of producing, visit the following link: `https://www.flickr.com/groups/qgis/pool/`.

Communicating with data

Perhaps the most common reason that people use GIS is to create maps. We have already covered the creation of data, as well as the loading and basic styling of vector and raster data in previous chapters. In this section, we are going to be bringing this together to make a map. In the final two chapters of this book, the focus will shift to geoprocessing and some of the more advanced features in QGIS 3, but for now, let's lay the foundations to enable you to create beautiful maps, and where better to begin than with the newly updated labeling tools in QGIS 3?

Labeling

We already have a number of layers in the layer panel, including both Vector and Raster. There are seventy-six airport points, each of which has an attribute called **name**. We will use this to label our data.

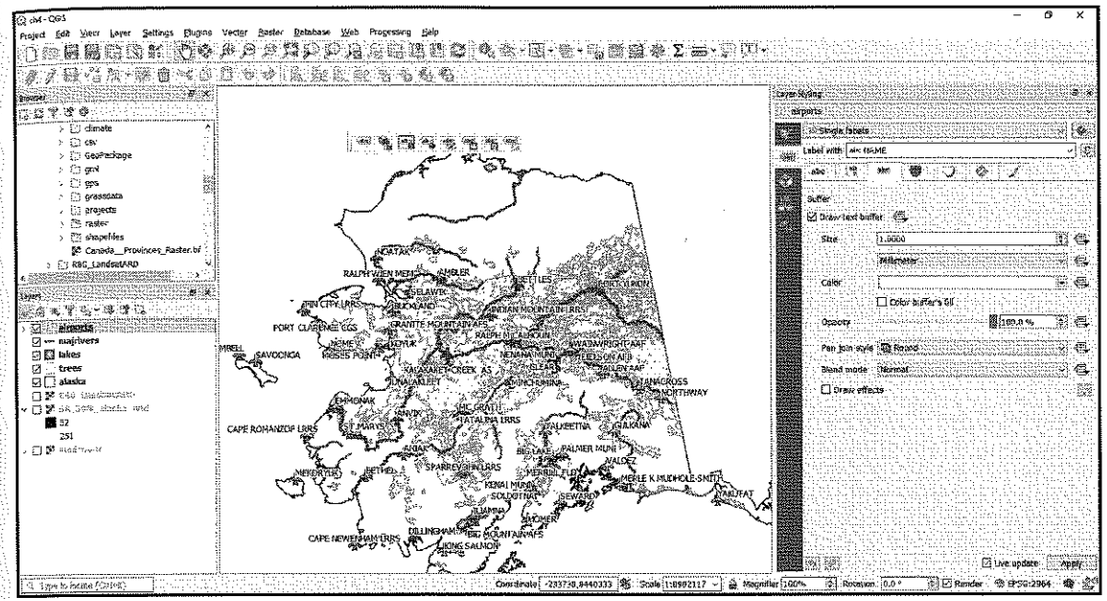
The QGIS labeling toolbar is shown in the following screenshot:

Labeling toolbar

If this is not shown in your QGIS project, navigate to **View | Toolbars | Label Toolbar,** and click to enable the toolbar. There are eight buttons on this toolbar. In order, these are as follows:

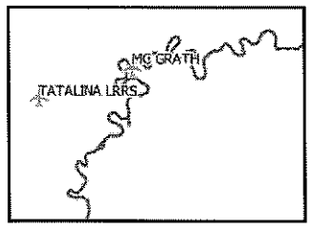
- Layer Labeling: Clicking on this will open the Layer Styling panel and the label tab by default.
- Layer Diagram properties: This is where we can control the input to our labels.
- Highlight pinned labels and diagrams.
- Pin/unpin labels and diagrams.
- Show/hide labels and diagrams.
- Move labels and diagrams.
- Rotate labels and diagrams.
- Change labels, used for label editing.

We will use these tools to help us label the airport layer. Click on the first button in the toolbar called **layer labeling**. In the **Layer Styling** panel, select **show labels for this layer** and set the label to **Name**. Check the box next to **Draw text buffer**. Your screen should look similar to the following diagram:



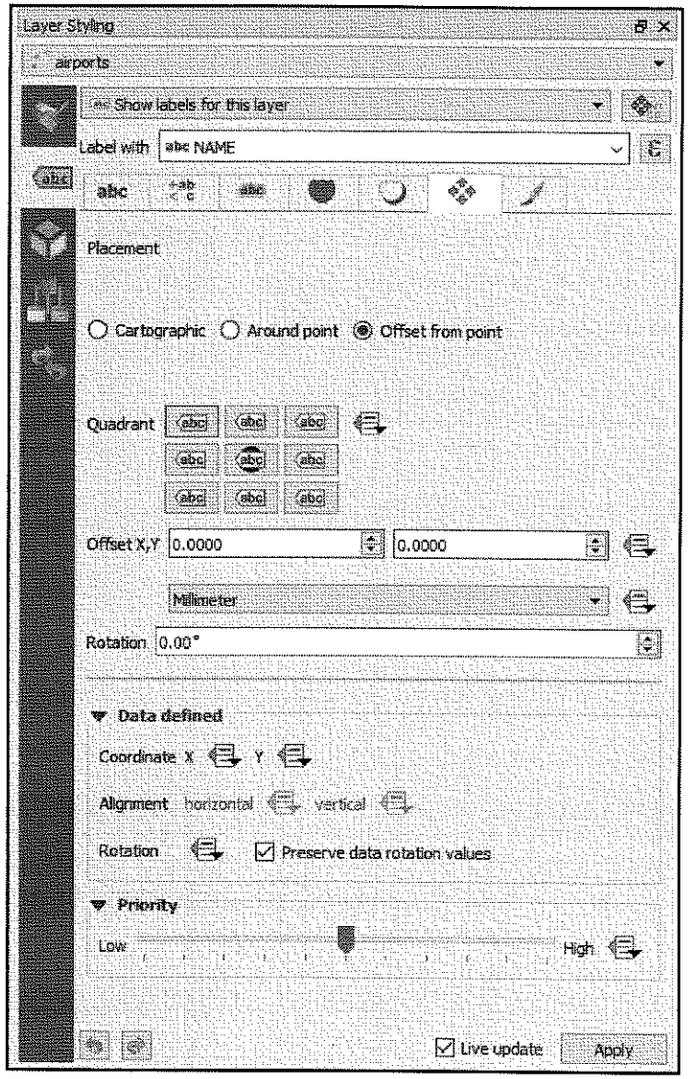
Labeling in the Layer Styling panel

Turn off every layer, apart from the **airports** and **alaska** layers, and navigate to your newly labeled data. Some labels conflict with each other. For example, turn on `majrivers` again and you will see that some of the labels are sitting over the rivers layer. To demonstrate this, **Tatalina LRRS** and **McGrath** airports in the following example are being displayed over the river:



Labels over features

Within the labels tab in the **Layer Styling** panel, we can set some placement rules with the **Placement** tab. In the following example, I have selected the **Offset from point** radio button and then selected the top-left quadrant to improve the placement:

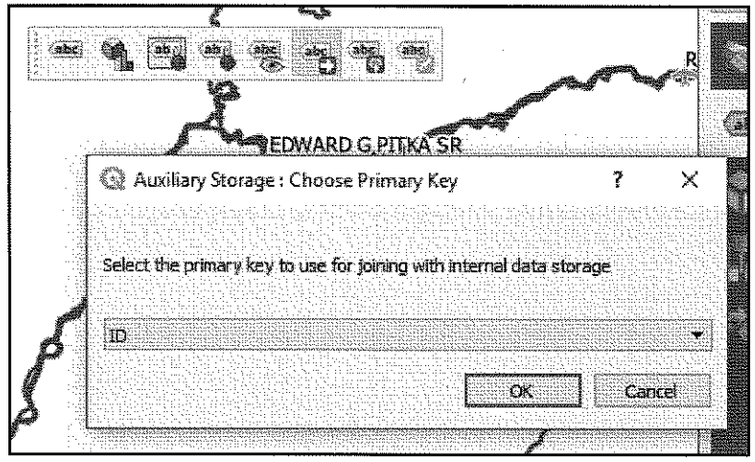


Defining the placement options in the Layer Styling panel

This does improve the labeling, but it may need some manual adjustments. That is where manual interaction can help.

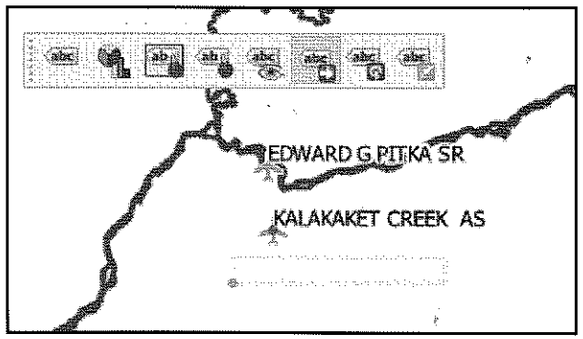
Interactively editing labels

A new feature in QGIS 3 is the ability to edit the labels interactively within the map using the label toolbar. Click on the move label and diagram button and accept **ID** as the primary key. This is shown in the following screenshot:



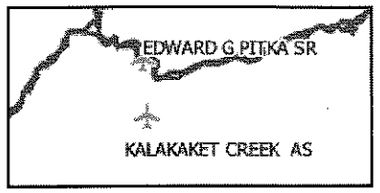
Defining the primary key

Now, click on a label and move it. As you click and drag a label, a placement box appears where the new location of the label will be. This is shown in the following screenshot:



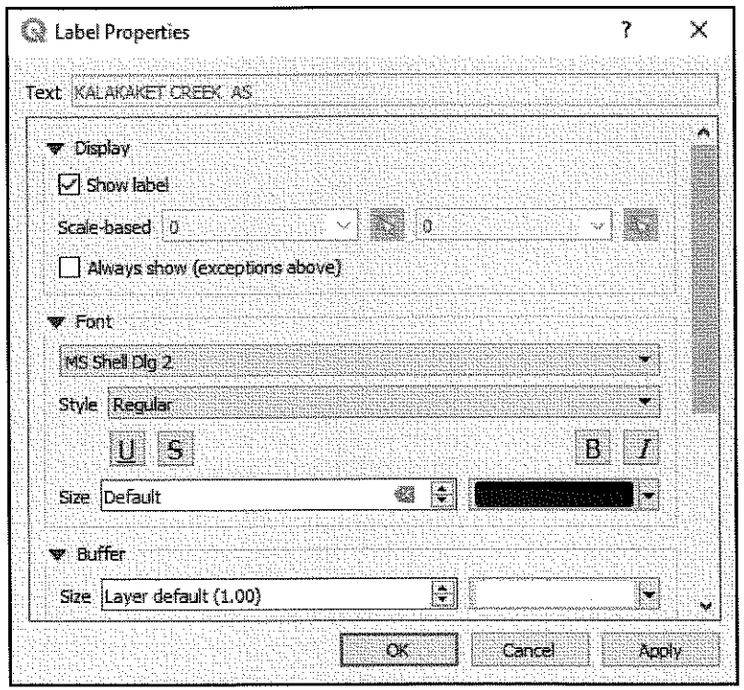
Adjusting the labeling placement

As you drag the box to the new location, a red dot will appear on the point associated with the label. When you are happy with the new location, release the mouse-click. The label will be moved to the new location, as shown in the following screenshot:



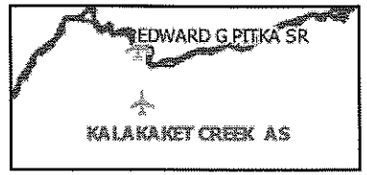
New label location

It is also possible to alter each label's properties. Click on the last button on the labeling toolbar and select the label you wish to edit. The **Label Properties** window will appear as follows:



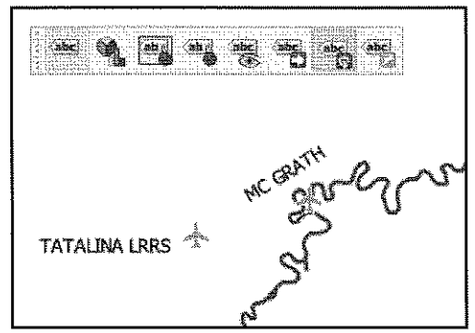
Label Properties

Change the label color to red, set it to bold, and click **OK**. This will just change the selected label. It should now look similar to the following screenshot:



Updated labels

Finally, in this section on interactive labels, click on the rotate button and rotate the label to show it so that it does not cross the river. This is shown in the following screenshot:



Rotating the labels

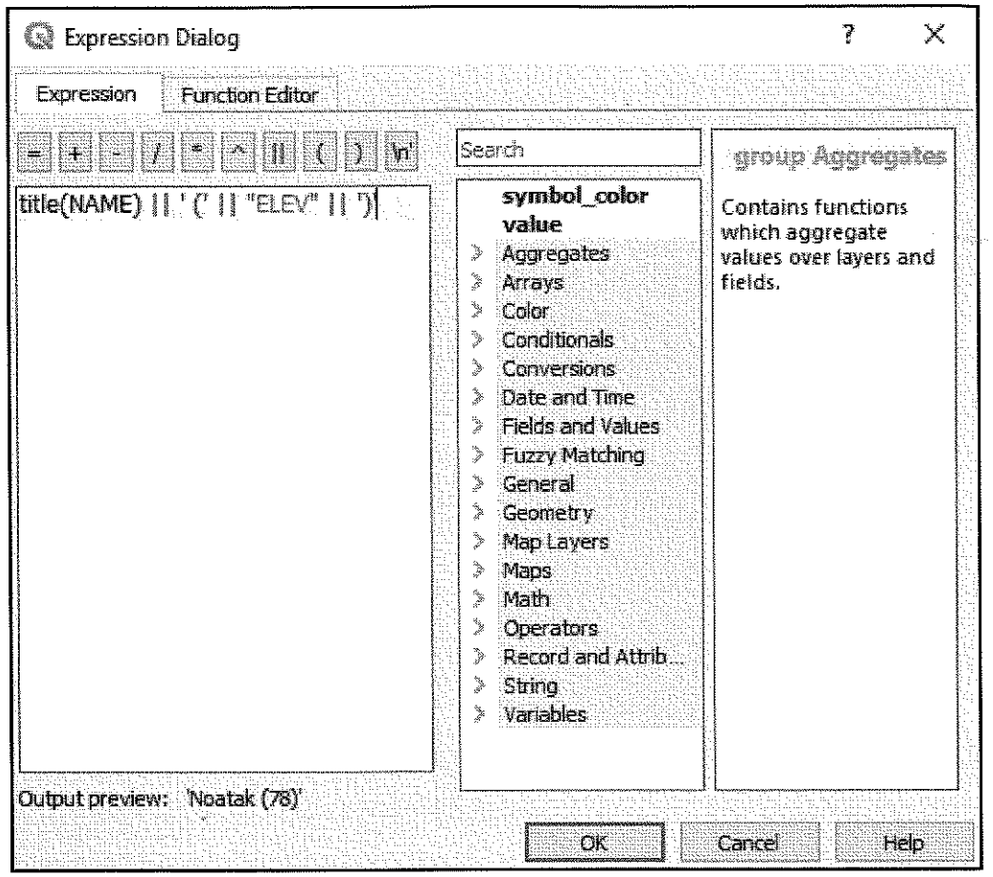
These may not be the optimum label placements, but they are fully customizable by the user, providing fast feedback.

Displaying more information using labels

It is possible to build expressions using labels. Using expressions (the button that is right beside the attribute drop-down list and looks like an E), we can format the label text. For example, the `NAME` field in our sample `airports.shp` file contains text in uppercase. To display the airport names in mixed case instead, we can set the `title(NAME)` expression, which will reformat the name text in the title case. We can also use multiple fields to create a label, for example, by combining the name and elevation in brackets using the concatenation operator (`||`), as follows:

```
title(NAME) || ' (' || "ELEV" || ')'
```

Note the use of simple quotation marks around text such as `' ('`, and double quotation marks around field names, such as **"ELEV"**. The dialog will be the same as that shown in the following screenshot:

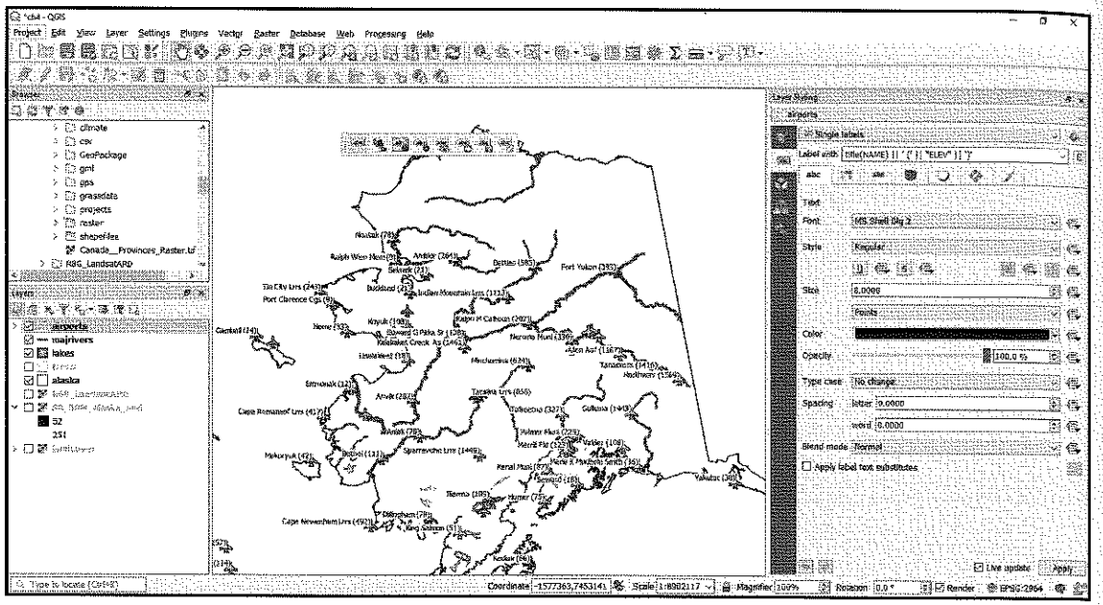


Expression Dialog window

In the bottom left of the expression window, the output will be previewed. This is common throughout any expressions built in QGIS. The results map window will now look similar to the following screenshot:

Labeling in the map window after setting an expression

Similar to the styling that we saw in `Chapter 3`, *Visualizing Data*, the possibilities are endless when it comes to labeling. For a final example, I have reduced the font size to 8 mm and, on the background tab, I have selected a background to be drawn. This often proves to be an effective way of displaying a large number of labels. This is especially true when manually editing labels is time-consuming and it is difficult to find a placement rule that fits all. My final point labeled map window ends up looking like the following diagram:



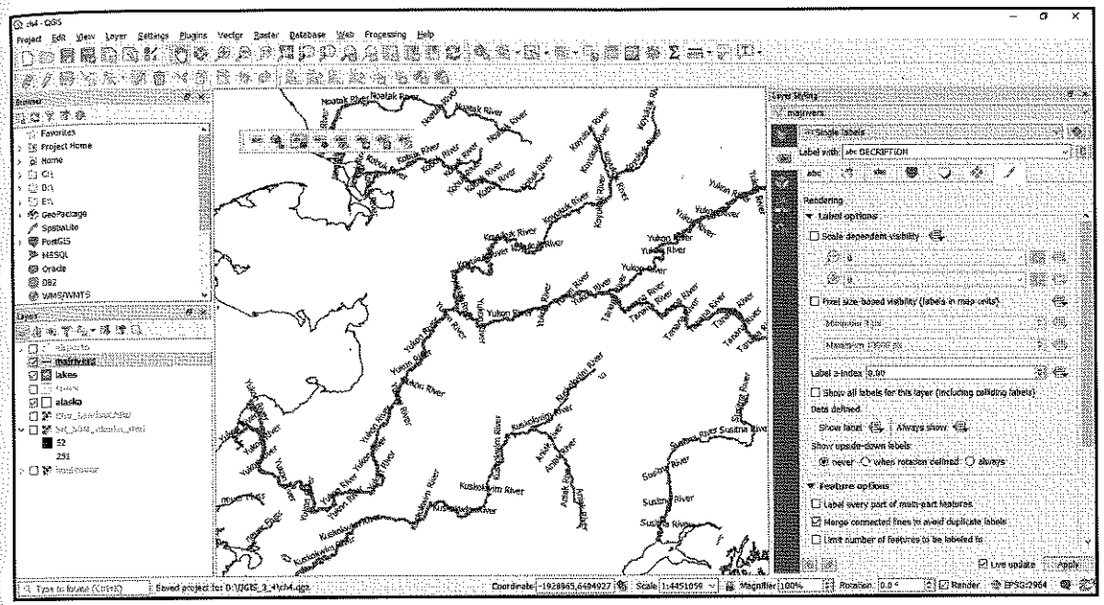
Final data after adding a buffer around the labels

Line labels

For line layers, we can choose from the following placement options:

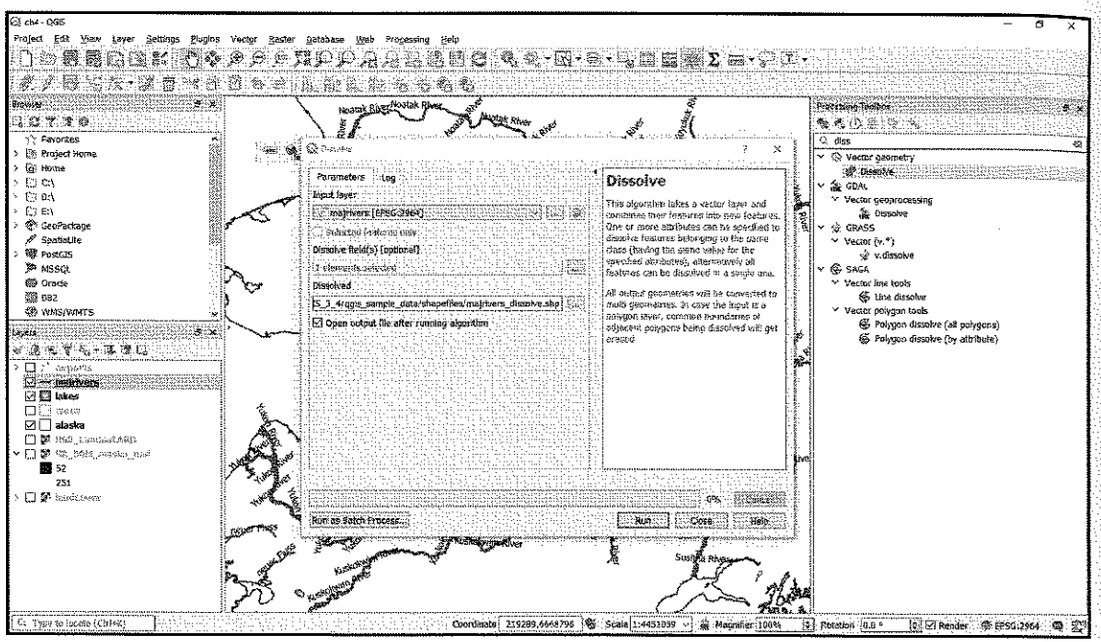
- Parallel for straight labels that are rotated according to the line orientation
- Curved for labels that follow the shape of the line
- Horizontal for labels that keep a horizontal orientation, regardless of the line orientation

For further fine-tuning, we can define whether the label should be placed above the line, on the line, or below the line, and how far above or below it should be placed using label distance. We can also utilize a setting shown in the following in the rendering tab called **Merge connected lines to avoid duplicate labels**. This does a reasonable job of reducing the labels on `majrivers.shp`, but it is still very noisy, as shown in the following screenshot:



Labeling lines

Ultimately, with this layer, which has five three-hundred and forty-five records in the attribute table, the best option is to dissolve the shapefile based on the description field. We do this to reduce each river to a single record and therefore a single label. This is a useful geoprocessing task and we will cover these more in the next chapter. Click **Processing** | **Toolbox** to bring up the processing tools. In the search bar, type `dissolve` and double-click on the dissolve process. In the **Unique ID** fields, select **DESCRIPTION** to dissolve based on the name of the river. After doing this, fill in the parameters shown in the following screenshot:

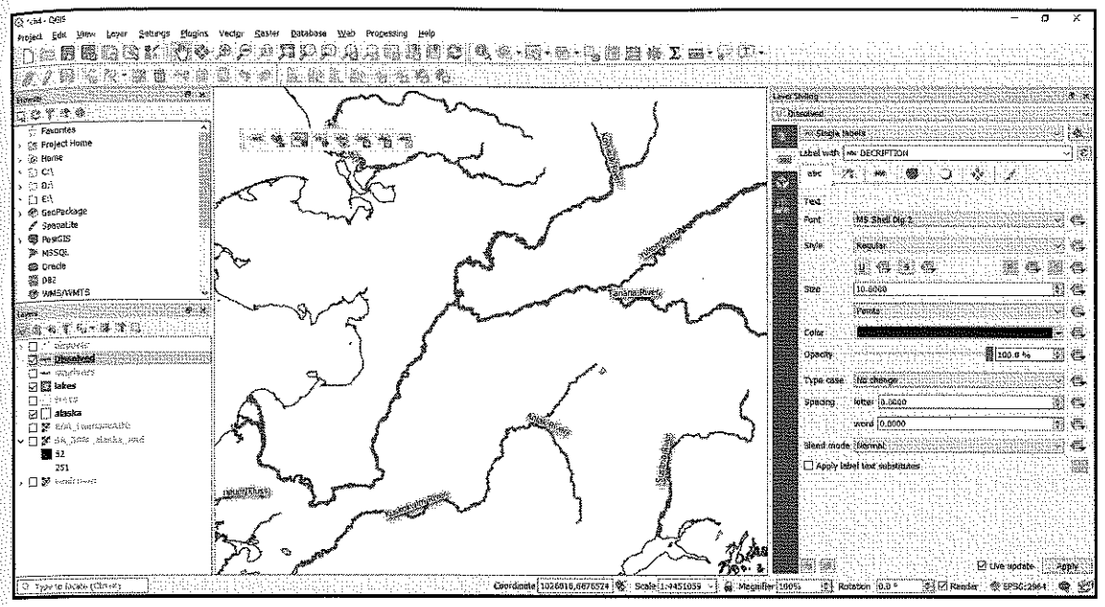


Using dissolve to make the labeling of the lines easier

Click on the **Run** button. Once complete, the newly created shapefile will appear in the map. It should now only have 12 features, and therefore only 12 labels to display.

Right-click on the **majrivers** layer, select **Style** | **Copy Style** | **All Style Categories,** and turn the layer off. Now, on the newly created dissolve layer, right-click and select **Style** | **Paste Style** | **All Style Categories** to take the layer styling across. Finally, click on the label toolbar's **label layering** button, turn labeling on for this layer, and select **Description** as the labeling field.

Use the same approach as used previously for labeling points. The following is a screenshot of the labels:



Post dissolve function labeling the lines

On a country scale, for the labels to follow the curve of the river better, it might be necessary to generalize the line to remove the nodes. Search for `v.generalise` in the **Processing Toolbox**. The **Processing Toolbox** is always worth exploring. Make adjustments to your layer based on the scale in which you wish to present your data.

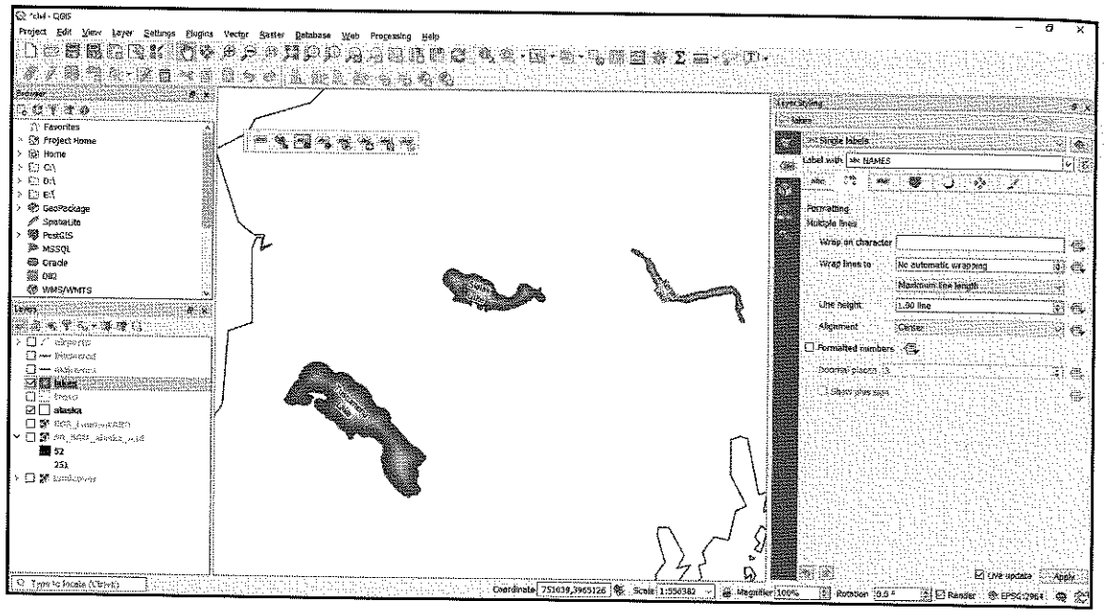
Polygon labels

For polygon layers, the placement options are as follows:

- Offset from centroid uses the polygon centroid as an anchor and works like offset from point-for-point layers.
- Around centroid works in a manner similar to around point.
- Horizontal places a horizontal label somewhere inside the polygon, independent of the centroid.

- Free fits a freely rotated label inside the polygon.
- Using perimeter places the label on the polygon's outline.

The following screenshot shows the **lakes** labels (`lakes.shp`) using the wrapping on the character as an empty space character (click and press the spacebar once), as well as center alignment, and, from the Placement tab, select positioning using the **Free** option. I have added a buffer to the label as well. This is shown in the following screenshot:



Polygon labels

Creating a map

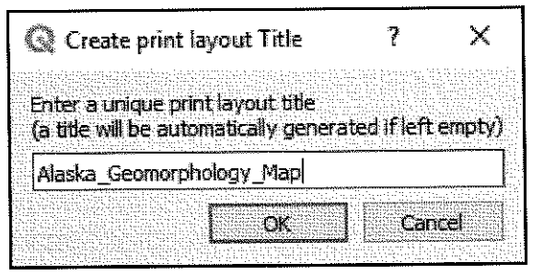
So, we have loaded, styled, and labeled our data with the help of the Processing Toolbox. Now, it is finally time to make a map.

To begin, turn on the following layers:

- Dissolved
- Lakes
- Trees
- Alaska
- SR_50m_alsaka_nad

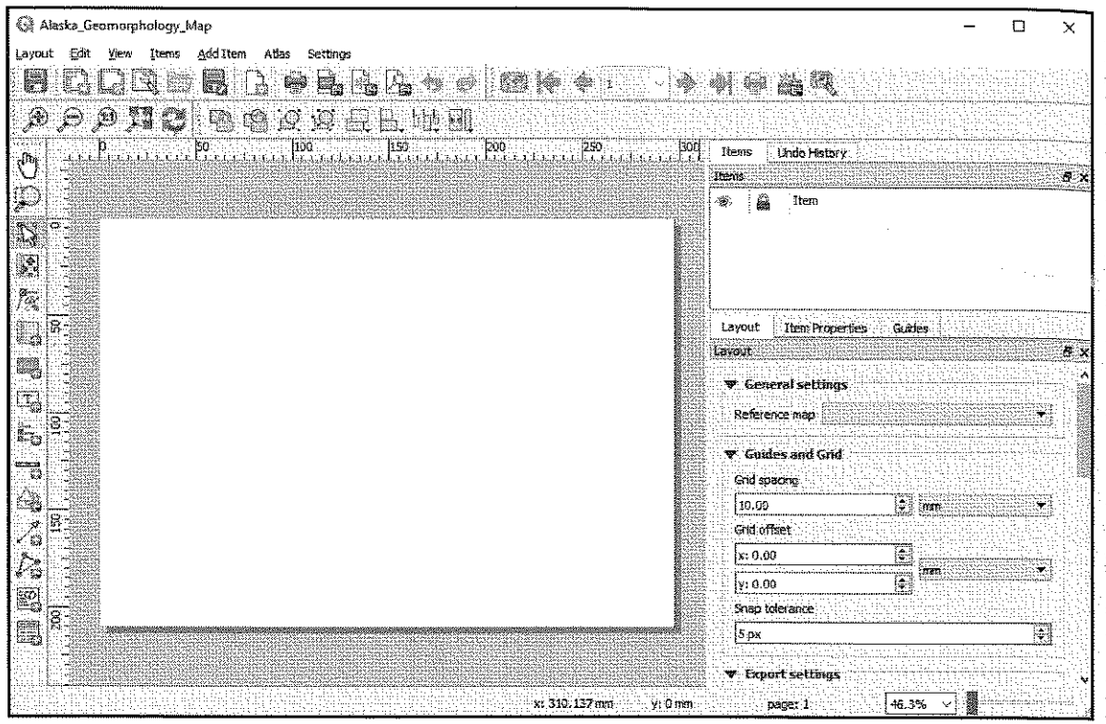
Right-click on **Dissolved** and rename it to **Major_Rivers**, then right-click on **SR_50m_alaska_nad** and rename it to **Hillshade**. Click on **Project** | **New Print Layout** (or click the corresponding button on the **Project** Toolbar). In the **Layer Styling** panel, change the **symbology** to **renderer** to **Single Band Psuedo Color** and select **Viridis** as the color ramp.

We are now ready to create a map. In the **Create print layout Title** dialog box give your new, empty map a title, and click **OK**. This is demonstrated as follows:



Creating a print layout Title

You will now have an empty canvas on which we will build our first map. It will look like this:



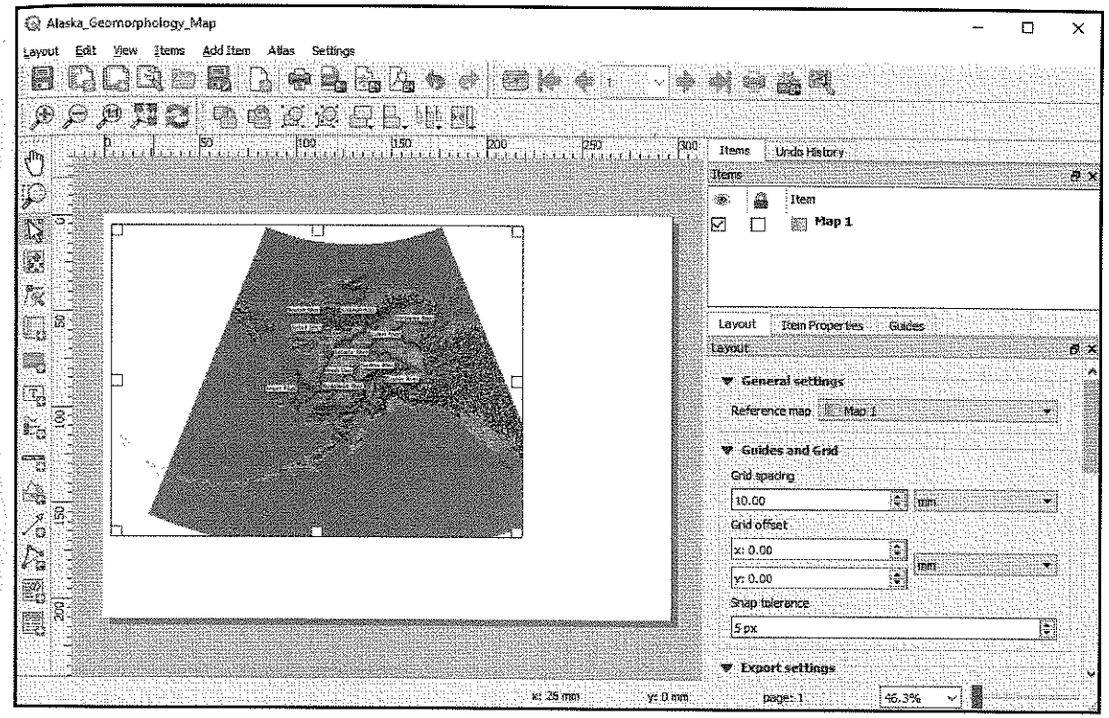
Starting with a blank map

There are many buttons and menus here. You can probably already tell that when creating maps, you can spend many hours adjusting them. There are panels for configuring layout, Item properties, and Atlas generation, as well as a command history panel for quick undo and redo actions. There are also toolbars designed to manage, save, and export layouts, navigate in the preview area, and add and arrange different layout items.

Once you have designed your print map the way you want it, you can save the template to a template `.qpt` file by going to **Layout | Save as template**. You can also reuse it in other projects by going to **Layout | Add Items** from Template.

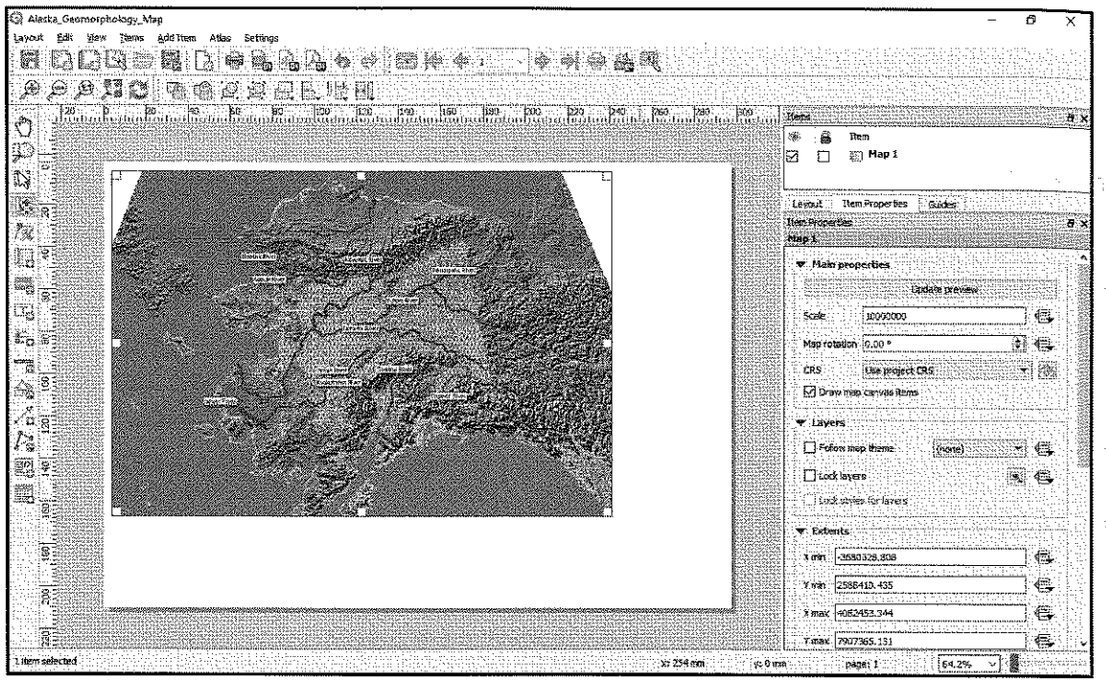
Loading data

Now add your map. This is the view of the symbolized data created in the last chapter and the start of this one to the layout canvas. The layout canvas is your empty white page at present. To add a map select **Add Item | Add Map**. Then click and drag the mouse to draw on the canvas in the location you want to put your map. This is shown in the following screenshot:



Adding the map to the layout canvas

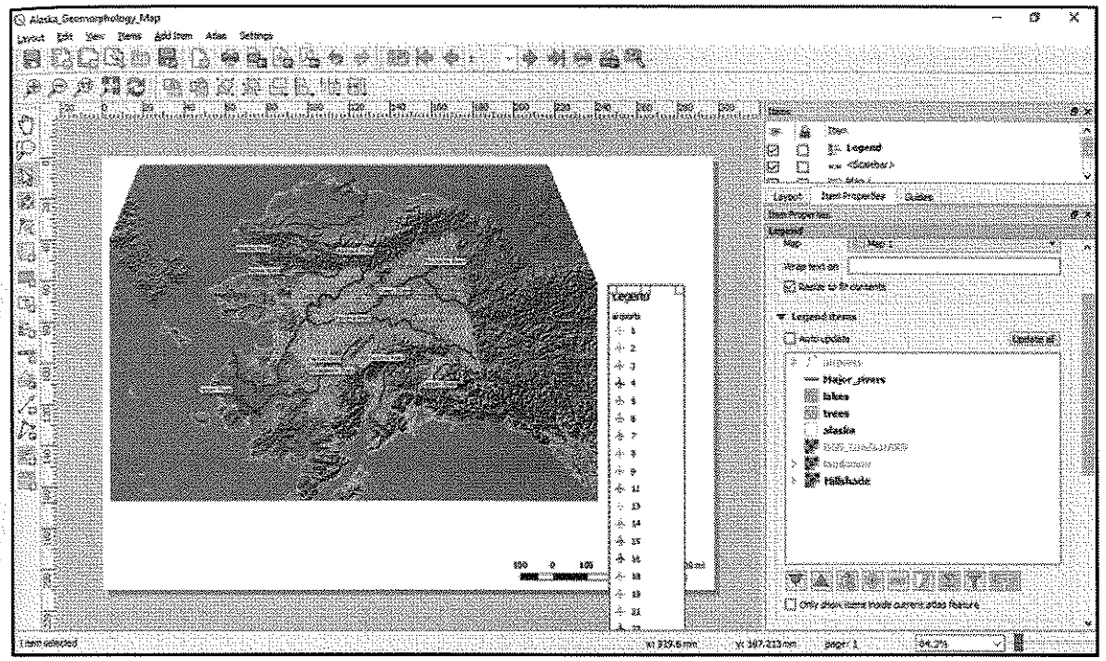
Use the move item tool to pan and zoom (using the mouse wheel) to adjust the map in your layout window. The Item properties panel's content depends on the currently selected layout item. If a map item is selected, we can adjust the maps **Scale** and **Extents**, as well as the position and size tool of the map item itself. Let's now set the scale to `10,000,000` (with the CRS set to EPSG:2964). The map now looks like the following screenshot:



Setting the scale

Adding layout items

We can add a variety of other items to our canvas. Click on **Add Item** | **Add Legend** and draw the area that will contain the legend. Repeat the same steps for adding a scale bar, which we will look at shortly. You might find that your layout is now looking distinctively messy. Uncheck the auto update button in the **Legend Items Properties** window, as shown in the following screenshot:

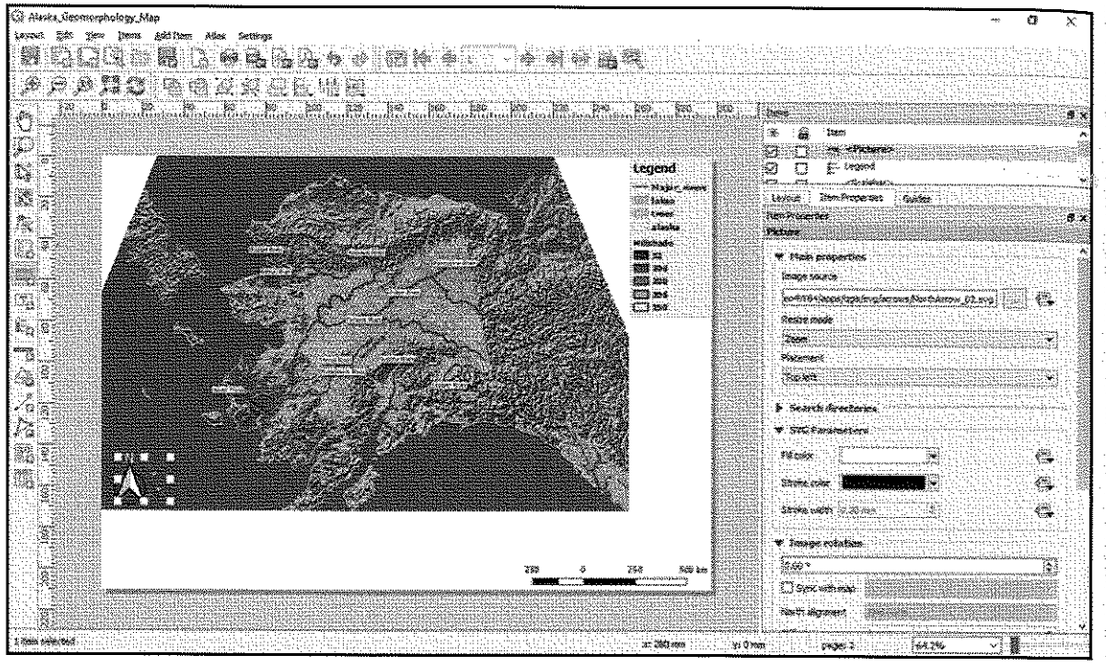


Adding a legend to the layout

By selecting a layer and then clicking on the red minus button, we can remove any layers that are not present in our final map. With this in mind, remove airports, `RGB_LandsatARD`, and `Landcover`. We still have a problem with the legend item for the Hillshade. Head back into the QGIS project and adjust the layer properties for the Hillshade, setting the **Mode** to **Quantile**. This will adjust the colors in the map as well. Back in the layout manager, click on **update all** and the legend will be updated.

In the fonts section, set all fonts to bold, set the background to gray, and update the map preview. Then select the scale bar and change the units to kilometers and the segments to **left 2** and **right 2**.

Add a North arrow by clicking **Add Item** | **Add Picture** and drawing a box to contain your north arrow. Use the item properties to point to the location on your computer where the QGIS SVG files are stored. In this example, I am using `.../apps/qgis/svg/arrows/NorthArrow_02.svg`, as shown in the following screenshot:



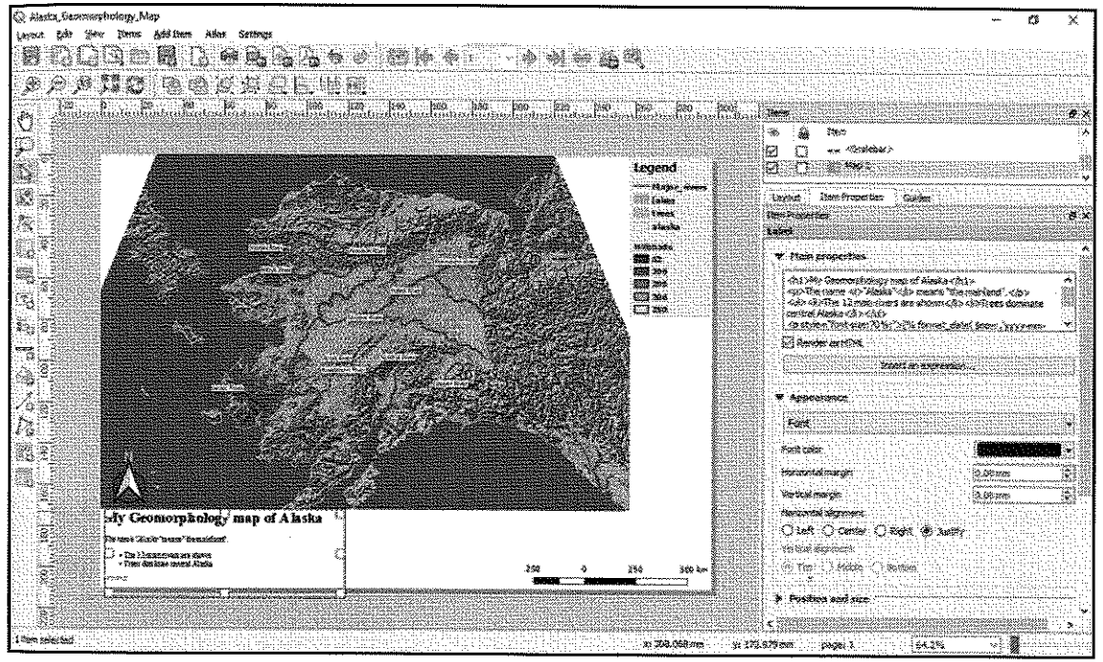
Changing the color scaling, and then adding a north arrow and scale bar

Add a title (or any text)

To add text to this map, select **Add Item** | **Add label**. Draw a box in the bottom-left corner and in the Item properties window, copy the following text:

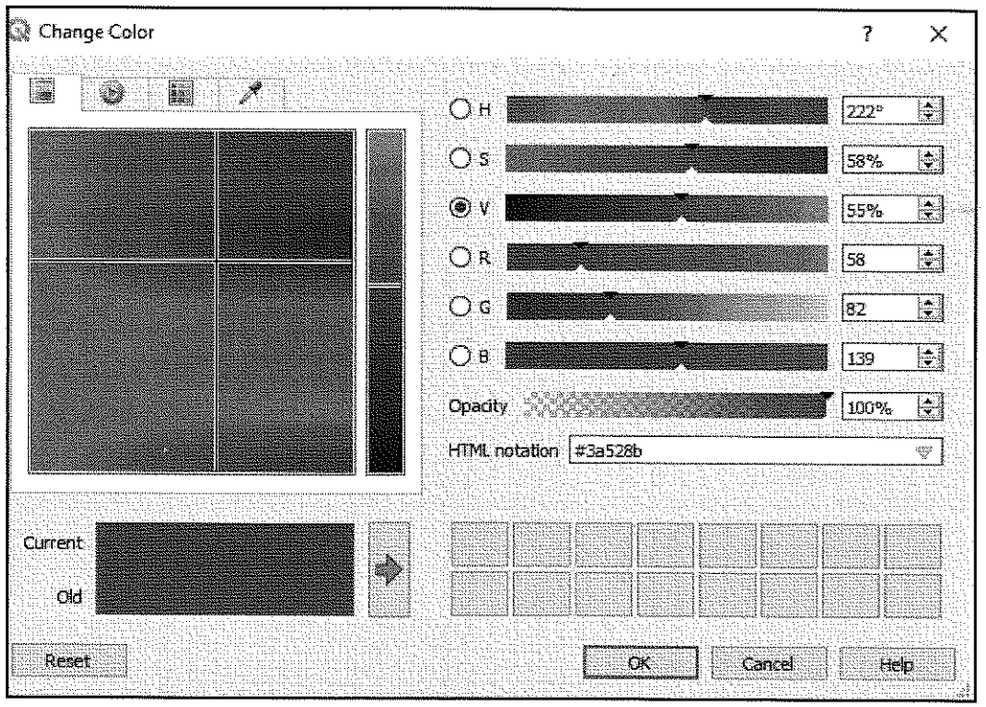
```
<h1>My Geomorphology map of Alaska</h1>
<p>The name <i>"Alaska"</i> means "the mainland".</p>
<ul><li>The 12 main rivers are shown</li><li>Trees dominate central
Alaska</li></ul>
<p style="font-size:70%;">[% format_date( $now ,'yyyy-mm-dd')%]</p>
```

Click on **render as HTML**. Your layout composer should now look similar to the following screenshot:



Adding a title to the map

Set the background to the same color as the sea so that we can remove the white triangles in the top-left and top-right corners. To get the exact numbers to input, go back to the properties in the QGIS project window and make a note. The following is a screenshot to save you going back if you are following my map:

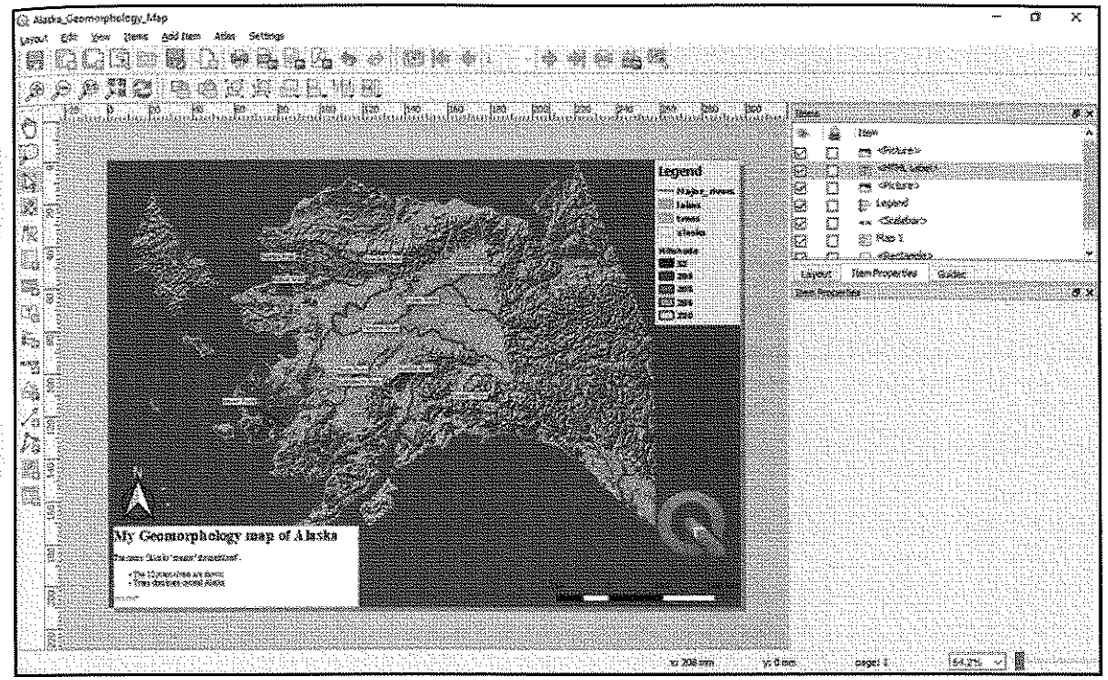


Color picker in QGIS

The preceding screenshot is the QGIS color picker. In our example, we were using it for matching colors. However, you can use the various tabs to select the ideal color for your requirements. More information can be found here: `http://nyalldawson.net/2014/09/whats-new-in-qgis-2-6-tons-of-color-improvements/`.

Your map should now be looking much closer to being complete; now it is a question of styling and personal preference. For example, your company logo could be added in the same way we added a north arrow, or more text could be added.

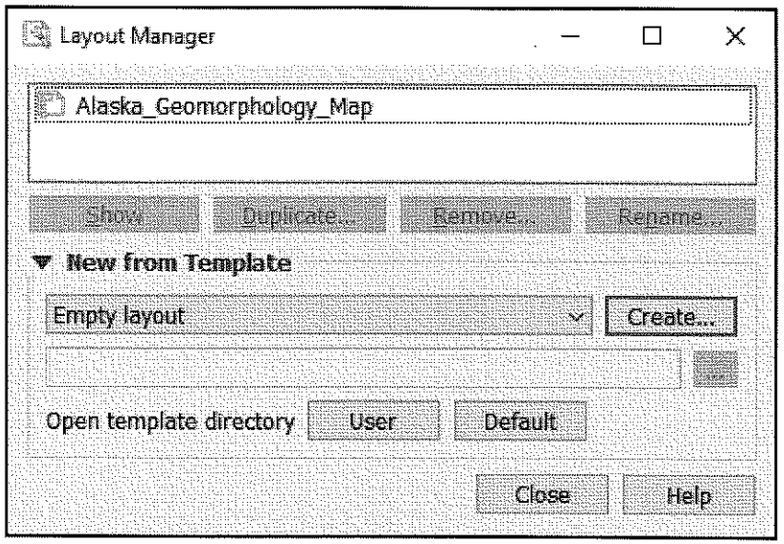
In my final map shown here, I have added a rectangle (**Add Item** | **Add Shape** | **Add Rectangle**), colored it in with the same blue and used the items order to drag it to the back. The rectangle is added to ensure that the blue color is the same throughout the layout. It is another tool to help style and create beautiful maps. I have also added the QGIS logo in the bottom-right corner, as shown in the following screenshot:



Final map created and styled

Further map creation options

Save your Geomorphology map and close the print layout. Back in the QGIS project, click **Project** | **Layout Manager,** and a new dialog box will appear as shown in the following screenshot:



The **Layout Manager**, containing all your layouts and the ability to create a new one

The **Layout Manager** is useful for managing all your layouts in a project. It is very likely that you will have several maps you wish to create, perhaps with different designs or using different templates.The **Layout Manager** helps you to make sense of these.

Click on **Create** to build a new layout. This time we will look at some of the other capabilities in the print layout. I am using this map for further examples. In QGIS, zoom into an area near Skilak lake, turn on the **Airports** layer and the **landcover** layer, and turn off the Hillshade. I have made adjustments to my Airports layer, offsetting the labels to the right of the points, setting the symbols to the default **topo airport** style, and making them (and the label) size 10. Back in **Layout Manager**, I have also added a map item to the canvas.

Adding Grids

With the map item selected, add a grid. Every map item can have one or more grids. Click on the + button in the Grids section to do this. The **Interval** and **Offset** values have to be specified in map units. We can choose between the following grid options:

- A normal solid grid with customizable lines.
- Crosses at specified intervals with customizable styles.
- Customizable markers at specified intervals.
- Frame and annotation will hide the grid while still displaying the frame and coordinate annotations.

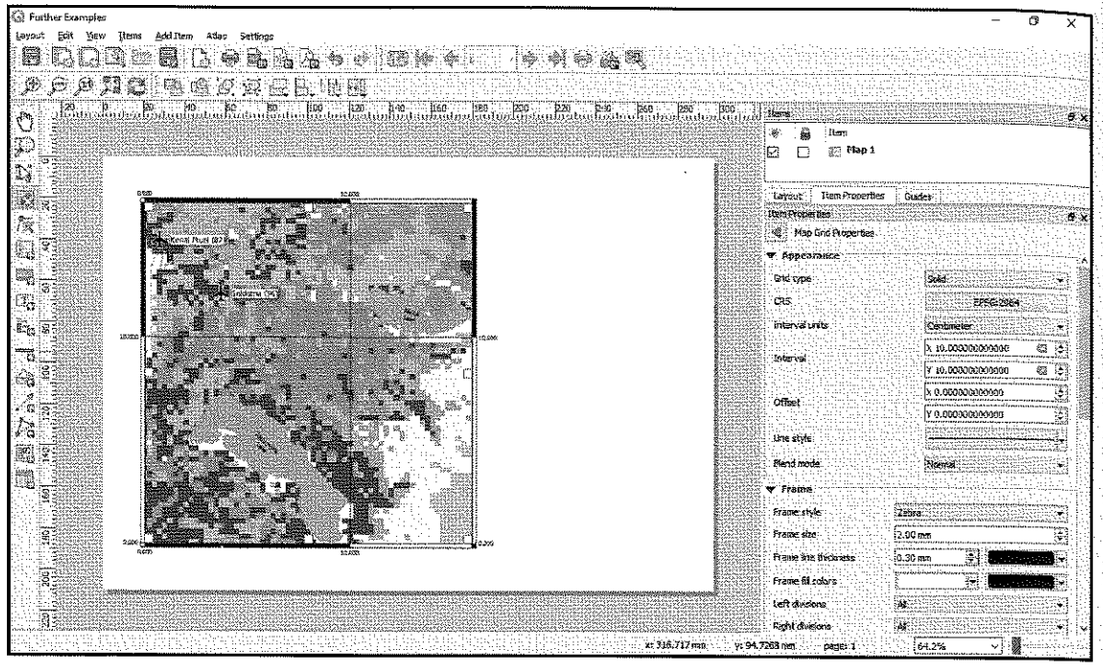
For Grid frame, we can select from the following frame styles:

- Zebra, with customizable line and fill colors, as shown in the next screenshot
- Interior ticks, Exterior ticks, or Interior and exterior ticks, for tick marks pointing inside the map, outside it, or in both directions
- Line border for a simple line frame

In the following example, I have made the following selections:

- Grid type = Solid
- Set the *X* and *Y* intervals to 10 cm
- Chosen the Zebra frame
- Checked the draw coordinates box (scroll down the dialog box to find this option)

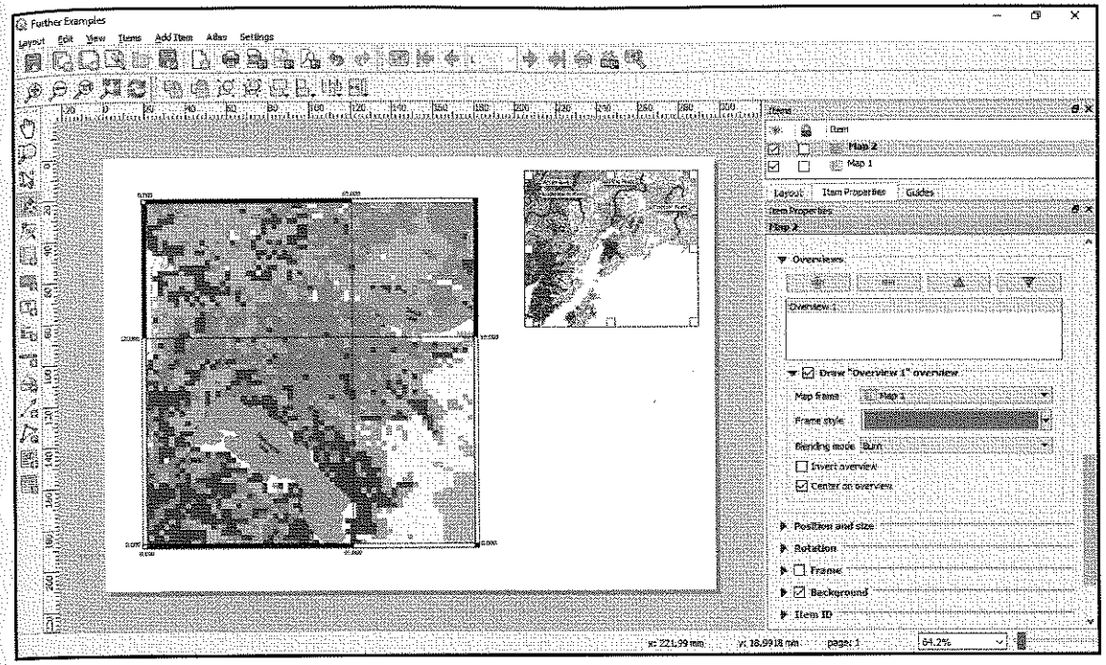
My print layout now looks like this:



Adding a new grid

Adding an overview map

Maps that show an area up close are often accompanied by a second map that tells the reader where the area is located, helping to provide context to your map. To create such an overview map, we need to add a second map item, then make it an overview map by clicking on the + button in the Overviews section. By setting the Map frame, we can define the map extent and how it should be highlighted. The following screenshot shows an example of this using an overview map. In the main map, the area is highlighted in red. This relates to the corresponding area in the overview window. I have checked the center on canvas button on the toolbar on the left of the following screenshot. You may need to return to the QGIS project window and make adjustments to improve each added map:



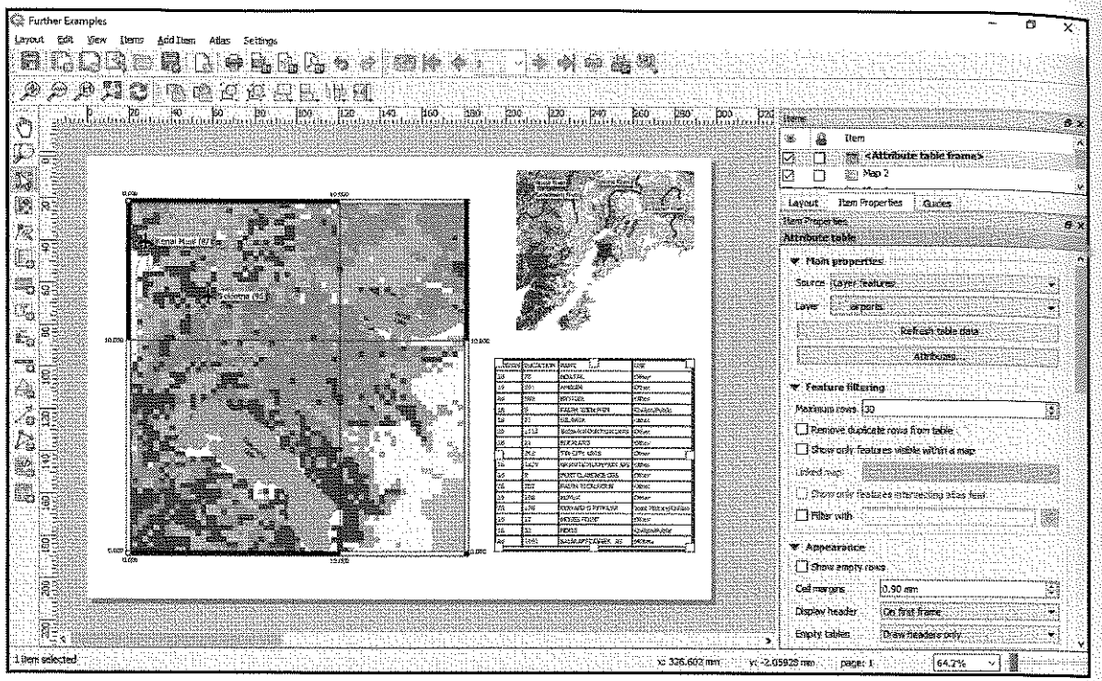
Adding an overview map

Every map item in a composition can display a different combination of layers. Generally, map items in a layout are synced with the map in the main QGIS window. So, if we turn a layer off in the main window, it is removed from the print composer map as well. However, we can stop this automatic synchronization by enabling Lock layers for a map item in the map item's properties.

Adding an attribute table

The final thing to add to this map is an attribute table. To do this, go to **Add Item** | **Add Attribute Table,** and then draw the bounding box on the canvas. Adjust the appearance first by clicking the **Attributes** button, renaming fields, and removing unnecessary ones. In the following example, I have selected the airport layer for my attribute layer, removed ID field, and changed the name of the other fields from **ELEV** to **Elevation**, and **fk_region** to **Region**.

I have also added a purple frame to surround the table. Scroll down through the **Item Properties** until you find the **Frame** options. My final map looks like the following screenshot:

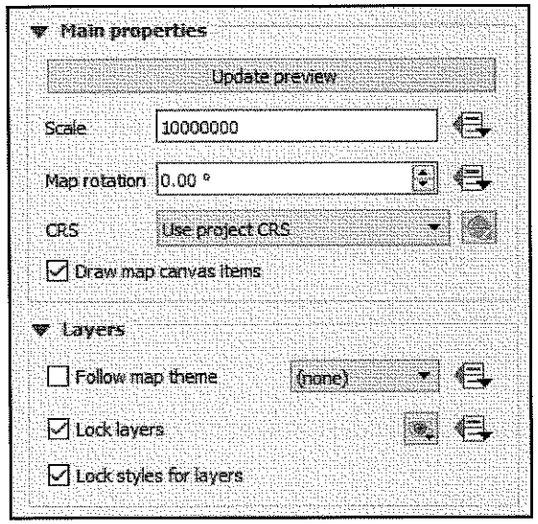


Adding an attribute table to the layout

Even more advanced content can be added using the **Add HTML frame** button. We can point the item's URL reference to any HTML page on our local machines or online, and the content (text and images as displayed in a web browser) will be displayed on the composer page. When you have done this, save your map.

Map outputs

Return to your Geomorphology map through the layout manager. You may have noticed that it looks a little different now. This is because we have made another map that has impacted this one. Reset the layers in the QGIS project to before (Major rivers, lakes, trees, alaska and Hillshade on – everything else off), check that your zoom level is still correct (scale: 10,000,000), and then, in the **Layers** section of the map item, click on **Lock Layers** and **Lock styles for layers**. This is shown in the following screenshot:



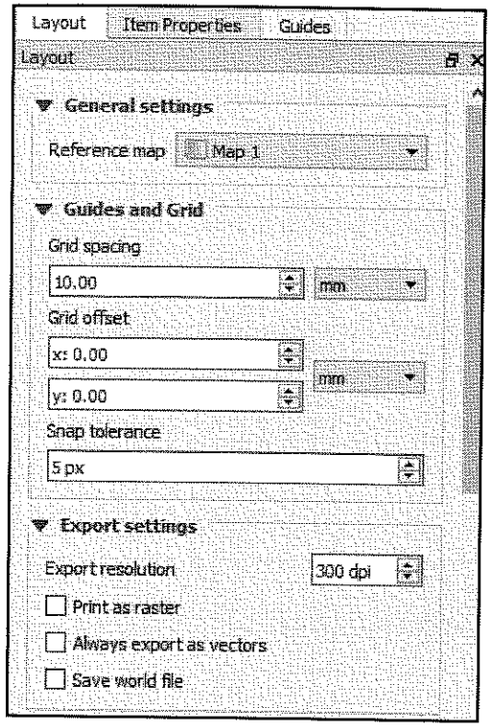
Changing the scale

We are now ready to create map outputs.

Saving maps to share

The simplest way to do this is to share the maps either to `.pdf` or `.jpg`, or to print them. This is all done through the Layout menu. For many of the processes in QGIS, once an operation has been performed, you will get a message at the top of your screen letting you know that it has been completed successfully. This is the case when saving your map to `.pdf`, for example.

To adjust properties such as the dpi, or determine whether a world file is written or not, select the **Layout** tab and look for the **Export settings**, as shown in the following screenshot:



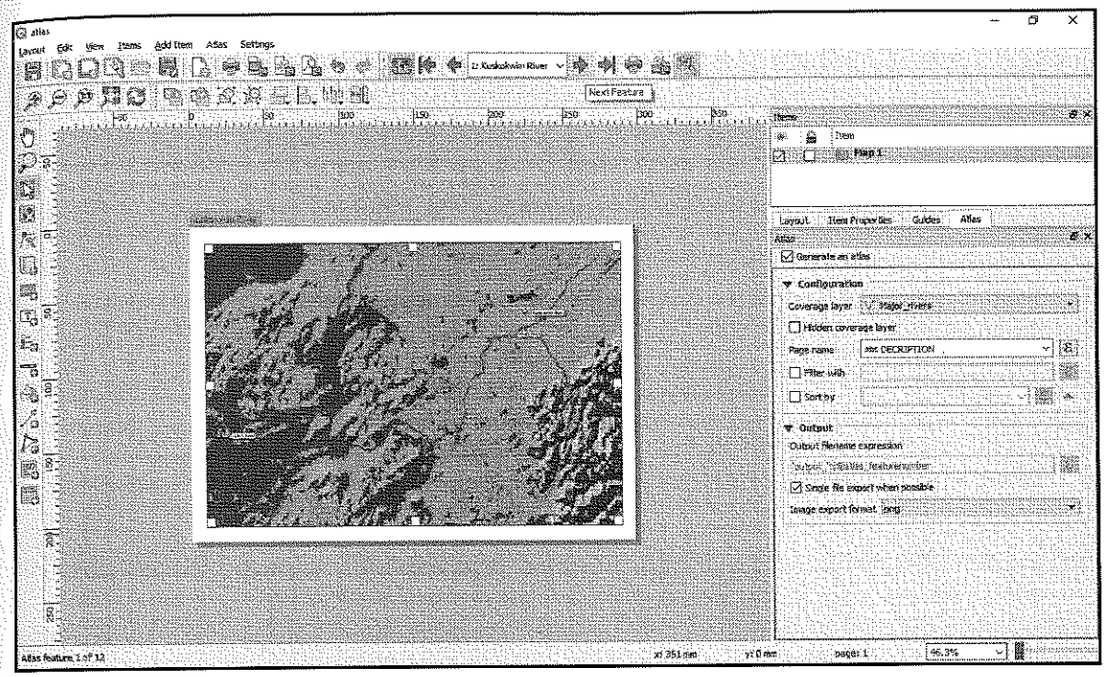
The export settings for the map prior to saving as an image

So that it can be loaded to the correct location in QGIS, select the world file option if you wish to maintain a projection with the map.

Creating an Atlas

QGIS also has the ability to create an Atlas. An Atlas is a series of maps that could be based on information in a layer, such as the name of a river. To do this, create a new print layout and draw a new map item in the center of the canvas. From the Menu, select **Atlas | Atlas settings** and then check the box next to **Generate Atlas**. Now, select the **Coverage layer** as **Major_rivers** and the page name as **DESCRIPTION**.

This will tell the Atlas to create one page per river description. In the **Item Properties,** navigate to **Controlled by Atlas** and check the box. Click on the **preview** button in the Atlas toolbar and use the arrows to scroll through the proposed Atlas. This is shown in the following screenshot:



Creating an Atlas

Finally, select **Atlas | Export Atlas** from the menu as `.pdf` and save to it disk. This is a relatively simple example, but it shows the power behind creating an Atlas and you only need to build one layout in order to do it.

Presenting Maps online

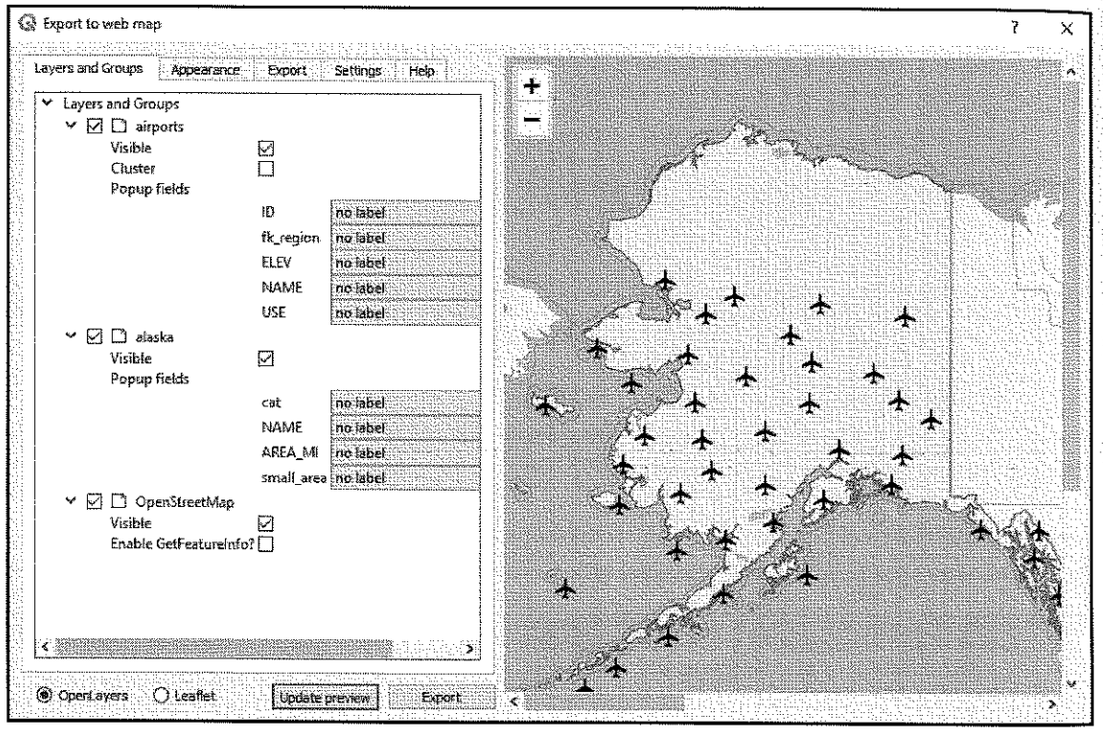
Besides print maps, web maps are another popular way of publishing maps. In this section, we will use different QGIS plugins to create different types of web maps. Plugins can change rapidly (for the better). More functionality is added frequently and the appearance can change slightly. We present these two examples as they were at the time of writing.

Exporting a web map

To create web maps from within QGIS, we can use the QGIS2Web plugin, which we have to install using the Plugin Manager. Once it is installed, go to **Web | qgis2web | Create web map** to start it. QGIS2Web supports the two most popular open source web mapping libraries: OpenLayers 3 and Leaflet.

I have created a new QGIS project and set the projection (in the bottom-right corner) to EPSG 3857. This is the web Mercator projection. I have loaded the `Airports` and `Alaska` shapefile and the OpenStreetMap XYZ tile (refer to data creation and editing in `Chapter 2`, *Data Creation and Editing*).

The following screenshot shows an example of our `airports` dataset. In this example, we are using the **OpenLayers** library (as configured in the bottom-left corner of the following screenshot). You could also choose Leaflet if you wish, which is a different JavaScript library for interactive maps:



QGIS2Web – an excellent way to export your data in openlayers or leaflet

In the top-left corner, you can configure which layers from your project should be displayed on the web map, as well as the info pop-up content, which is displayed when the user clicks on, or hovers over, a feature (depending on the **Show popups on hover** setting).

Using the **appearance** tab, you can further configure the web map. All available settings are documented in the **Help** tab, so the content is not reproduced here. Again, don't forget to click on the **Update preview** button when you make changes.

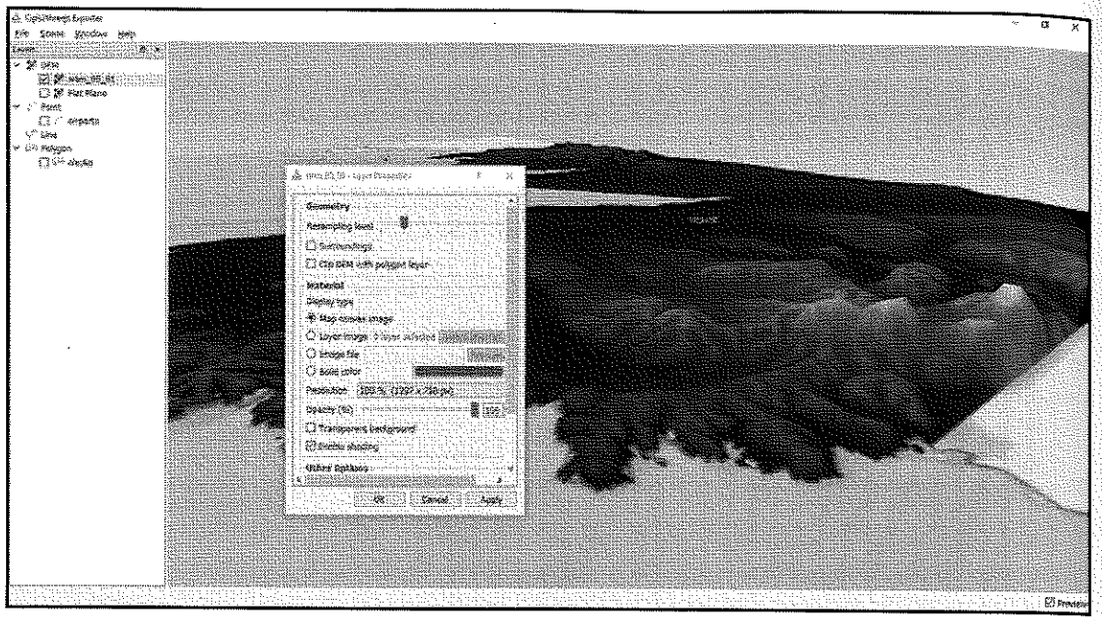
When you are happy with the configuration, click on the **Export** button. This will save the web map at the location specified as the `Export` folder. Then open the resulting web map in your web browser. You can copy the contents in the `Export` folder to a web server to publish the map. The QGIS2Web plugin is a very efficient way of creating web maps.

Exporting a 3D web map

To create stunning 3D web maps, we need the Qgis2threejs plugin, which we can install using the **Plugin Manager**.

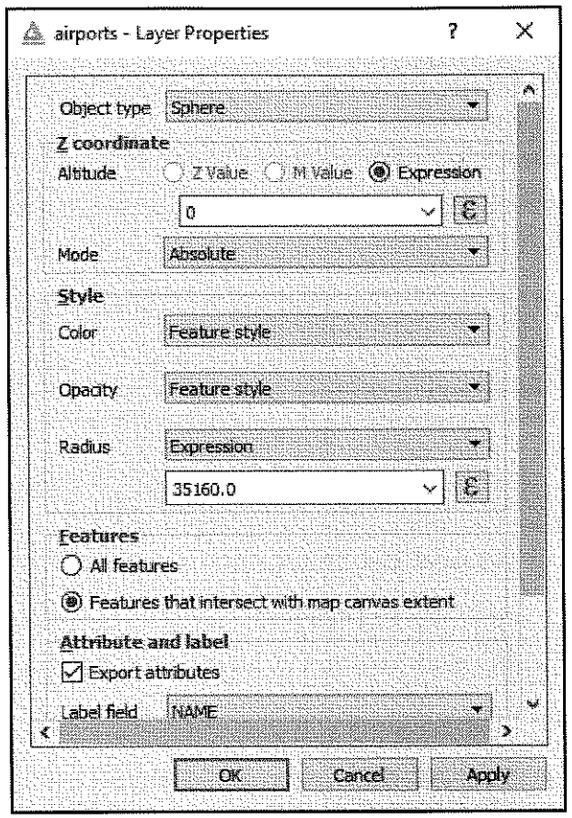
For example, we can use our `srtm_05_01.tif` elevation dataset to create a 3D view of that part of Alaska. The following screenshot shows the configuration of a DEM Layer in the Qgis2threejs dialog. From the scene menu, I have changed the vertical exaggeration to 10 times to highlight the elevations. Right-click on the `srtm_05_01.tif` layer to bring the layer properties box up.

By selecting **Map canvas image** under **Display type**, we therefore define that the current map image will be draped over the 3D surface:



Setting up the elevation for a 3D view in the browser from QGIS with the Qgis2threejs plugin

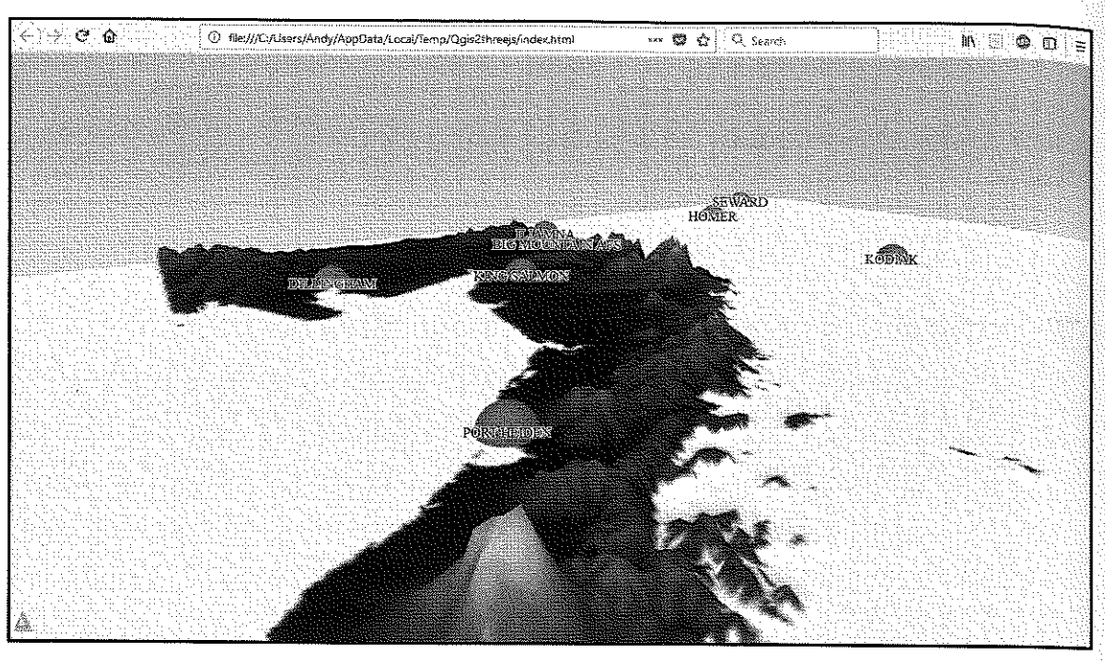
Besides creating a 3D surface, this plugin can also label features. For example, we can add our **airports** and label them with their names. Right-click on the **airports** layer and select properties. Check the box next to **Export attributes** and choose **NAME** as the label field. The properties box should look like the following screenshot:



Labeling the airports in the 3D view

If you click on **File | Export to web**, the plugin will create the export and open the 3D map in your web browser. On the first try, it is quite likely that the surface will look too flat. Luckily, this can be easily changed by adjusting the Vertical exaggeration setting in the World section of the plugin configuration.

The following example was created with a Vertical exaggeration of 10:



Final visualization of the data

`Qgis2threejs` exports all files to the location specified in the Output HTML file path. You can copy the contents in that folder on a web server to publish the map.

Summary

In this chapter, we looked at creating maps. Firstly, we studied labeling capabilities and then we moved on to map generation with the layout composer. There is a great deal of power in the layout composer and it is worth spending time exploring this in more detail in order to add more value to your maps.

We have now achieved a major milestone in this book: we have built familiarity with QGIS as a GIS, navigated how to load and create data, styled and presented our data, built maps, and created web maps as well as an Atlas.

In the final chapter of this book, we will look at extending and customizing QGIS 3. But first, in `Chapter 5`, *Spatial Analysis*, we will look at the processing toolbox. Let's become spatial scientists!