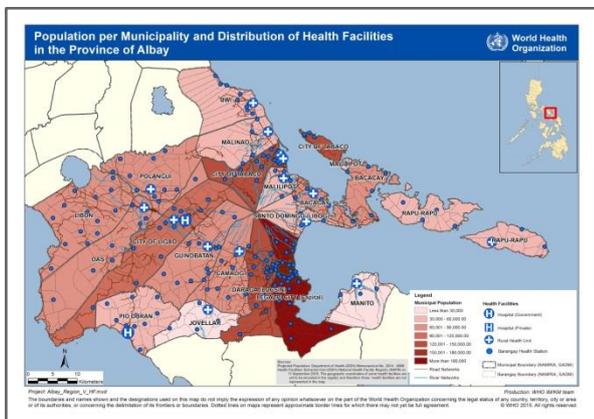


Guidance for the management and use of geospatial data and technologies in health

Part 2 - Implementing the geospatial data management cycle: 2.6 Distributing, using, and updating the data - 2.6.1 Creating good thematic maps using desktop GIS software

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Purpose and audience

The purpose of the Health GeoLab series of guidance is to inform concerned practitioners about the key elements they need to be aware of when it comes to managing and using geospatial data and technologies in public health and guide them through the processes to be followed in that regard.

The audience for this guidance includes geospatial data managers, technical advisors, and any other practitioners that are directly or indirectly involved in the collection and use of geospatial data and technologies in public health.

Please note that some of the sections in the present guidance require a basic understanding of concepts pertaining to the management and use of geospatial data and technologies.

Abbreviations

ADB	Asian Development Bank
AeHIN	Asia eHealth Information Network
GIS	Geographic Information System
HGL	Health GeoLab
HIS	Health Information System
MORU	Mahidol Oxford Tropical Medicine Research Unit
SDG	Sustainable Development Goal
WHO	World Health Organization

1. Background

The Health GeoLab (HGL) is a regional resource supporting low- and middle-income countries in Asia and the Pacific for them to fully benefit from the power of geography, geospatial data, and technologies to reach the health-related Sustainable Development Goal of healthy lives and well-being for all (SDG 3)¹.

The HGL uses the HIS geo-enabling framework to strengthen in-country capacity. The present document has been developed as part of this approach and with the objective of being used by the largest number of users possible.

This volume is part of a series of guidance started under the umbrella of the AeHIN GIS Lab and now continued by the HGL. The complete series is organized as follows:

- Part 1 - Introduction to the data-information-knowledge-decision continuum and the geospatial data management cycle [1]
- Part 2 - Implementing the geospatial data management cycle:
 - 2.1 Documenting the process and defining the data needs [2]
 - 2.2 Defining the terminology, data specifications, and the ground reference [3]
 - 2.3 Compiling existing data and identifying gaps [4]
 - 2.4 Creating geospatial data
 - 2.4.1 Extracting vector format geospatial data from basemaps [5]
 - 2.4.2 Collecting data in the field [6]
 - 2.5 Cleaning, validating, and documenting the data
 - 2.5.1 Documenting the data using a metadata profile [7]
 - 2.5.2 Using advanced Microsoft Excel functions [8]
 - 2.6 Distributing, using, and updating the data
 - 2.6.1 Creating good thematic maps using desktop GIS software (the present document)
 - 2.6.2 Using thematic maps for decision making [9]
 - 2.6.3 Developing and implementing the appropriate data policy [10]

This guidance is a living document made to evolve based on the inputs received from the users. Please don't hesitate to [contact us](#) if you have any suggestions for improvement.

The terms used in the present guidance are defined in the following glossary of terms maintained by the Health GeoLab: <https://bit.ly/3ctoHiS>

Please also contact us using the same email address should you use this document as part of your activities and would like to have your institution recognized as one of the document's users.

¹ <https://www.un.org/sustainabledevelopment/health/>

2. Introduction

A thematic map can be defined as "a map designed to convey information about a single topic or theme, such as population density or geology."²

Thematic maps represent key instruments for public health decision makers not only by providing them with information to investigate, understand, and communicate health issues but also to analyze where, why, and how resources can be allocated to improve the health of the population.

While the use of GIS has simplified the creation of thematic maps, creating good thematic maps requires for some specific components to be considered and a process to be followed.

The main objective of the present guidance is to describe these components and the process to be followed when using desktop GIS software.

3. The components of a good thematic map

A good thematic map easily and effectively conveys the information it contains to the reader.

To help reach such a result, a thematic map should always contain (Figure 1):

1. The map area where the symbolized and labeled data is located.
2. A title with the indication of the date of the information contained on the map.
3. A legend indicating what the different symbols used in the map represent on the ground and the source and year/date that the data was collected. The source and year/date may sometime be placed separately from the legend if the text is too long.
4. A scale showing the relationship between the distance or area on a map and the corresponding distance or area on the ground. It can be a scale bar, representative fraction, or a verbal scale.
5. A north arrow showing the direction of north on the map. Although it is rare for maps not to have the "north up" orientation, it is good practice to always include a north arrow in the map layout.
6. The map production information stating the person and/or organization who created the map, their contact information, and the date when the map was created.

² http://wiki.gis.com/wiki/index.php/GIS_Glossary

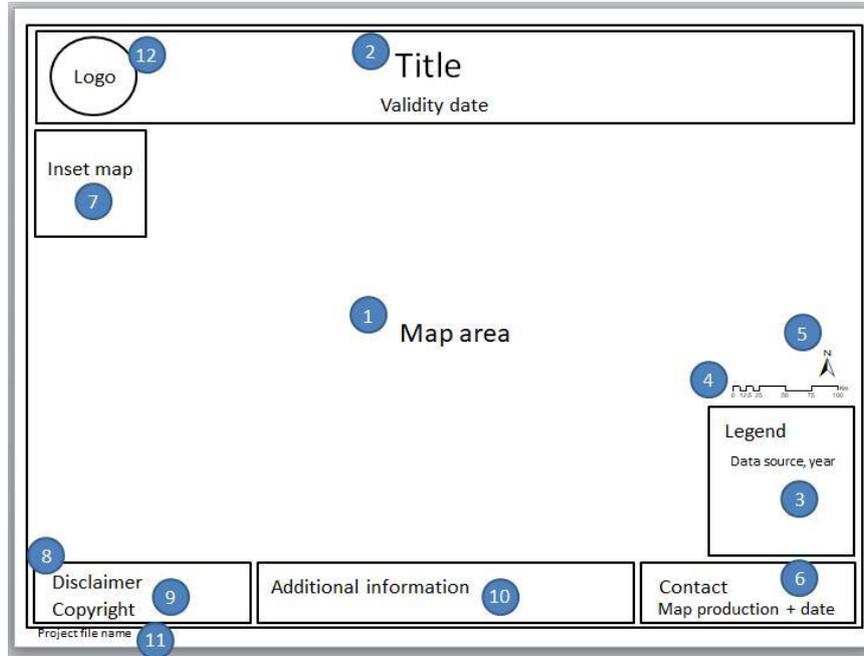


Figure 1 - Components of a good thematic map

While not mandatory, the following elements are also important for inclusion:

7. An inset map showing a detailed part of the map at a larger scale, the location of the main map in the context of a larger area, or information for a related location that cannot easily fit into the same map.
8. A disclaimer delimiting the scope of rights and responsibilities of the author regarding the content of the map.
9. The copyright detailing use and distribution information for the map.
10. Additional information that would provide further context to the map.
11. The project file name and its complete path to help the GIS technician who created the map to easily find the project in case changes need to be made.
12. The logo of the organization creating the map.

All the above constitute what is referred to as a map layout. Examples of thematic maps with these components are provided in Annex 1.

4. The thematic mapping process

The thematic mapping process goes through 3 main steps:

- Understanding the context of the map to be created (Section 4.1)
- Collecting and preparing the necessary data (Section 4.2)
- Creating the thematic map itself (Section 4.3)

These steps are detailed in the following sections.

4.1 Understanding the context of the map to be created

Creating a good thematic map is a time-consuming exercise. The author of the map must first understand the context in which the map is created to guarantee its usefulness.

He must therefore first understand the purpose of the map and its audience, define its content and identify the medium that will be used for sharing it. Ignoring these elements can result in the creation of a poorly conceptualized map that will not meet the needs of its users.

The following subsections discuss these elements in detail.

4.1.1 Understand the purpose of the map

As mentioned in the previous chapter, a good thematic map should be able to convey the information it contains easily and effectively to the reader. For that to happen, the author of the map should first and foremost identify the purpose of the map he/she wants to create. He/She must set the objectives and expected outcomes for creating the map.

There are numerous uses for a thematic map including disseminating information to a community or aiding in decision making. Identifying the purpose for which the map is going to be used helps in identifying the information it needs to contain.

The questions that this element is trying to answer are:

- What is the map going to be used for? For example, is this for general information or support decision making?
- What is/are the message/s that the map is meant to convey?
- When and where will this map be used?
- Who will present the map?

4.1.2 Understanding the audience

Knowing who will use the map has a significant impact on the content and design of the map. The author of the map should at least have an idea of the knowledge level of the audience on the topic to be presented on the map. This would help decide on the amount and technical complexity of the data to be presented.

For example, if the audience has limited knowledge of the area being mapped, it would be necessary to include information to help readers orient themselves on the map. Another example is a thematic map for a group of doctors that could contain technical medical terminology as opposed to the same map that would be presented to non-medical practitioners.

4.1.3 Defining the content of the map

Once the purpose and the audience of the map are known, the information the map needs to contain has to be identified. The information must be enough to achieve the identified objectives and expected outcomes. The way the information is to be represented on the map must also be defined.

It is important to keep in mind that there should not be too much information presented in one map. Too much information can make the map appear too crowded and can confuse the reader.

4.1.4 Identifying the medium

Identifying the medium on which the map will be presented is important. It is how the map will reach its audience.

Most commonly, maps are included in reports, printed to be hung on a wall, or viewed electronically in a PowerPoint presentation for example.

When creating maps for printing, the size of the printing material should be determined. This size should be defined when setting up the “paper” size. This would ensure a crisp and clear printed map as the resolution would be appropriate for the size.

4.2 Collecting and preparing the necessary data

Once the purpose, audience, medium, and content of the map have been identified, the next step consists of compiling and preparing the necessary for its creation.

The data in question are of two main types:

1. Geospatial data
2. Statistical data

Geospatial data, also referred to as spatial data, are information about the locations and shapes of geographic features and the relationships between them, usually stored as coordinates and topology. Statistical data are the statistics that can be attached to a specific geographic object using a unique identifier.

When compiling and preparing data, ensure that:

1. All the geospatial data comply with the data specifications defined to ensure the quality of such data [3].
2. The statistical data is represented using geospatial data in the same level at which they are representative. For example, if the statistical data is for the second sub-national level, then it should be represented using geospatial data containing the second sub-national level boundaries and not the third level.

Aside from the geospatial data and statistical data needed to convey the message of the map, the basemap should also be compiled and prepared. Basemaps represent multiple aspects of the Earth’s surface at once, such as satellite imagery and topographic maps. They provide background and context to thematic layers, helping readers orient themselves on the map.

These terms are explained further in Volume 1.2.2 of the Guidance on the Use of Geospatial Data and Technologies in Immunization Programs [11].

While the previous steps (Section 4.1) help identify the data needs, it might be that geospatial data are being collected or extracted without having the necessary processes and protocols in place. This results in geospatial data and products which are not of sufficient quality for their intended use. This is why the data specification and ground reference meant to ensure the quality of the data to be used should ideally be developed at the beginning of the data life cycle and use during all of it. These issues are further discussed in volumes 2.1 [2] and 2.2 [3] of the Health GeoLab guidance documents.

The process of compiling existing data and identify gaps is presented in volume 2.3 of the guidance documents [4] while how to fill the geospatial data gaps is discussed in volumes 2.4.1 [5] and 2.4.2 [6]. All the collected data must then be cleaned, organized, validated, and documented as discussed in volumes 2.5.1 [7] and 2.5.2 [8].

4.3 Creating the thematic map

Once the necessary data are compiled and prepared, it is then possible to create the thematic map itself using the available GIS software.

While the specific functions to be used for this might vary from one GIS software to another, the following steps are common to all of them:

1. Import the data into the GIS software.
2. Create the geographic data to be displayed on the map.
3. Select the appropriate mode of representation.
4. Fix the symbology.
5. Add labels to the map
6. Choose the map orientation.
7. Fix the other elements of the layout.
8. Save the final map in the appropriate format.
9. Eventually, fix some elements of the map outside the GIS software.

The above-mentioned steps are described in more detail in the following sub-sections.

Annexes 2 and 3 describe the functionalities to be used for each of these steps. Annexes 4 and 5 describe the steps to be followed to create a map template while annexes 6 and 7 describe how to create thematic maps using map templates. Annexes 2, 4, and 6 use ArcMap (version 10.8) and 3, 5, and 7 use QGIS 3.34.

4.3.1 Import the data into the GIS software

To start creating the thematic map, all the geospatial and statistical data needed to create the thematic map must be added in the data frame/canvas of the GIS software.

At this stage, the data to be added should already be of quality if the practices described in the HGL guidance documents for compiling, collecting, cleaning, organizing, validating, and documenting the data as mentioned in Section 4.2 have been followed correctly. Both geospatial and statistical data should also use the same coding scheme to uniquely identify each of the geographic object present in both the geospatial and statistical data as this will allow the statistical data to be joined to the geospatial data and consequently be symbolized on the map. The basemaps to be used must also be added in the GIS software.

Each of the geospatial data imported into the GIS software is referred to as a layer of the map.³

The geographic coordinate system (GCS) or projected coordinate system (PCS) of the project in the GIS software will be set by default to the GCS or PCS of the first layer that has been added. Adding other layers presenting a different GCS should trigger a warning message to the user and the need to adjust the original geospatial data for all the layers to present the same GCS before creating any maps to avoid misalignments between layers (Section 4.2).

Depending on the purpose of the thematic map being created, the map creator might nevertheless want to adjust the GCS or PCS of the project. Changing the GCS or PCS of the project will only change how the map layers are viewed in the GIS software and represented on the thematic map. This will not change the native GCS or PCS of the geospatial data. The HGL guidance document volume 2.2 [3] could help in guiding the decision of using a different GCS or PCS than the one of the data being added to the map view.

4.3.2 Create the geographic data to be displayed on the map

Geospatial data is information describing the location and attributes of things, including their shapes and representation. Geographic data results from the combination of geospatial data with statistical data or information.

In the thematic mapping context, creating geographic data corresponds to joining the statistical data you want to represent on the map to the attribute table of the shape file (geospatial data) that contains the electronic representation of the geographic features to which the statistical data is attached.

The join in question is made possible thanks to the use of the same coding scheme in both the attribute table of the shape file and the tabular file containing statistical data.

4.3.3 Select the appropriate mode of representation

The most appropriate way to represent the data on a thematic map depends on the data and the message we are trying to pass with the map.

The most common thematic mapping methods are choropleth, proportional symbol, isarithmic or isopleth, chorochromatic, dot density or dasymetric⁴.

Choropleth maps are thematic maps in which areas are shaded or patterned proportionate to the value set for each area. Choropleth maps illustrate the value of a variable across the landscape with color that changes across the landscape within a particular geographic area⁵. A common use of choropleth maps would be to illustrate population density (Figure 3).

³ http://wiki.gis.com/wiki/index.php/GIS_Glossary/L (Layer)

⁴ http://wiki.gis.com/wiki/index.php/Thematic_map#Methods_of_thematic_mapping

⁵ http://wiki.gis.com/wiki/index.php/Choropleth_map

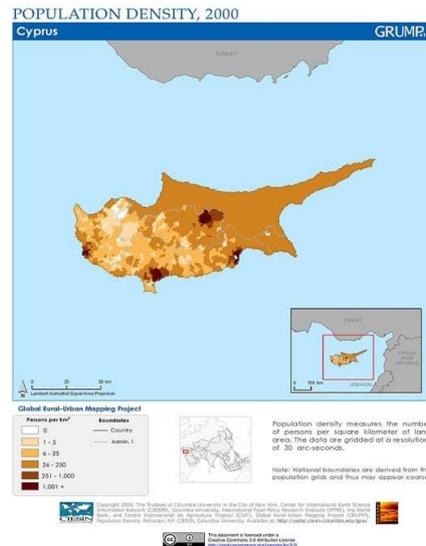


Figure 3. Example of choropleth map showing the population density of Cyprus⁶

Proportional symbol maps are maps that use symbols of varying but proportional size depending on the value of the variable they represent. This type of map is useful for visualization when raw data can be represented as a ratio or proportion.⁷

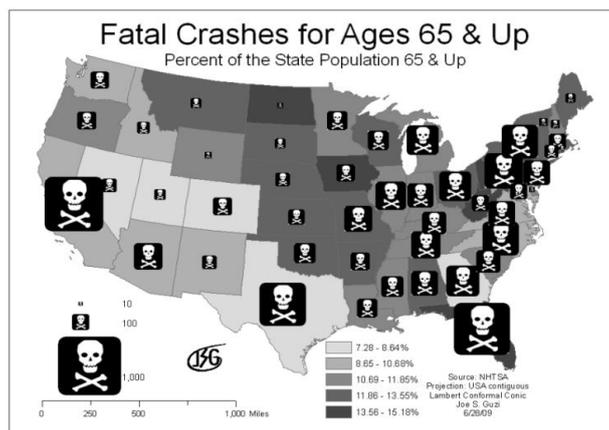


Figure 4. Example of proportional symbol map showing the percent of fatal crashes for ages 65 and up in the US

Isarithmic or Isopleth maps are also known as contour maps. They represent a continuous field using line and/or region symbols to connect places of similar value and help visualize continuous data sets by utilizing color, especially hue and value (luminosity).⁸

⁶ Center for International Earth Science Information Network - CIESIN - Columbia University, International Food Policy Research Institute - IFPRI, The World Bank, and Centro Internacional de Agricultura Tropical - CIAT. 2011. Global Rural-Urban Mapping Project, Version 1 (GRUMPv1): Urban Extents Grid (Africa). Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). [Urban Extent Polygons, v1.02: Global Rural-Urban Mapping Project \(GRUMP\), v1 | SEDAC \(columbia.edu\)](http://sedac.columbia.edu/Urban_Extent_Polygons_v1.02_Global_Rural-Urban_Mapping_Project_(GRUMP)_v1).

⁷ http://wiki.gis.com/wiki/index.php/Proportional_symbol_map

⁸ http://wiki.gis.com/wiki/index.php/Isarithmic_map

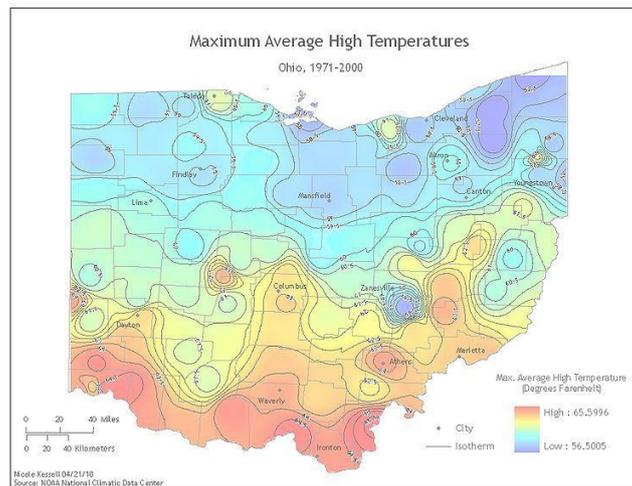


Figure 5. Example of isarithmic map showing the maximum average high temperatures in Ohio⁹

Chorochromatic maps are used to map nominal data using various colors, color shades, or symbols to distinguish classes. The boundaries between different colors are based on the data and not on political boundaries as with choropleth maps. Common examples of chorochromatic maps include soil maps and climate classification maps.

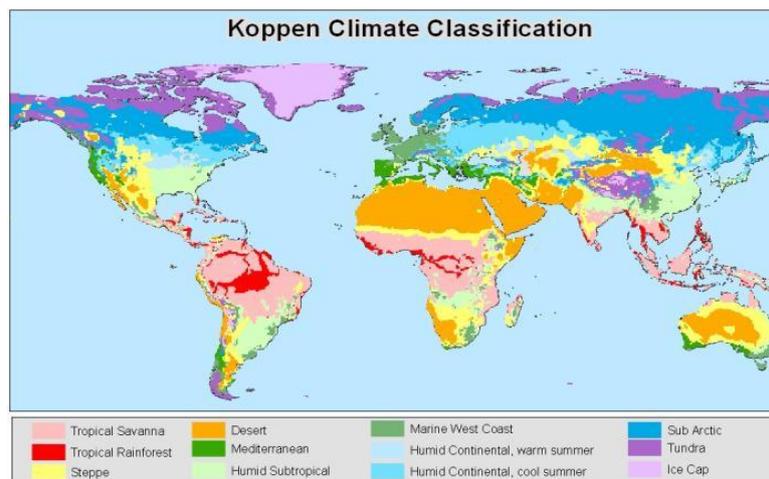


Figure 6. Example of Chorochromatic map showing the Koppen Climate Classification

Dot density maps use the density of dots (points) to portray the relative amounts and geographic distribution of something. Each dot may represent a single object or event (one-to-one) or it may represent many objects or events (one-to-many).

There are two types of dot maps, produced through very different techniques, but to similar effect: 1) point feature maps, based on point data representing for example the location of every individual in the population, and 2) choropleth dot maps, using the same kind of polygon/aggregate-statistical data used for choropleth maps, but showing the value for each zone (example district) using a number of randomly placed dots within the zone rather than a solid fill color (Example in Figure 7).¹⁰

⁹ <http://enb150-2011f-jd.blogspot.com/2011/09/thematic-maps.html>

¹⁰ http://wiki.gis.com/wiki/index.php/Dot_density_map

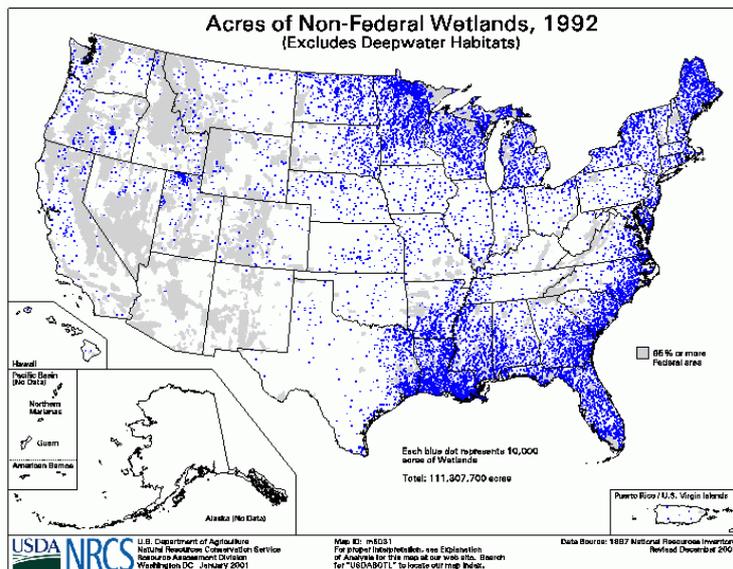


Figure 7. Example of dot density map showing the acres of non-federal wetlands as choropleth dots¹¹

Dasymetric maps are variation of choropleth maps wherein the original data organized by a large or arbitrary areal unit are redistributed more precisely within that unit using geographic information about the distribution of the phenomenon of interest and/or by the superposition of geographic boundaries that exclude, restrict or confine the attribute in question. (example in Figure 8).¹²

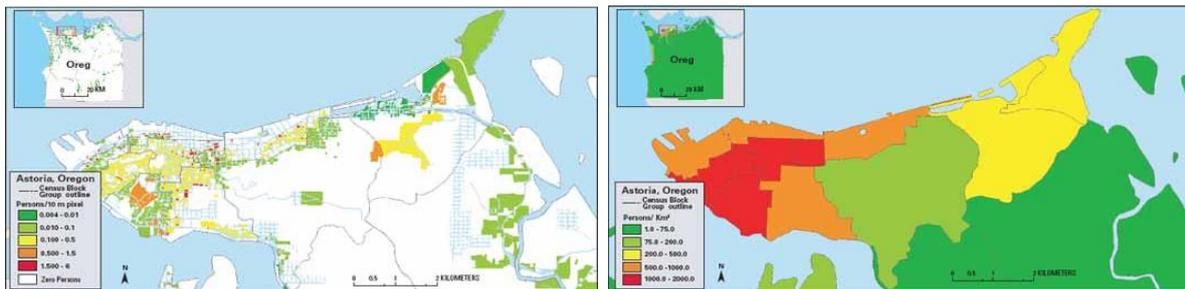


Figure 8. Example of dasymetric map (left) compared to a choropleth map (right) showing population distribution¹³

4.3.4 Fix the symbology

A symbol is a graphic used to represent a geographic feature or class of features¹⁴ while symbology is the set of conventions, rules, or encoding systems that define how geographic features are represented with symbols on a map.¹⁵

Choosing the appropriate symbol to represent the data is critical in communicating the message of the map. It is advisable to use well-known symbols and symbologies including national/international standards and conventions as applicable to the theme of the map. This would eliminate the need to devise new symbols for already established objects and prevent confusion among readers.

¹¹ https://www.nrcs.usda.gov/wps/portal/nrcs/detail/id/home/?cid=nrcs143_013772

¹² http://wiki.gis.com/wiki/index.php/Dasymetric_map

¹³ <https://pubs.usgs.gov/tm/tm11c2/>

¹⁴ <http://support.esri.com/en/other-resources/gis-dictionary/term/symbol>

¹⁵ <http://support.esri.com/en/other-resources/gis-dictionary/term/symbology>

The size of the different symbols used in the map should be carefully calibrated. The symbols should be proportionate to their importance in the map and the actual size of the map layout. Great care should be taken to prevent multiple symbols from overlapping and covering each other.

The three types of vector data can be symbolized using the following:

- a. Point data can use symbols that look like what they represent (e.g., trees, houses, fire hydrants), or they can be abstract shapes or characters (examples in Figure 9).

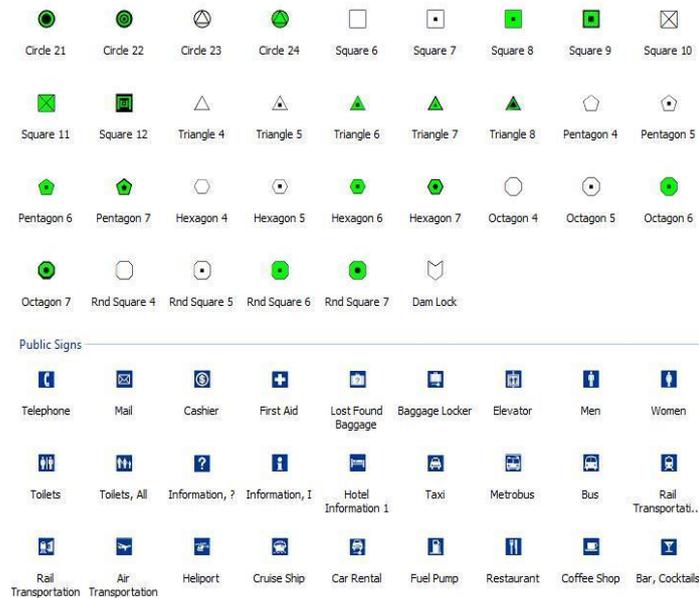


Figure 9. Example of point type symbols

- b. Line data such as roads and rivers can be represented by lines of varying width, style, and color. The outlines of polygon such as administrative boundaries can also be represented by line symbols.



Figure 10. Example of line type symbols

- c. Polygon data can be represented by varying the colors of the polygon such as in a choropleth or chorochromatic map and by proportional symbols or dot density.

The visual hierarchy of how different types of symbols are shown on the map is usually point symbols on top, then lines, and lastly, polygons on the bottom.

The use of colors and patterns can enhance or ruin the map. A colorful map may be visually enticing but it may not be communicating the information accurately. It is important to understand the data and how it is presented to be able to choose appropriate colors.

There are some conventions followed when choosing colors for a map:

- a. Bodies of water (oceans, seas, rivers, etc.) are generally colored blue but oceans and seas may sometimes be colored white to prevent the map from being too colorful
- b. Areas with no data are colored gray
- c. Areas representing vegetation cover and parks are colored green

Some color conventions are dependent on the thematic and/or practice. For example, land-use planners have their own color scheme to represent different land-use zones and U.S. Geological Survey (USGS) have their own color and pattern standards and conventions for geologic maps. It is best to check if your industry follows a color convention before creating your map.

Choropleth maps are the most common type and rely heavily on good choice of color scheme and the correct use of different hues, saturation, and brightness. Below is some guidance on the color schemes to select depending on the statistical data to be mapped.

1. Nominal data are data that are divided into classes within which all elements are assumed to be equal to each other, and in which no class comes before another in sequence or importance¹⁶. An example is a group of polygons colored to represent the different crops planted in an area. This type of data can best be represented by using a nominal color scheme i.e., different hues for each of the classes of the data (example in Figure 11).



Figure 11. Example of a nominal color scheme²⁰

2. For numerical data or data that has orderable categories (such as low/medium/high), it can best be represented by using a sequential color scheme i.e., ordered by sequential differences in lightness/saturation.

The values assigned for the light and dark colors depend on what needs to be highlighted on the map. Dark colors are usually assigned to values that need to be emphasized (example in Figure 12).

¹⁶ <https://support.esri.com/en/other-resources/gis-dictionary/term/nominal%20data>



Figure 12. Example of sequential color scheme²⁰

3. For data that has a natural mid-point such as zero (e.g., positive and negative growth, land elevation), it can best be represented by using a diverging color scheme. A typical diverging color scheme pairs sequential schemes of two different hues that spread from a shared light-colored midpoint. The colors darken as they reach each extreme (example in Figure 13).

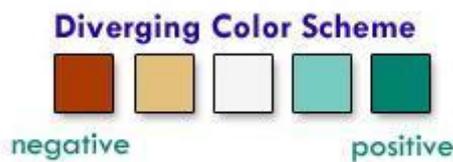


Figure 13. Example of diverging color scheme²⁰

The medium for the map can also affect its final colors. A test print onto paper or a check of the appearance of the map on a monitor/projector should be done to check for any color issues.

When choosing color schemes, it is important to also take into account certain visual impairments such as color blindness, of which red-green is the most common type, affecting around 5% of males worldwide and up to 10% in some populations.

Some websites such as Color Oracle¹⁷ and Vischeck¹⁸ allow users to see how their maps look to a colorblind person. Color Brewer¹⁹ shows which of the available color schemes on the website are colorblind safe and also if they are photocopier-, LCD-, or print-friendly.

When creating maps for electronic viewing, it should be noted that individual computer monitors and projectors present colors differently. This may result in the colors of the map being fine on the computer it was created on but not on the monitor or projector used for the presentation. It is therefore important to be aware of such differences and possibly check how the map will appear on the computer or projector to be used for a particular presentation.

4.3.5 Add labels to the map

In cartography, a label is text placed on or near a map feature that describes or identifies it.²⁰ Labels on a map do not only name geographic features, but they also help map readers understand the information being presented.

Two important things to consider when labeling map features are intellectual hierarchy and visual hierarchy. Intellectual hierarchy is the ranking of importance of the different map features.

¹⁷ <http://colororacle.org/>

¹⁸ <http://www.vischeck.com/>

¹⁹ <http://colorbrewer2.org/>

²⁰ http://wiki.gis.com/wiki/index.php/GIS_Glossary/L (Label)

Determining this will help create the visual hierarchy of map labels. An example would be the intellectual hierarchy of administrative divisions: country being the highest, then province, district, and cities.

Visual hierarchy is the way the map labels are designed to help map readers organize geographical information. This design makes it easier to know the grouping and categories of map features thus making it easier to scan the map for information.

There are some basic conventions that can help in proper labeling of a map.²¹

- Prioritize the position of point feature labels: 1) above and to the right, then 2) below and to the right, then 3) above and to the left, then 4) below and to the left. Positioning directly above, below, or to the sides is not preferred.
- Visually center, increase the letter-spacing and use uppercases to labels area features (administrative units for example) to reinforce their size/shape.
- Use serif fonts for natural features, e.g., lake or forest, and sans serif fonts for man-made features, e.g., town or airport.
- Label water features in blue and in an italic font.
- Distinguish ranked categories by at least two text size points when label sizes are small.
- Don't rotate labels upside-down i.e., all labels should be upright.
- Labels should not be smaller than around 6-7 points for printed maps or 9-10 points for maps displayed on screen.
- If necessary, use one serif and one sans serif font, but don't use more than one sans serif font on the map.

4.3.6 Choose the map orientation

Once the preceding steps are done, the next one is to work on the map layout. Some GIS software requires working on a different window for the map layout than the window where the data are processed.

Carefully assess how the data is best visualized including whether a portrait (vertical) or landscape (horizontal) orientation of the map and of the page makes the best use of available space. This is particularly helpful when choosing the most appropriate map template if already available for either orientation. Going through all the previous steps should have given a good idea of the map orientation to be selected.

A map template is a map layout with the position of the map elements predefined as specified by the author or organization. The text for map elements that changes from one map to another such as the title, legend, and map production date are left blank although their positions are already fixed in the layout. The text for map elements that remains the same for all maps such as map production (author) information, disclaimer, logo and copyright are already supplied.

It is beneficial to create a map template as it makes the creation of thematic maps faster by eliminating the need to arrange the map elements every time a map is made. It can also serve as the corporate image of the organization. It is good to have a template prepared in landscape and another in portrait format.

²¹ <https://www.axismaps.com/guide/labeling>

However, if no map template is available, the placement of other map elements such as title, legend, scale, etc. has to be taken into account when choosing the orientation.

For example, in the South Esk Reconnaissance Soil Map in Figure 14²², the data that is mapped fits in a landscape orientation but because of the addition and position of the other map elements, the portrait orientation was finally chosen.

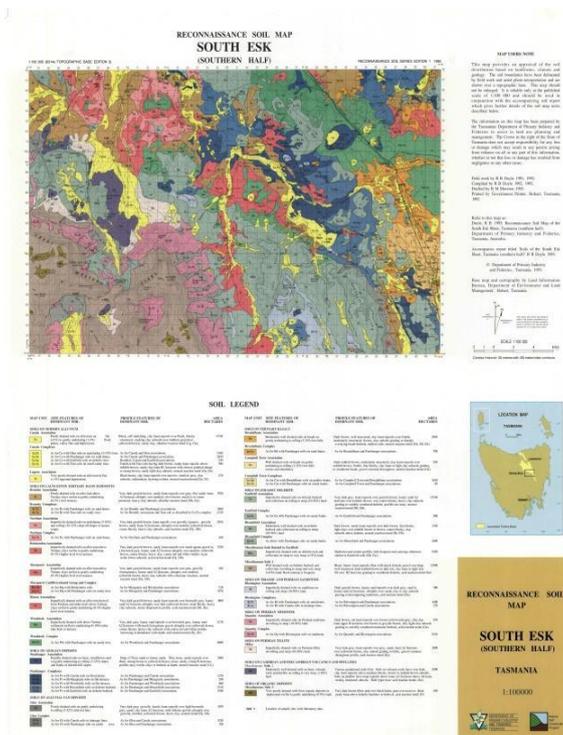


Figure 14. Example of portrait map orientation with horizontally oriented data

It is best to choose the map orientation that would allow the data and other map elements to fit comfortably on the page.

4.3.7 Fix the other elements of the map layout

Once the orientation is chosen, fix the location of the map elements around the map area. Consult Chapter 3 above to ensure that all the mandatory and other elements are included in the map.

Ensure that the placement of the map layout elements does not cover the main feature(s) of the map itself. Arrange the elements in such a way that they are distributed across the whole page and not crowded in one area.

Similar to map labels, all the text of the map layout elements should be big enough to be readable. Avoid stylized fonts, if possible, especially for maps for professional use.

²² Doyle, R B 1993: Reconnaissance Soil Map of the South Esk Sheet, Tasmania (southern half). Department of Primary Industry and Fisheries, Tasmania, Australia.

Finally, as a rule, legend items labels should be singular nouns.²³ Plural labels imply something different. The most common interpretation of legend item labels that are plural is that there are multiple geographic features of the same type in a single location.²⁵

4.3.8 Save the final map in the appropriate format

Once the map layout has been finalized, the map should be saved in a file format that would best suit the end use. The most common file formats for saving are JPEG, BMP, PNG, and PDF.

If there is no need to zoom in the map, it can be saved in JPEG, BMP, or PNG file format. Otherwise, it is best to save it in PDF format.

It is critical to save the map layout in a sufficiently high resolution so the map is clear in the form it will be viewed. For printing maps, it is advisable to save at least 300 dots per inch (dpi).

4.3.9 Fix some elements of the map outside the GIS software

Sometimes, the final map layout needs minor editing.

If the source map document or GIS software is not available, the modifications can sometimes be done using graphics or image editing software. These changes would mostly be repositioning or adding labels, correcting colors or adding text information.

Image editing software is also sometimes used to improve the aesthetic elements in a map where this is not possible, or more difficult, using GIS software e.g., adding drop shadows or creating infographics.

Raster type image files such as JPEG, BMP, and PNG can be edited using Microsoft Paint or Adobe Photoshop. While vector type files such as PDF and AI can be edited using Adobe Illustrator.

It should be noted that when saving the edited map, some software like Microsoft Paint could cause a decrease in resolution.

²³ <https://www.esri.com/arcgis-blog/products/arcgis-pro/mapping/legend-item-labels-singular-or-plural/>

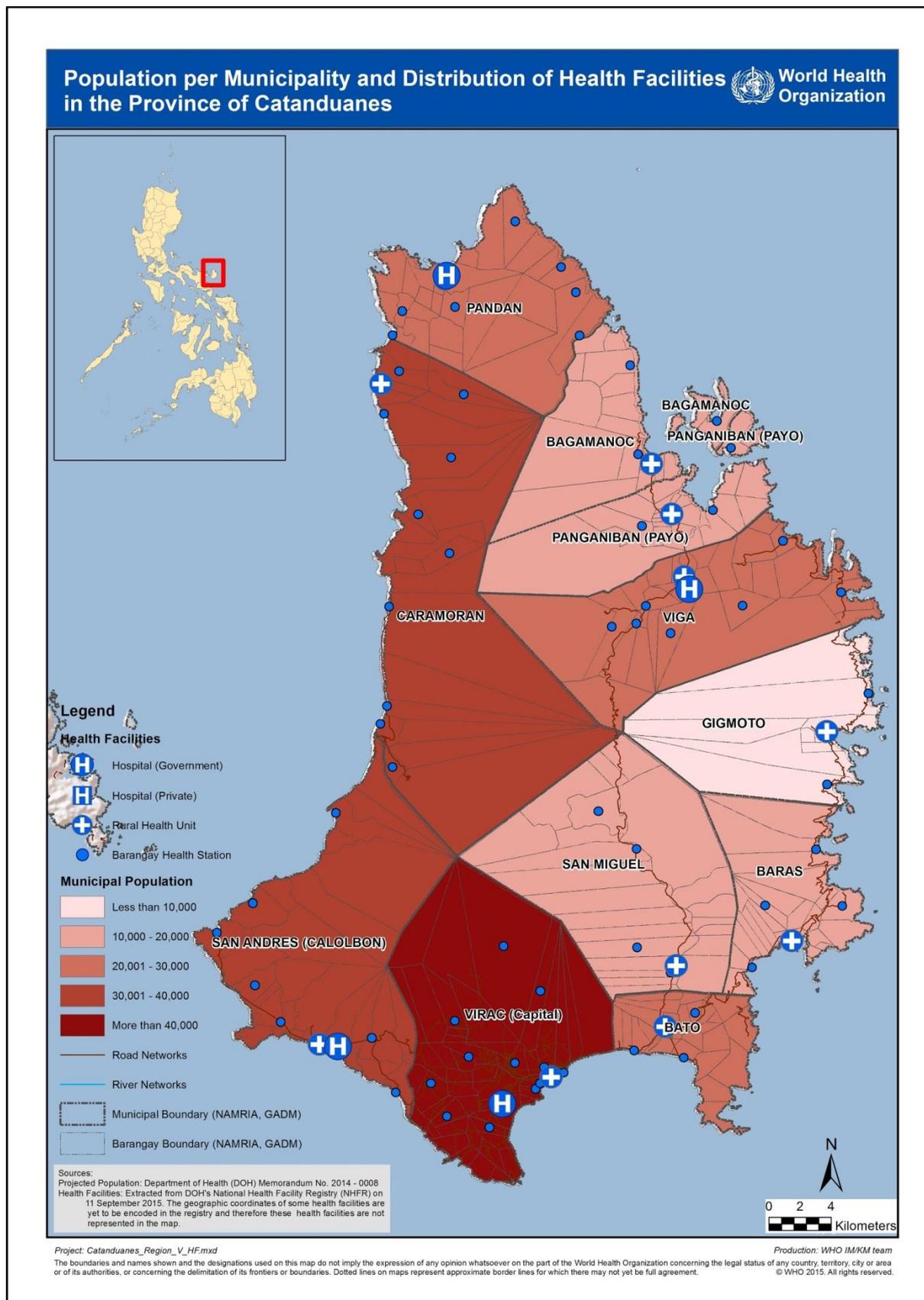
References

- [1] Ebener S. (2016): Guidance for the management and use of geospatial data and technologies in health. Part 1 - Introduction to the data-information-knowledge-decision continuum and the geospatial data management chain. Health GeoLab document: https://www.healthgeolab.net/DOCUMENTS/Guide_HGL_Part1.pdf [Accessed 3 March 2024]
- [2] Ebener S. (2016): Guidance for the management and use of geospatial data and technologies in health. Part 2 - Implementing the geospatial data management cycle: 2.1 Documenting the process and defining the data needs. Health GeoLab document: https://www.healthgeolab.net/DOCUMENTS/Guide_HGL_Part2_1.pdf [Accessed 3 March 2024]
- [3] Ebener S. (2016): Guidance for the management and use of geospatial data and technologies in health. Part 2 - Implementing the geospatial data management cycle: 2.2 Defining the terminology, data specifications, and the ground reference. Health GeoLab document: https://www.healthgeolab.net/DOCUMENTS/Guide_HGL_Part2_2.pdf [Accessed 3 March 2024]
- [4] Pantanilla I., Ebener S., Mercado C.E., Maude R. (2018): Guidance for the management and use of geospatial data and technologies in health. Part 2 - Implementing the geospatial data management cycle: 2.3 Compiling existing data and identifying gaps. Health GeoLab document: https://www.healthgeolab.net/DOCUMENTS/Guide_HGL_Part2_3.pdf [Accessed 3 March 2024]
- [5] Ebener S. (2021): Guidance for the management and use of geospatial data and technologies in health. Part 2 - Implementing the geospatial data management cycle: 2.4 Creating geospatial data - 2.4.1 Extracting vector format geospatial data from basemaps. Health GeoLab document: https://healthgeolab.net/DOCUMENTS/Guide_HGL_Part2_4_1.pdf [Accessed 29 October 2023]
- [6] Ebener S., Maude R.J., Gault P. (2018): Guidance for the management and use of geospatial data and technologies in health. Part 2 - Implementing the geospatial data management cycle: 2.4 Creating geospatial data - 2.4.2 Collecting data in the field. Health GeoLab document: https://www.healthgeolab.net/DOCUMENTS/Guide_HGL_Part2_4_2.pdf [Accessed 3 March 2024]
- [7] Ebener S., Pantanilla I., Mercado C.E., Maude R. (2018): Guidance for the management and use of geospatial data and technologies in health. Part 2 - Implementing the geospatial data management cycle: 2.5 Cleaning, validating, and documenting the data - 2.5.1 Documenting the data using a metadata profile. Health GeoLab document: https://www.healthgeolab.net/DOCUMENTS/Guide_HGL_Part2_5_1.pdf [Accessed 3 March 2024]
- [8] Ebener S., Pantanilla I. (2019): Guidance for the management and use of geospatial data and technologies in health. Part 2 - Implementing the geospatial data management cycle: 2.5 Cleaning, validating, and documenting the data - 2.5.2 Using advanced Microsoft Excel functions. Health GeoLab document: https://healthgeolab.net/DOCUMENTS/Guide_HGL_Part2_5_2.pdf [Accessed 3 March 2024]

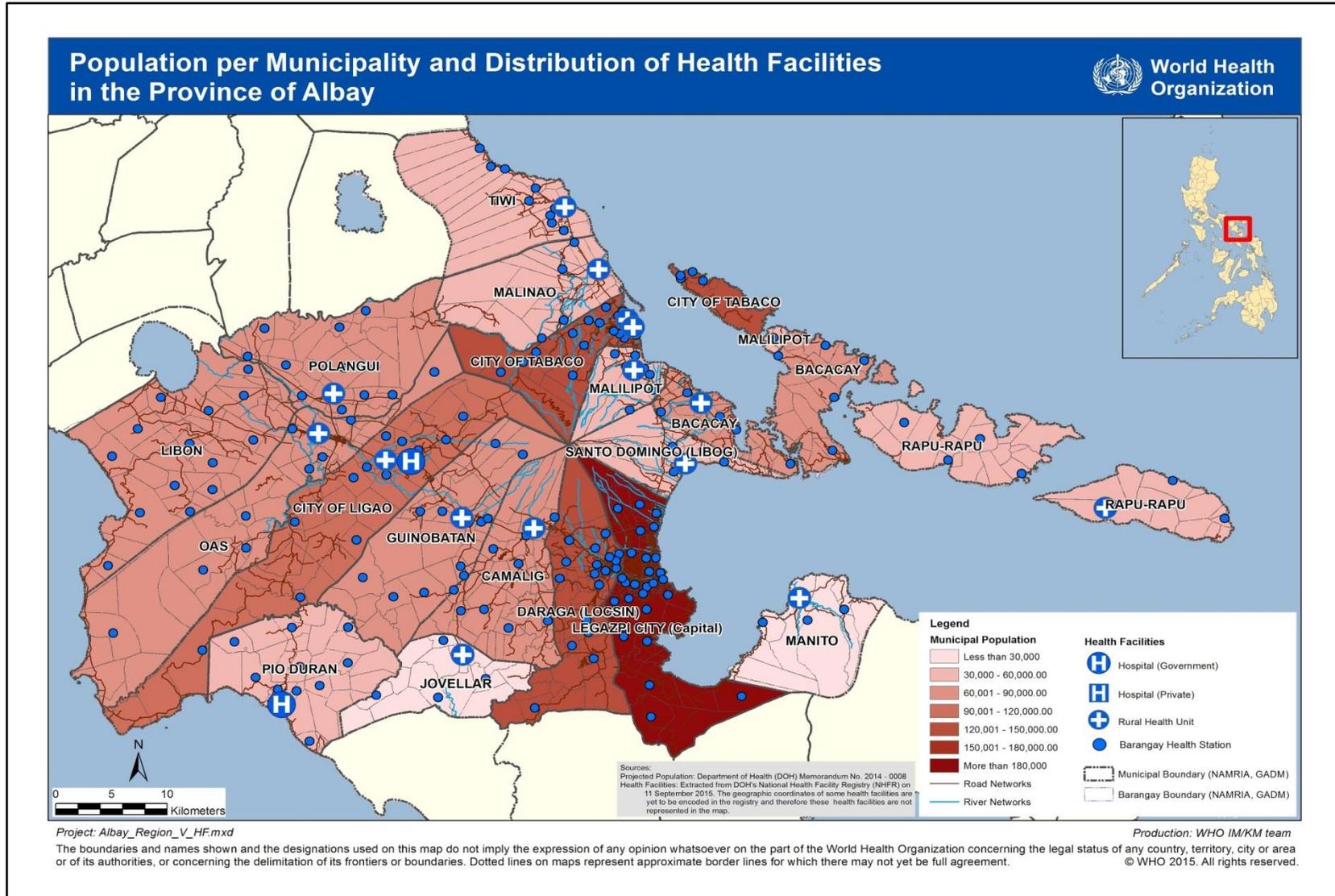
- [9] Ebener S. (under preparation): Guidance for the management and use of geospatial data and technologies in health. Part 2 - Implementing the geospatial data management cycle: 2.6 Distributing, using, and updating the data - 2.6.2 Using thematic maps for decision making. Health GeoLab document.
- [10] Ebener S. (under preparation): Guidance for the management and use of geospatial data and technologies in health. Part 2 - Implementing the geospatial data management cycle: 2.6 Distributing, using, and updating the data - 2.6.3 Developing and implementing the appropriate data policy. Health GeoLab document.
- [11] Panaciera, R., Muñiz, M., and Ebener S. (2017): Guidance on the Use of Geospatial Data and Technologies in Immunization Programs: Overview and Managerial Considerations for In-Country Strengthening. UNICEF: <https://www.unicef.org/media/58181/file> [Accessed 3 March 2024]

Annex 1 – Examples of good thematic maps

This is an example of a thematic map in portrait orientation.



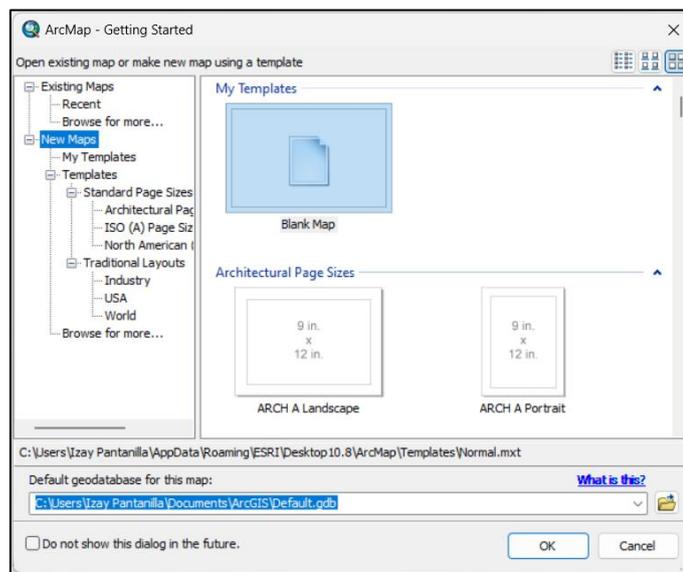
This is an example of a thematic map in landscape orientation



Annex 2 – Creating a thematic map in ArcMap

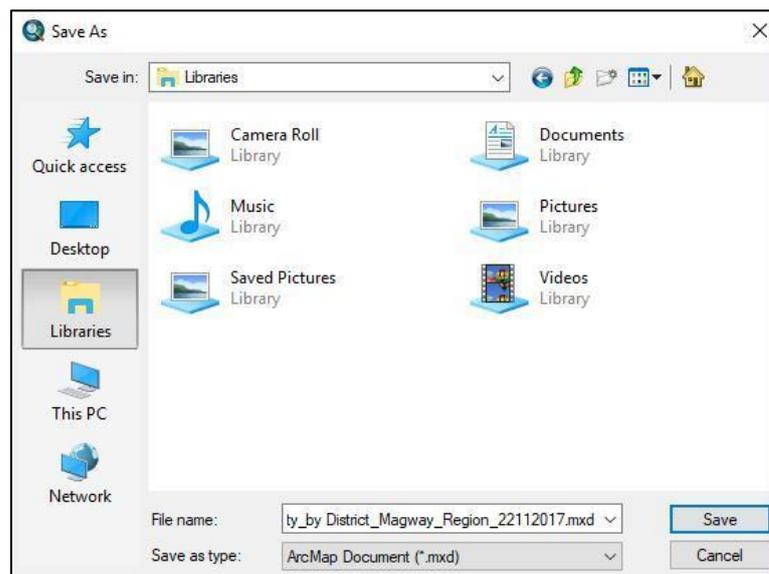
This Annex describes the steps in creating a thematic map in ArcMap (version 10.8) without using a map template.

1. Open ArcMap.
2. When the ArcMap – Getting Started dialog box opens, click *New Maps* from the left-side menu then click the icon for the *Blank Map*. Click *OK*.



3. Save your new ArcMap document by going to the main menu, click *File > Save* or by clicking the *Save* button .

4. Since this is the first time you are saving the document, the *Save As* dialog box will open. Go to the folder location you want to save your ArcMap document in.



5. Type in the name for of your ArcMap document. Click *Save*.

IMPORTANT NOTE: Remember to periodically save your ArcMap document as you go through the next steps. This ensures that your work is saved even if the GIS software or your computer suddenly crashes.

6. From the main menu, go to *File > Add Data > Add Data...* or click the *Add Data* button



to add the prepared data to your map.

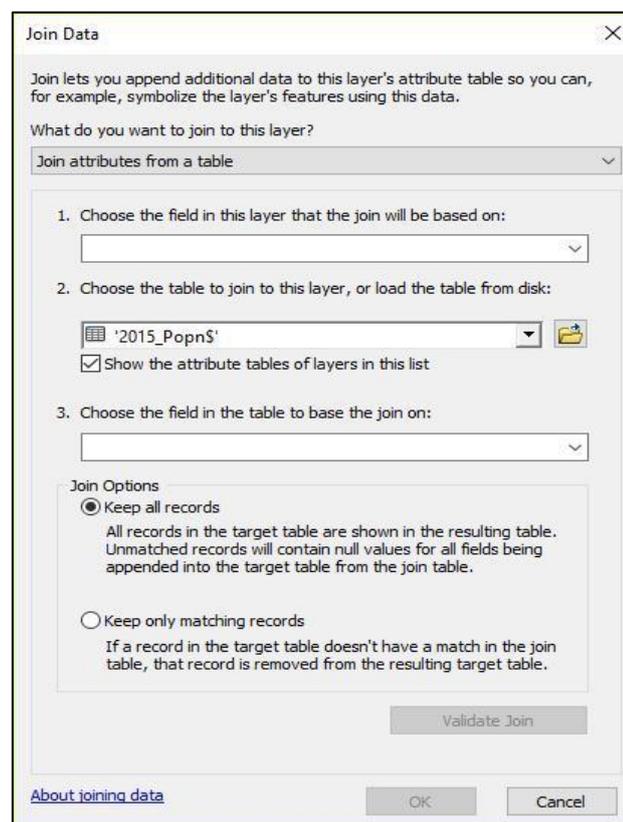
7. Go to the folder location of your prepared data. Select the data you need then click *Add*.

You may add more than one data from the same folder by pressing the Control (Ctrl) key on your keyboard while clicking on the data you need to add.

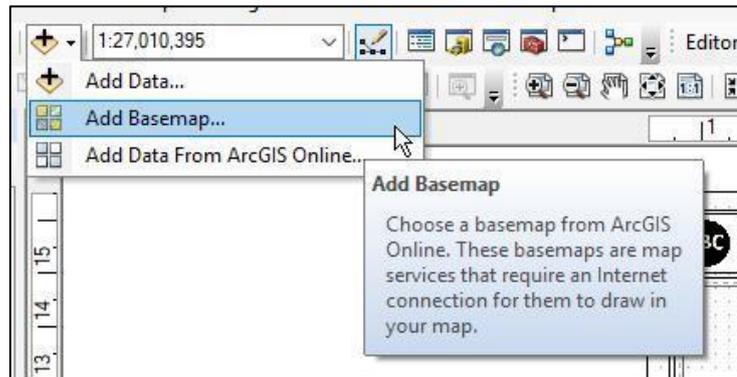
You will have to repeat steps 6 and 7 if your data are in different folders.

Make sure to add both the geospatial data and statistical data. Ensure that both use the same coding scheme to uniquely identify each of the geographic objects present in both the geospatial and statistical data as this will allow the statistical data to be joined to the geospatial data.

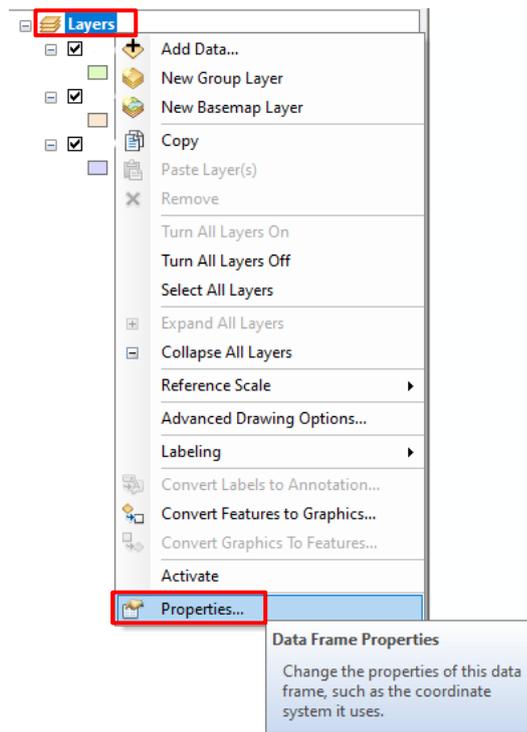
8. To join a geospatial data to a table, right-click on the geospatial data, click *Join and Relates > Join...*
9. The Join Data dialog box opens. Choose the appropriate fields (fields containing the unique identifier) and the correct table to join to the layer.



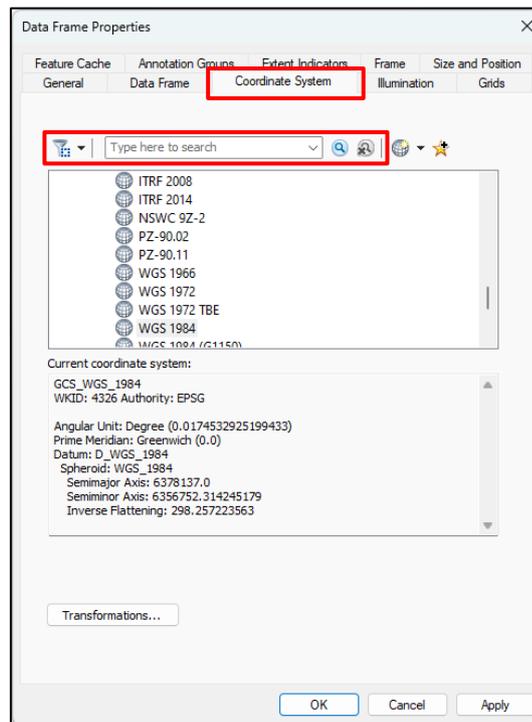
10. Add a basemap by going to *File > Add Data > Add Basemap...* or by clicking the dropdown button beside the *Add Data* button and clicking *Add Basemap...*



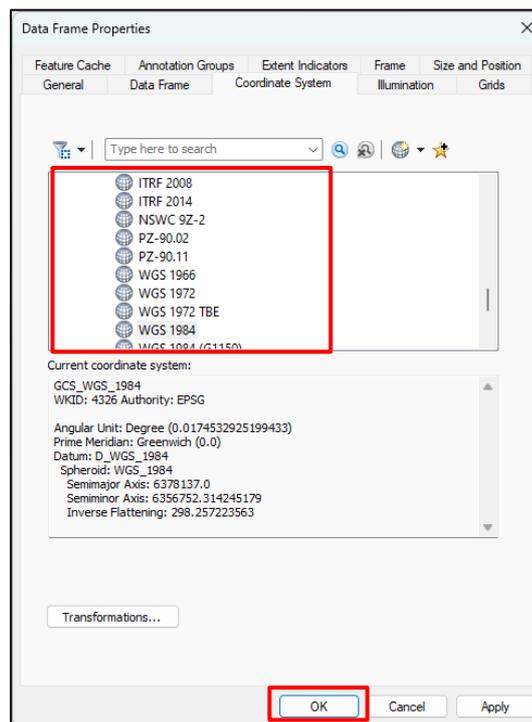
11. Select the appropriate basemap then click *Add*.
12. Decide if the GCS or PCS needs to be adjusted to match the map's purpose. If not, proceed to step 20. If yes, proceed to the next step.
13. Right-click on the name of the data frame you would like to change the GCS or PCS of and choose *Properties...*



14. The Data Frame Properties dialog box opens. Click on the Coordinate System tab. Navigate to the desired coordinate system for your map display. To help narrow down the choices, you can filter the coordinate systems by performing a Spatial Filter, a String Filter, or a combination of the two.

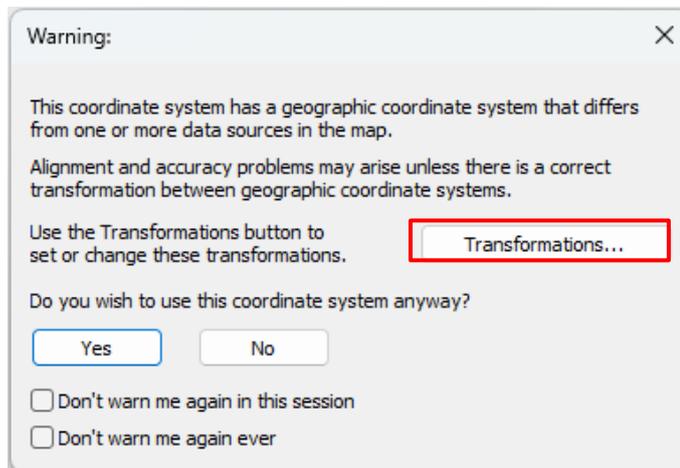


15. Select the desired coordinate system from the list and click *OK*.

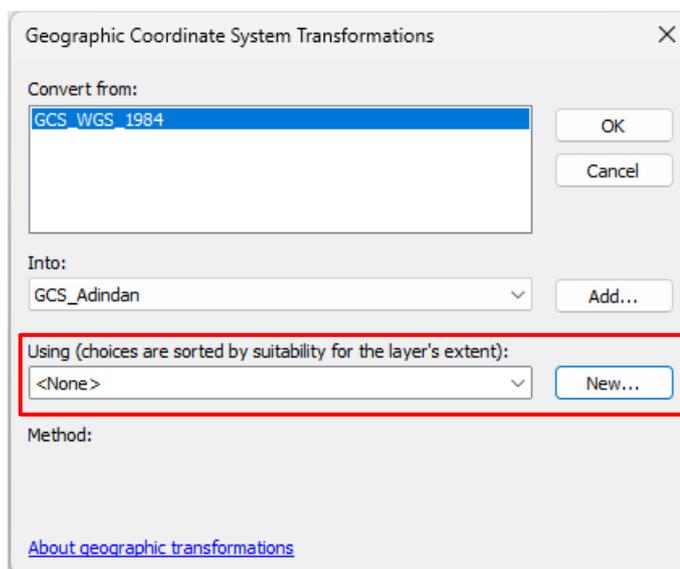


Note: Changing the coordinate system of the data frame does not change the native GCS or PCS of the geospatial data being used to create the map.

16. You will get a warning message when changing from one geographic coordinate system to another. Click *Transformations...* button.

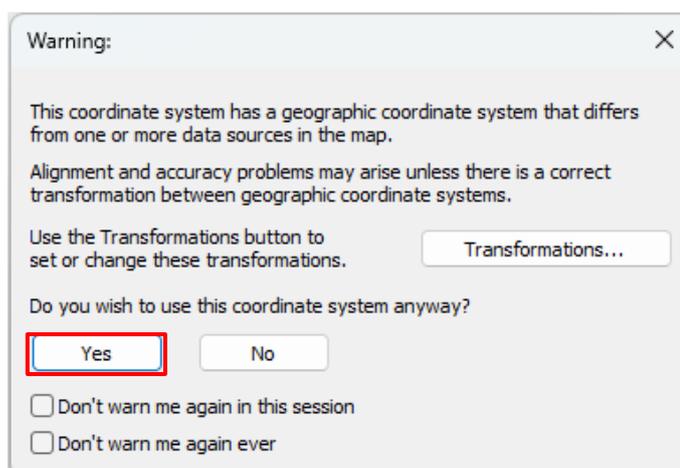


17. Choose the appropriate transformation when available or specify a new one. Click **OK**.



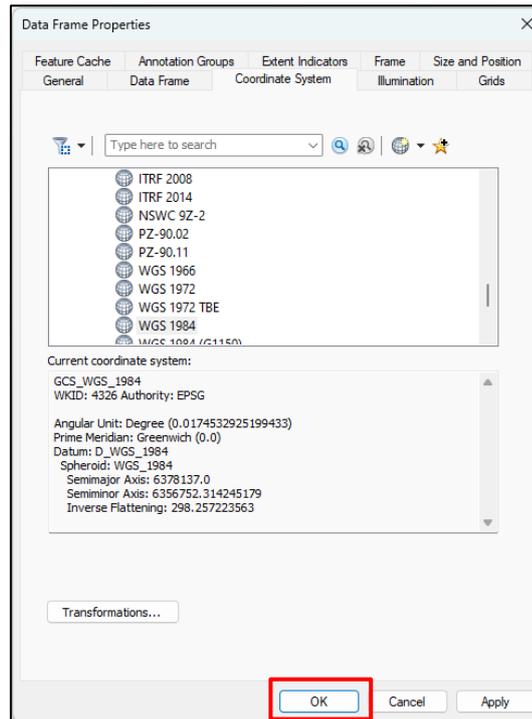
Note: You can learn more about geographic transformation from this source.²⁴

18. Click **Yes**.



²⁴ <https://www.esri.com/arcgis-blog/products/product/mapping/about-geographic-transformations-and-how-to-choose-the-right-one/>

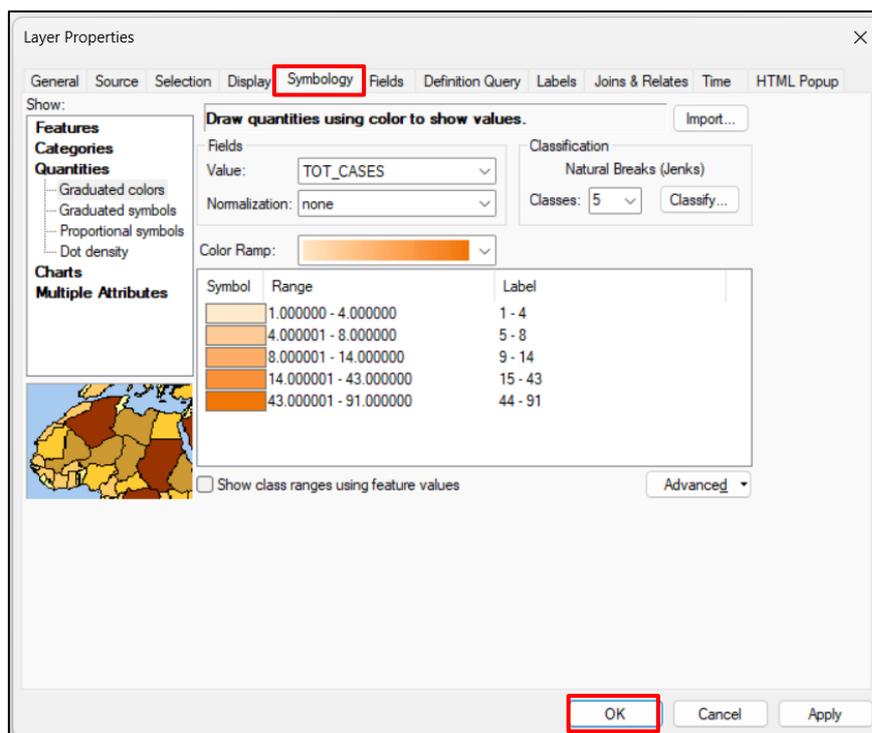
19. Click *OK* in the Data Frame Properties dialog box.



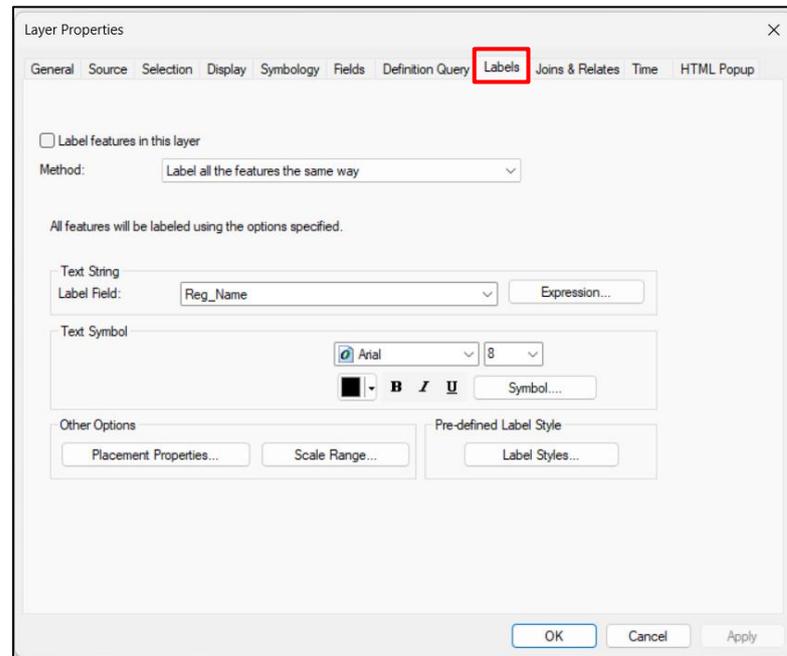
20. Decide the appropriate mode of representation for your data. (In this example, the data will be presented as a choropleth map.)

21. Symbolize your data by right-clicking on your geospatial layer then click *Properties...*

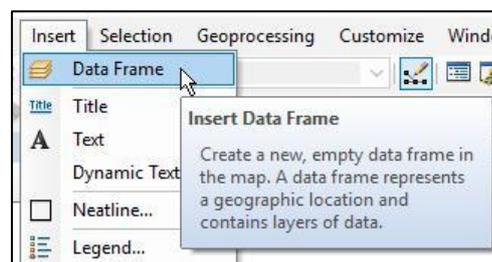
22. The Layer Properties dialog box opens. Go to the Symbology tab. On the left side bar, choose the mode of representation. Adjust the different parameters. Click *OK*.



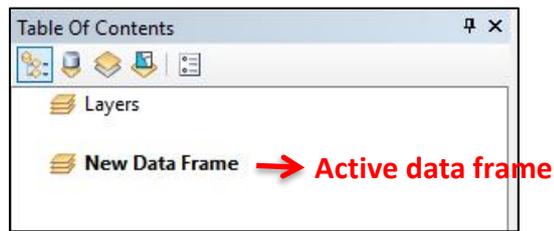
23. If you are not satisfied with how your data is symbolized, you may go back to the Symbology tab to adjust the symbology accordingly.
24. Add labels to your map by right-clicking on the geospatial layer you would like to put a label on then click *Properties...*
25. The Layer Properties dialog box opens. Go to the Labels tab. Check the box *Label features in this layer* by clicking it.



26. In the Label Field, choose the field from your geospatial data that you would like to use as the label. Alternatively, you may choose to use an expression to label your data.
27. Adjust the font type and size of the label to suit your map. Click *OK*.
28. If you are going to add an inset map to your map layout, click *Insert > Data Frame*. A New Data Frame will appear in the Table of Contents.



29. Before adding the data/layer for the inset map, ensure that the New Data Frame is the active data frame. You can tell this by looking at the Table of Contents section. The data frame in **bold** font is the active data frame. To switch from one data frame to another, right-click on the data frame you need to work on and click *Activate*.

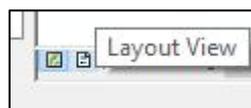
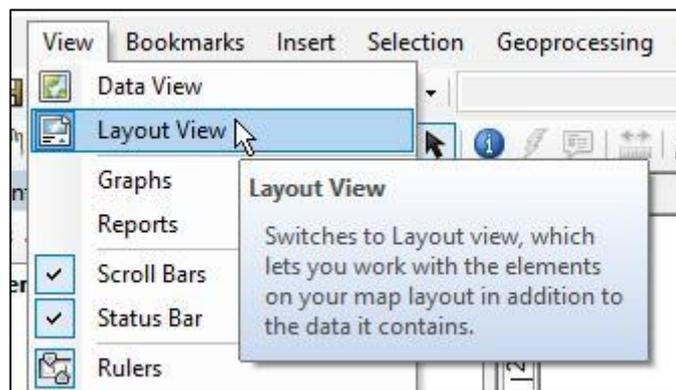


30. Add, symbolize, and label (if needed) the data for the inset map by following the relevant steps in steps 6 to 27 as necessary.

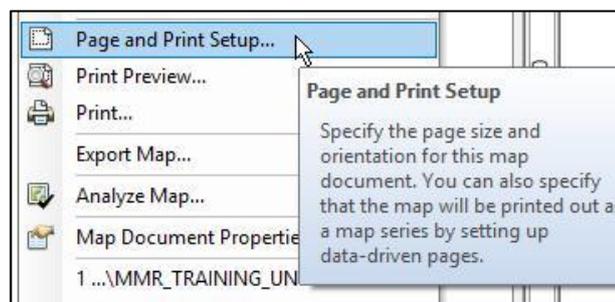
31. Once all the data are properly symbolized and labeled, proceed to creating the map layout.

Note: The orientation of the map layout to be created should already be known at this point.

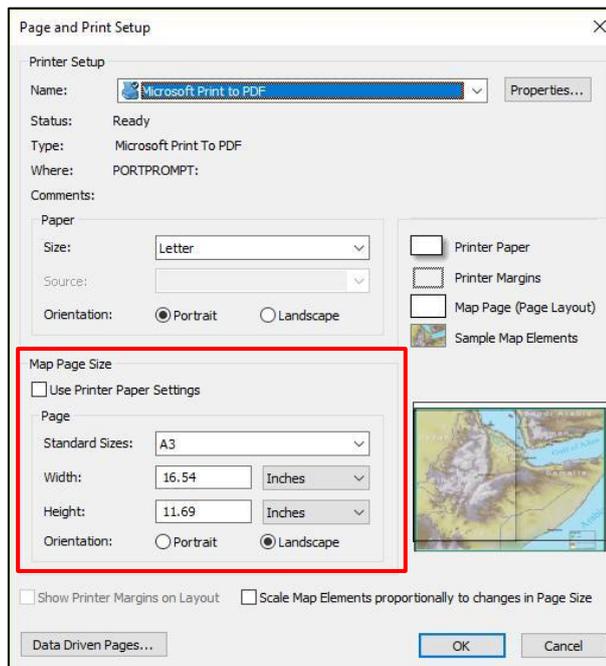
32. Go to Layout View by going to the main menu, click *View > Layout View* or by clicking the *Layout View* button (second button) at the bottom beside the Table of Contents pane. The Layout View immediately shows the data you have symbolized and labeled.



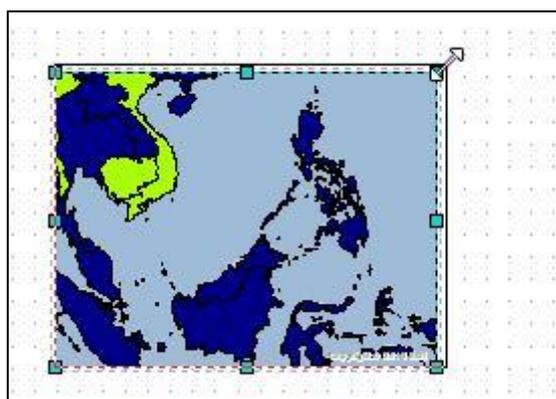
33. To set the page size, go to the main menu, click *File > Page and Print Setup...*



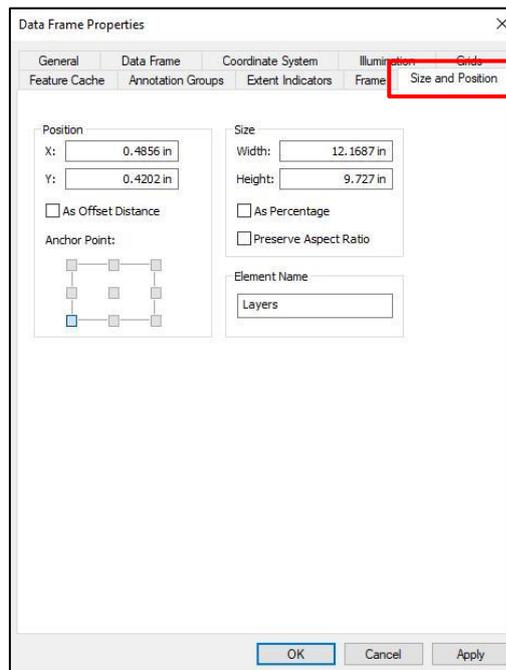
34. The Page and Print Setup dialog box will open. In the Map Page Size section, choose/input the desired paper size and the correct orientation. Click *OK*.



35. Visualize the placement of the map elements. If it would help, sketch your planned layout on paper first. This will give you an idea of how all the map layout elements look together.
36. To help align the elements as you are positioning them, you can make the grid visible by clicking *View* from the main menu and activating the *Grid*.
37. Once you have an idea of the placement of the map elements, resize the map area accordingly and move it to the desired position in the layout. To resize, click the map area to select it and click and drag the tiny box at the corners and sides to the right size.



Or you can right-click on the map then choose *Properties....* The Data Frame Properties dialog box opens. In the Size and Position tab, input the desired size either by the actual measurement or by percentage in the Size section. Click *OK*.



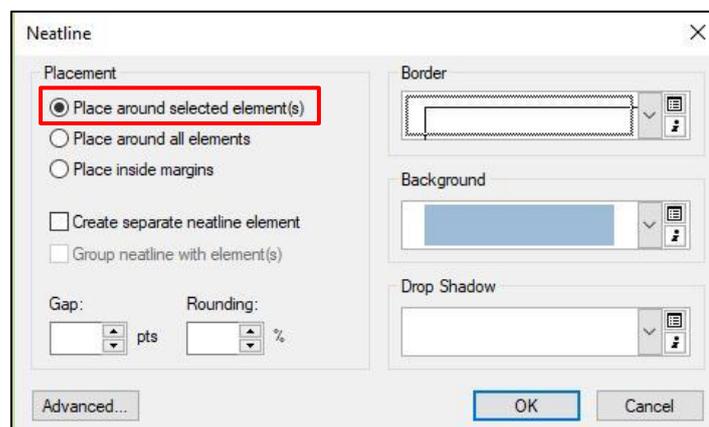
Note: If you have another data frame for your inset map, it would initially appear in the middle of the map layout (same as the main map). So that it is not in the way while you position the other map layout elements, you could click to select it and drag it outside of the page for the moment.

38. Ensure that the focus of your map is in the center of the map area. Move your map if it is not centered by using the zoom in, zoom out, and pan buttons on the Tools toolbar

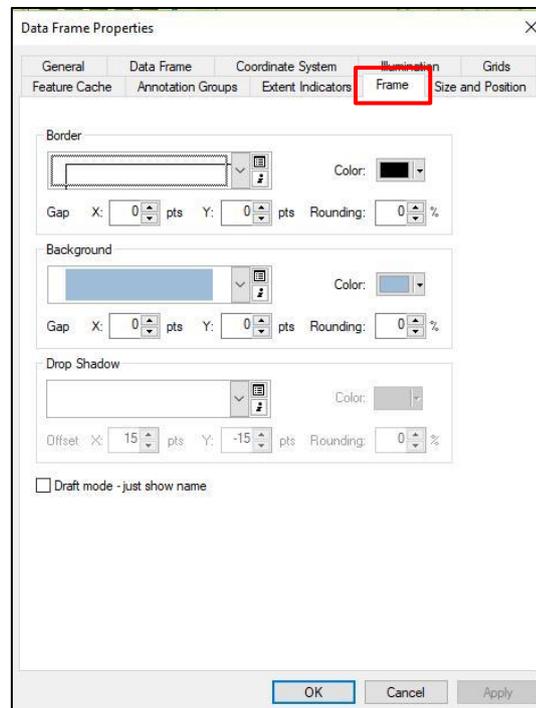


39. To add a border to your map area:

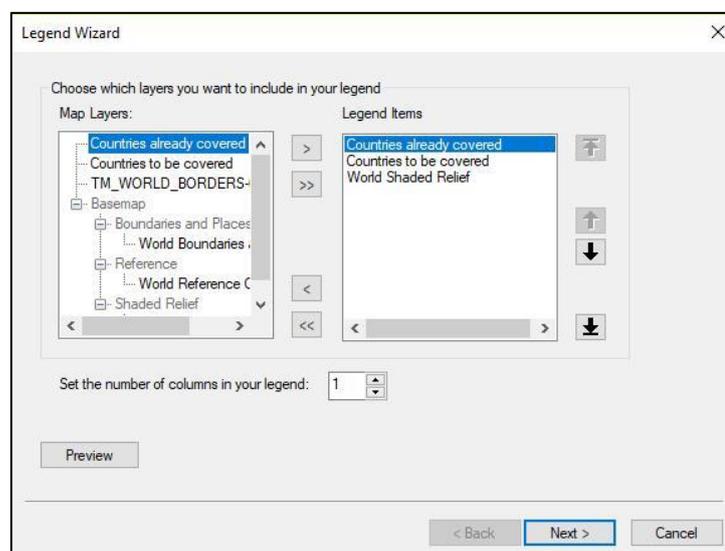
- a. Select the map area by clicking it. From the main menu, click *Insert > Neatline...*. The Neatline dialog box will open. In the Placement section, select *Place around selected element(s)*. In the Border section, click the dropdown menu and select the type of border you want. If you want to set a background color for your map area, click the dropdown menu in the Background section and choose the background you want. Click *OK*.



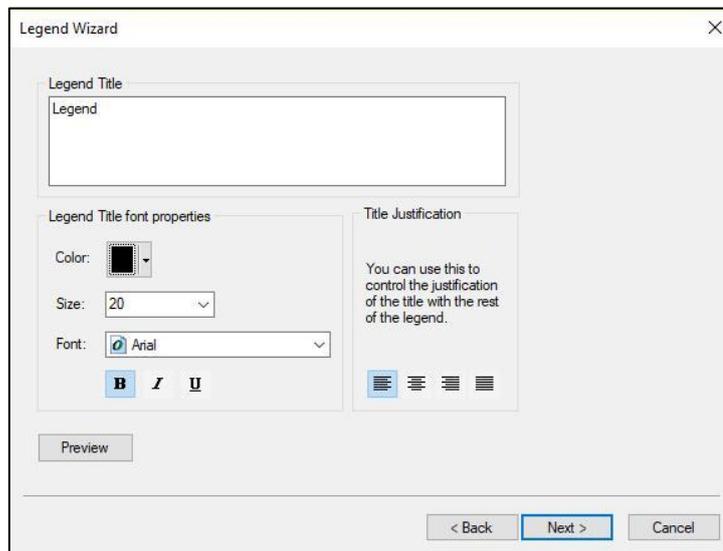
- b. Or you can right-click on the map then choose *Properties*. The Data Frame Properties dialog box opens. In the Frame tab, In the Border section, click the dropdown menu and select the type of border you want. If you want to set a background color for your map area, click the dropdown menu in the Background section and choose the background you want. Click *OK*.



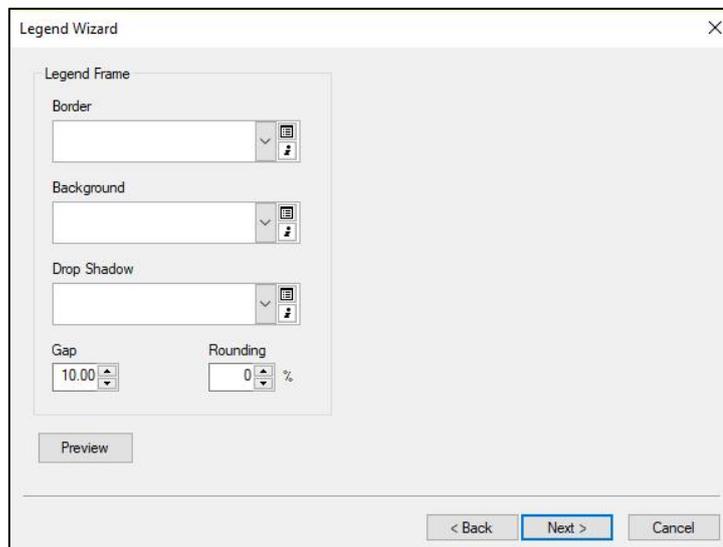
40. If you have added another data frame for an inset map, click it in the layout and apply steps 37 – 39.
41. To add the map legend, activate the main map area first. From the main menu click *Insert > Legend...* The Legend Wizard dialog box will open. Choose the map layers you want to appear in the legend then click the forward arrow to add it/them to the Legend Items box. Click *Next*.



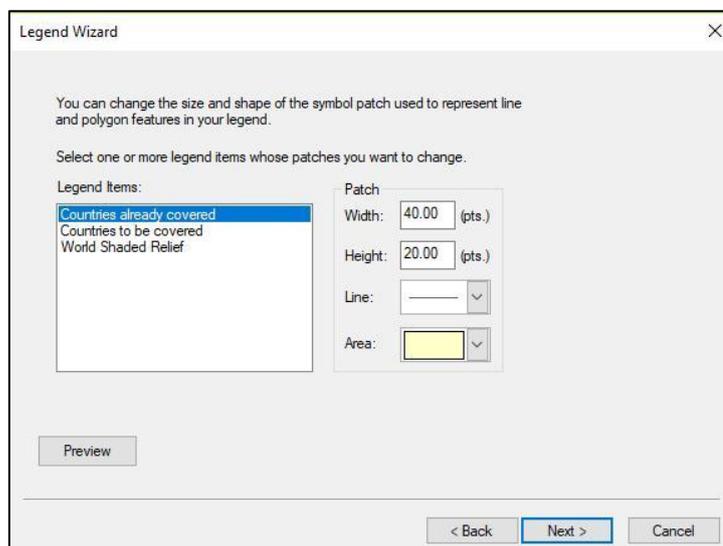
42. Select the color, size, font, and justification of the legend title. Click *Next*.



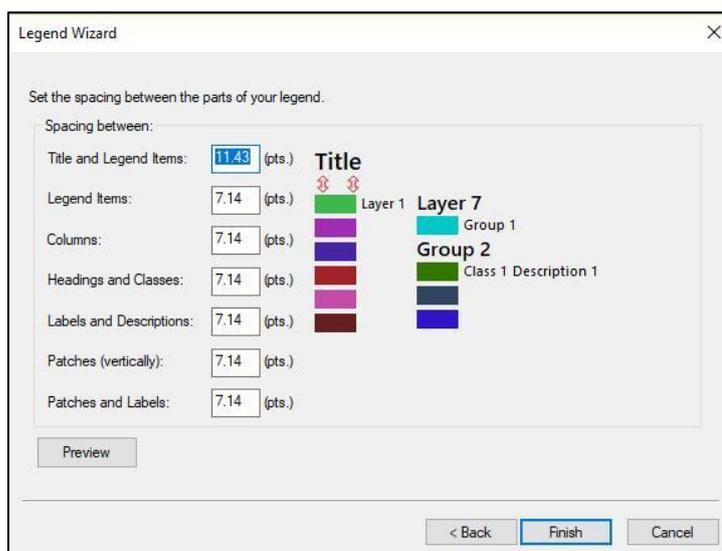
43. You can set the border, background, drop shadow, gap, and rounding of the legend area (optional). Click *Next*.



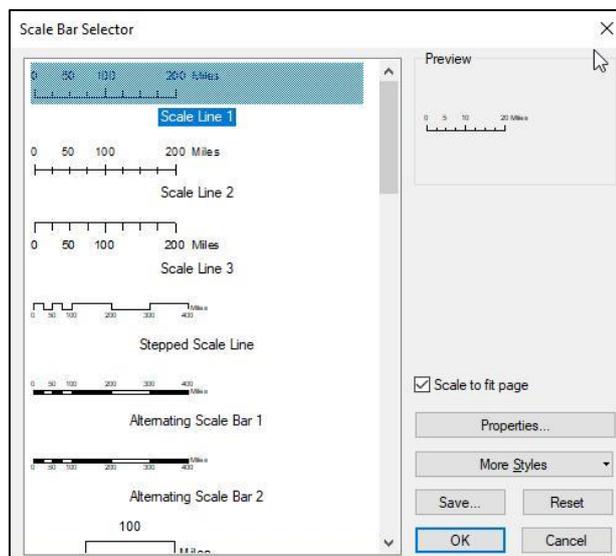
44. You can change the size and shape of the symbol patch/es used to represent line and polygon features in your legend (optional). Click *Next*.



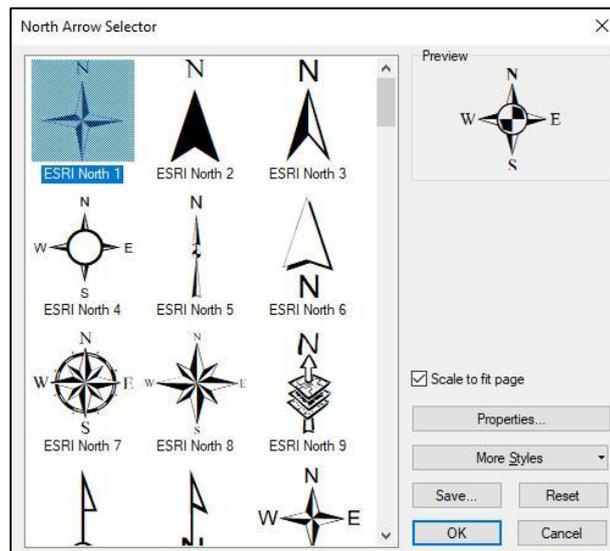
45. You can set the spacing between the patch/es of your legend (optional). Click *Finish* if you are done or click *Back* if you want to change the settings on the previous pages.



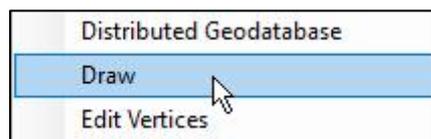
46. Position your legend by clicking and holding it then dragging to the desired position.
47. To add a scale, click *Insert > Scale Bar...* or *Scale Text* from the main menu. Depending on which you choose, the Scale Bar Selector or Scale Text Selector dialog box will open. Choose the scale bar or scale text you want by clicking it.



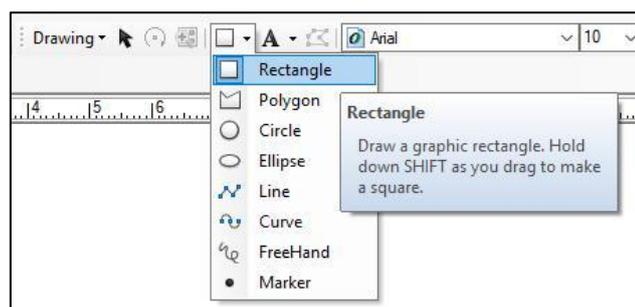
48. Click the *Properties* button to choose the scale settings. Once set, click *OK*. Then click *OK* on the Scale Bar/Text Selector dialog box.
49. To add a north arrow, click *Insert > North Arrow...* from the main menu. The North Arrow Selector dialog box will open. Choose the north arrow style you want by clicking it. Click *OK*.



50. Position your north arrow by clicking and holding it then dragging it to the desired position. Resize the north arrow if necessary.
51. To add border/box to position the title, make sure that the Draw toolbar is visible. If this is not the case, right-click anywhere on the Toolbar area and click *Draw* from the list of toolbars that appears.



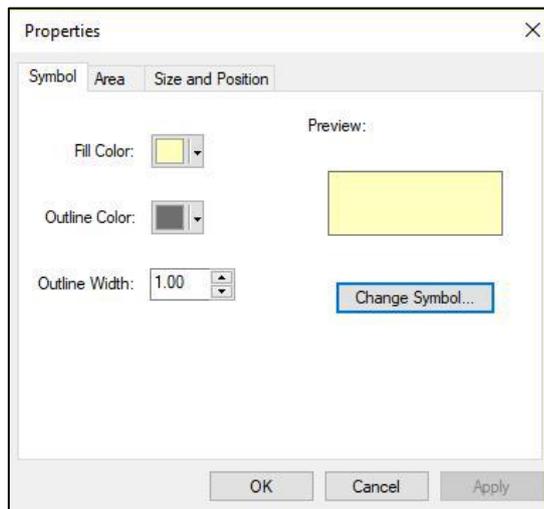
52. Click the dropdown menu and choose *Rectangle*.



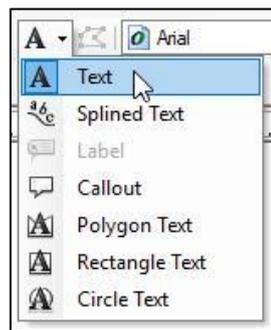
53. Click and drag the cursor in the position you want to create the box/border. To resize the box, click and drag the tiny box at the corners and sides to the correct size.



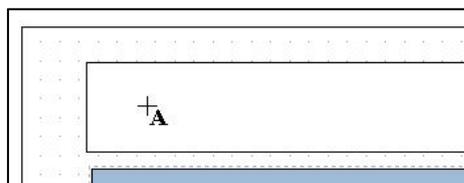
54. To change the fill and outline colors and the outline width, right-click on the box and choose *Properties*. Select the desired fill and outline colors and the outline width. Click *OK*.



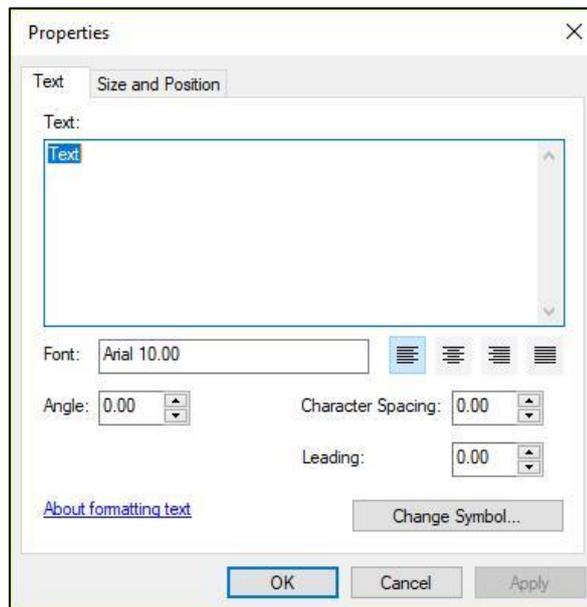
55. Repeat steps 52 to 54 to add the border/box for the other map elements (map production date, disclaimer, additional information, etc.).
56. To add a text, click the dropdown menu beside the letter A in the Draw toolbar and choose *Text*.



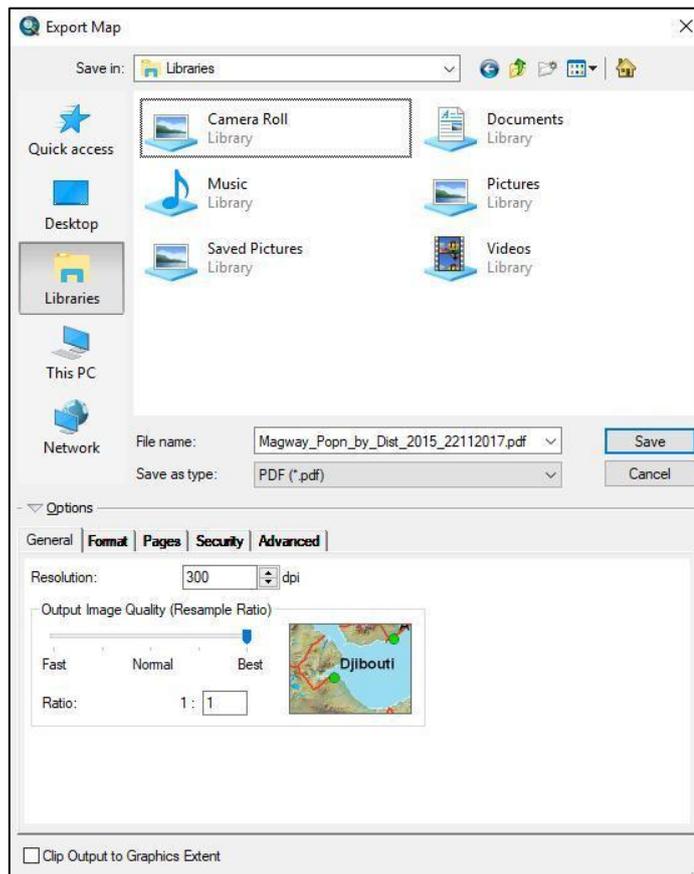
57. Click the Text cursor in the box you want to put the text in.



58. To edit the text, click the pointer button  on the Draw toolbar. Double-click the text you want to edit. The (Text) Properties dialog box will open. Enter the necessary text in the box.



59. To modify the font, click the *Change Symbol* button. The Symbol Selector dialog box opens. Make the necessary changes then click *OK*. Then click *OK* on the (Text) Properties dialog box.
60. Repeat steps 56 to 59 to add the text for the other map elements (map production date, disclaimer, additional information, etc.)
61. To add a logo, click *Insert > Picture...* from the main menu. Go to the folder location of your logo then click *Open*.
62. Resize your logo as necessary and position it where desired.
63. Review your map layout to make sure that the elements are complete and the overall look is clean and balanced.
64. Once you are satisfied with your map, click *File > Export Map...* from the main menu.
65. The Export Map dialog box opens. Go to the folder location you want to save your map layout in.



66. Type in the file name for your final map layout.

67. Select the appropriate file format in the Save as type field.

68. In the Options section below (expand if needed), in the General tab, set the resolution to at least 300 dpi. Adjust the other settings as needed for your map layout.

69. Click *Save*.

You have now successfully created your own thematic map using ArcMap.

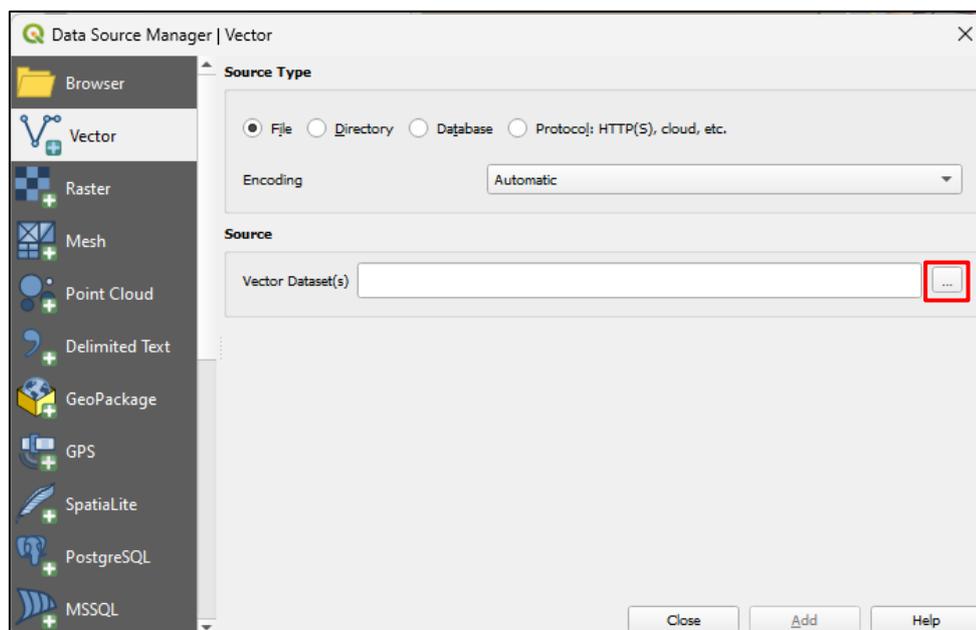
Annex 3 – Creating a thematic map in QGIS

This Annex describes the steps in creating a thematic map in QGIS Desktop version 3.34 without using a map template.

1. Open QGIS.
2. Create a new map document by going to the main menu, click *Project > New*.
3. Save your new map document by going to the main menu, click *Project > Save* or by clicking the Save button .
4. The Choose a QGIS project file dialog box opens. Go to the folder location you want to save your map document in.
5. Type in the name for your map document. Click *Save*.

IMPORTANT NOTE: Remember to periodically save your map document as you go through the next steps. This ensures that your work is saved even if the GIS software or your computer suddenly crashes.

6. From the main menu, go to *Layer > Add Layer > Add Vector Layer...* or click the *Add Vector Layer* button  to add the prepared data to your map document.
7. The Data Source Manager dialog box opens. Go to the folder location of your prepared data.



8. Select the data you want to add then click *Open*. (As a shapefile is composed of several files, choose the file with the “.shp” file extension.)

You may add more than one data from the same folder by pressing the Control (Ctrl) key on your keyboard while clicking on the data you need to add.

9. Click *Add*.

You will have to repeat steps 7 - 9 if your data are in different folders.

Make sure to add both the geospatial data and statistical data. Ensure that both use the same coding scheme to uniquely identify each of the geographic objects present in both the geospatial and statistical data as this will allow the statistical data to be joined to the geospatial data.

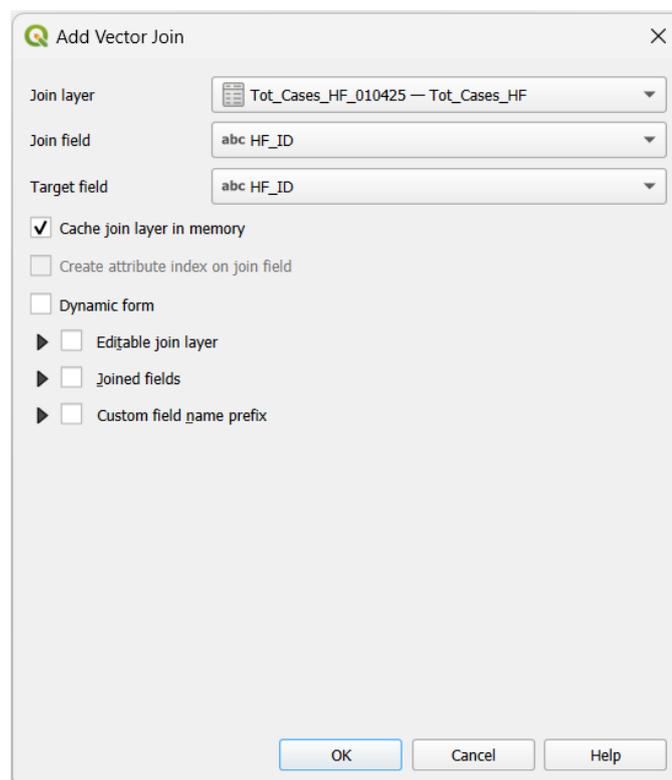
10. Once all the needed data are added, close the Data Source Manager dialog box.

11. To join a geospatial data to a table, right-click on the geospatial data, click *Properties*.

12. The Layer Properties dialog box opens. Click *Joins* from the left-hand menu then click

the plus sign  on the bottom left.

13. The Add Vector Join dialog box opens. Choose the layer to join (statistical data) and the join and target fields (fields containing the unique identifier). Click *OK*.



14. Click *Apply* then *OK* in the Layer Properties dialog box.

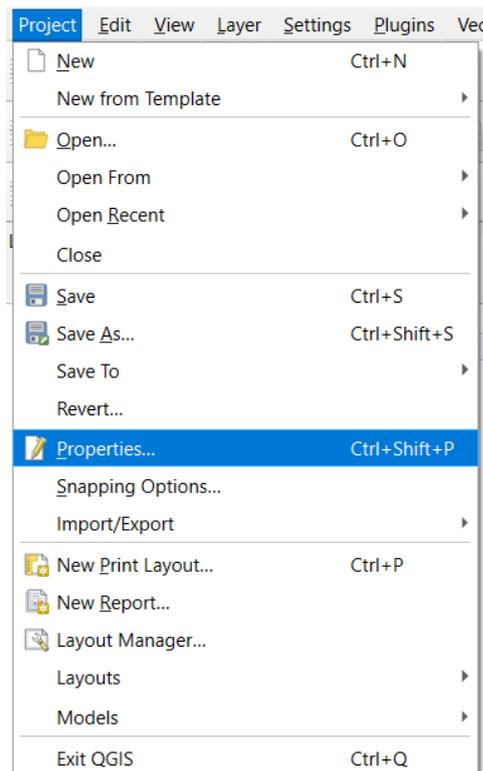
15. You may add a basemap by going to *Web > QuickMapServices* from the main menu or

by clicking the *QuickMapServices* button  in the Web toolbar. Select the appropriate basemap.

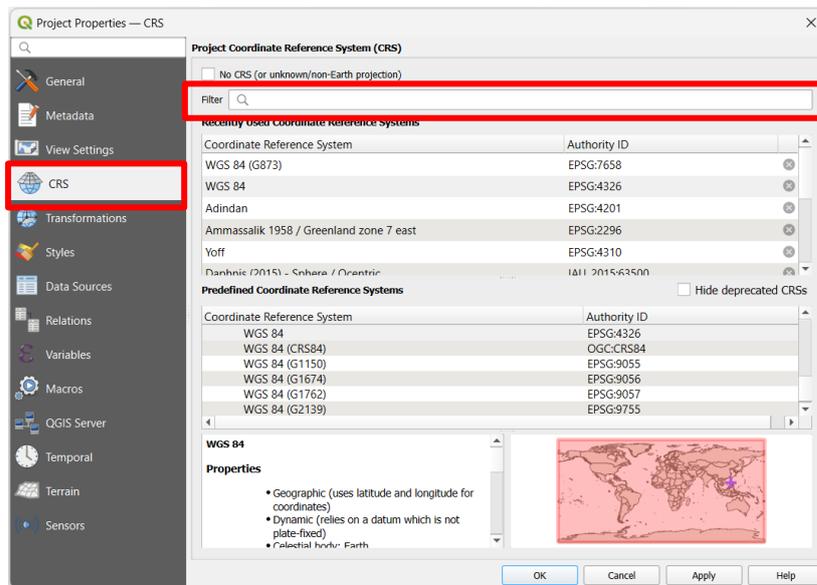
This step will only work if you have installed the Quick Map Services plugin. If this is not the case, click *Plugins > Manage and Install Plugins...* from the main menu. The Plugins dialog box will open. In the Search field, type “QuickMapServices.” Once it appears, click it to select it and click the *Install plugin* button on the lower right side. Wait for the plugin to install then close the plugin dialog box.

16. Decide if the GCS or PCS needs to be adjusted to match the map’s purpose. If not, proceed to step 21. If yes, proceed to the next step.

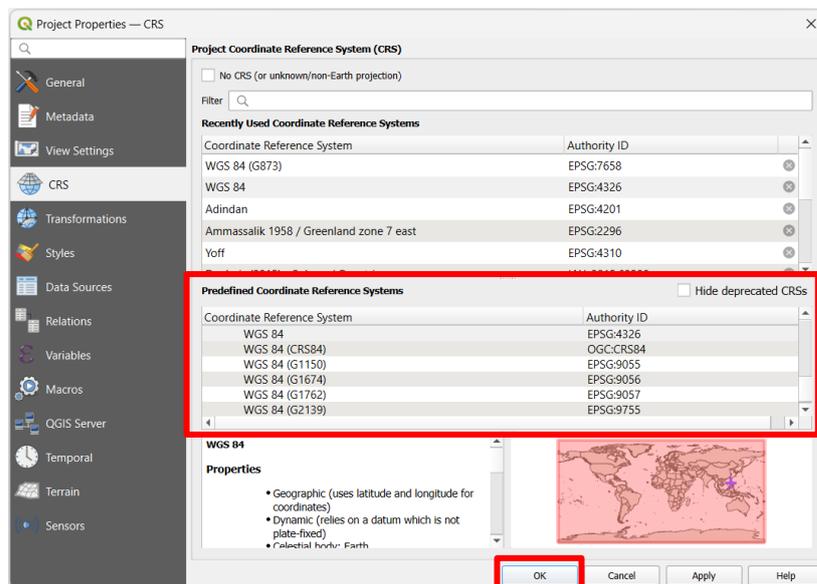
17. From the main menu, go to *Project > Properties...*



18. The Project Properties dialog box opens. Click on *CRS* from the left-hand menu. Navigate to the desired coordinate system for your map canvas. To help narrow down the choices, you can filter the coordinate systems by entering the coordinate system you would like to use or key words.

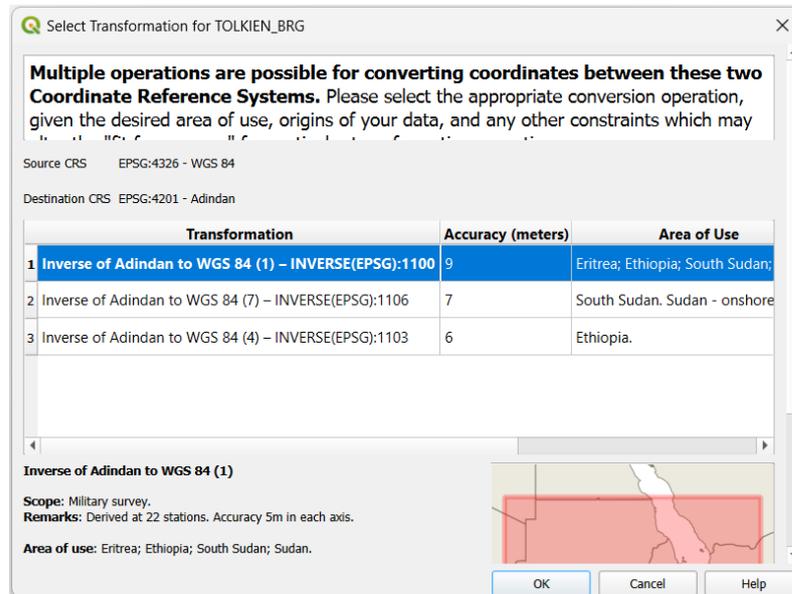


19. Select the desired coordinate system from the list and click *OK*.



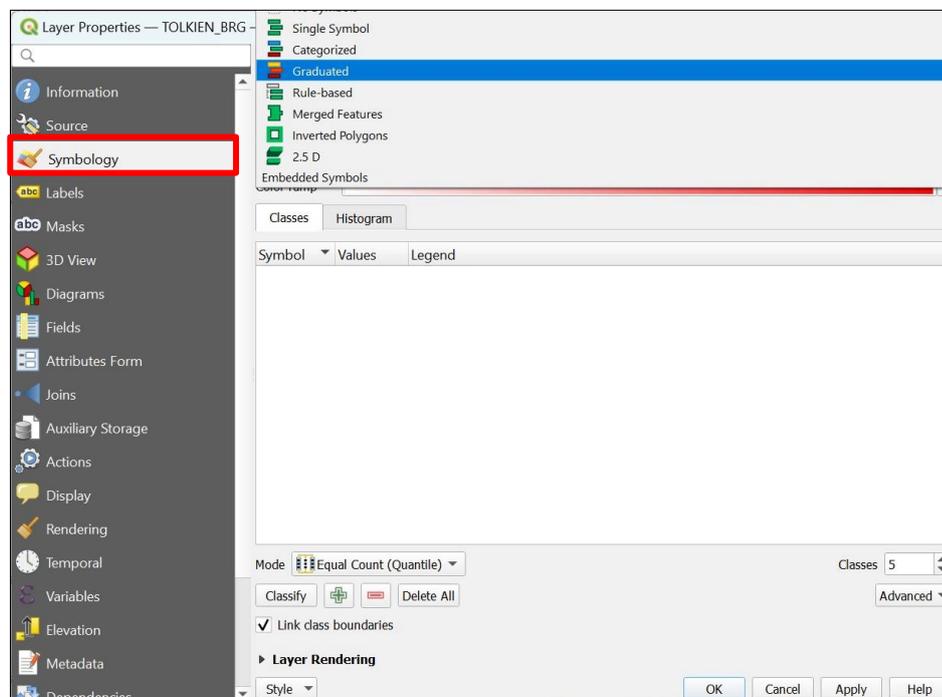
Note: Changing the coordinate system of the project does not change the native GCS or PCS of the geospatial data being used to create the map.

20. You will be prompted to select a geographic transformation to use when changing from one geographic coordinate system to another (similar to the image below). Choose the appropriate transformation and click *OK*.



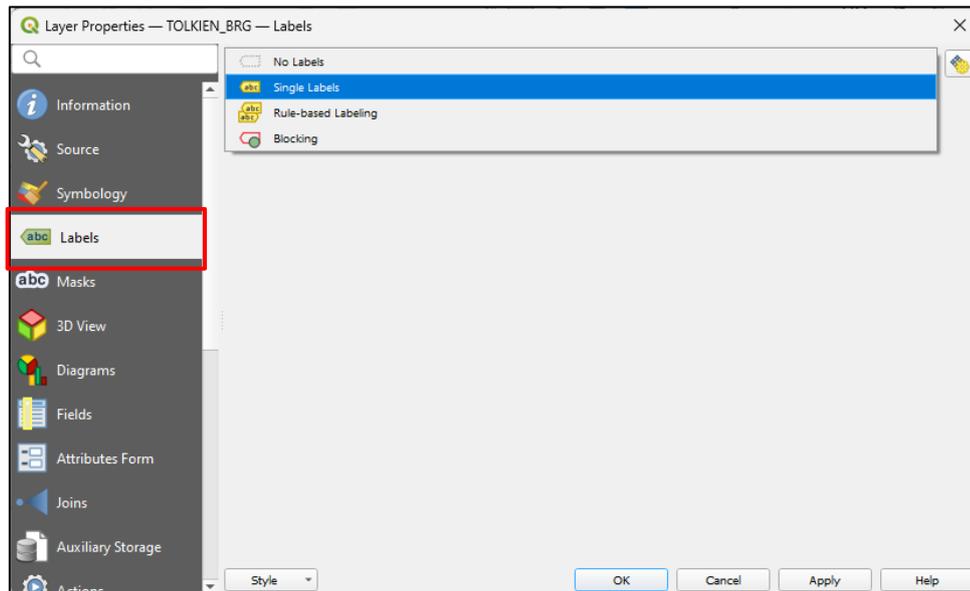
Note: You can learn more about geographic transformation from this source.²⁵

21. Decide on the appropriate mode of representation for your data. (In this example, the data will be presented as a choropleth map.)
22. Symbolize your data by right-clicking on your geospatial layer then click *Properties*.
23. The Layer Properties dialog box opens. Click *Symbology* from the left-hand menu. From the dropdown menu at the top, choose how to show your data to correspond to your chosen mode of representation. Adjust the different parameters. Click *OK*.

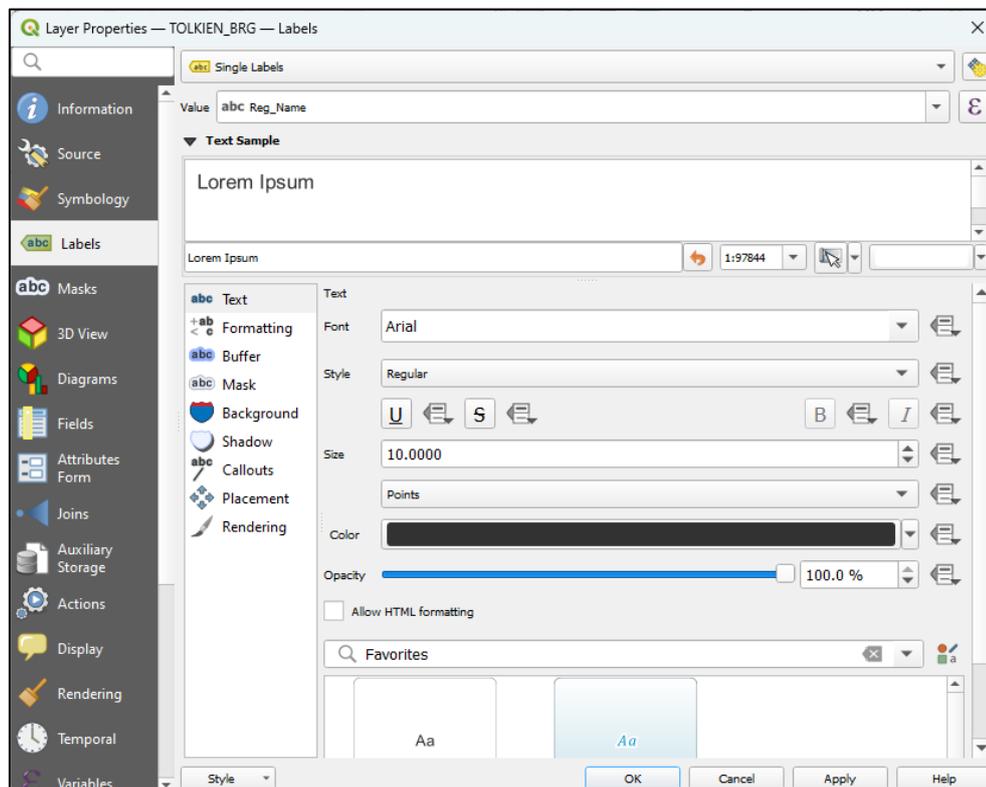


²⁵ <https://www.esri.com/arcgis-blog/products/product/mapping/about-geographic-transformations-and-how-to-choose-the-right-one/>

24. If you are not satisfied with how your data is symbolized, you may go back to the *Symbology* tab to adjust the symbology accordingly.
25. Add labels to your map by right-clicking on the geospatial layer you would like to put a label on then click *Properties*.
26. The Layer Properties dialog box opens. Go to *Labels* from the left-hand menu. From the dropdown list at the top, choose *Single labels*.



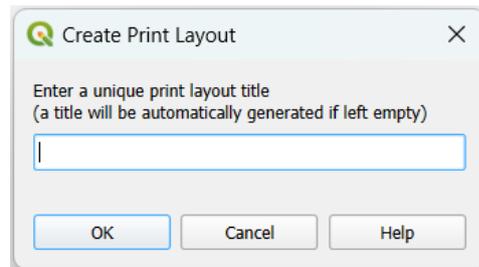
27. In the *Value* field, choose the field from the geospatial layer that you would like to use as its label. Alternatively, you may choose to use an expression to label your data.



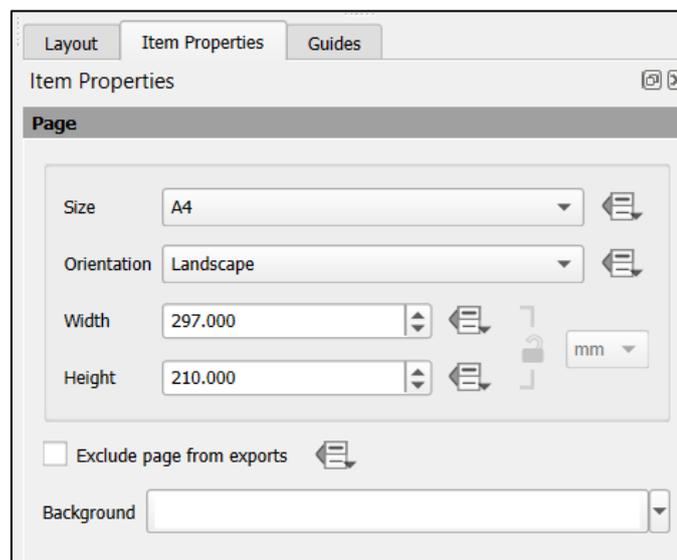
28. Adjust the font type and size and other settings of the label to suit your map. Click *OK*.
29. Once all the data are properly symbolized and labeled, proceed to creating the map layout.

Note: The orientation of the map layout to be created should already be known at this point.

30. Click *Project > New Print Layout* from the main menu. A small dialog box will open asking you to create a unique title for your print layout. If you do not enter a title, one will be generated automatically for you. Enter a title if you want. Click *OK*.



31. The Print Layout window opens. Visualize the placement of the map elements. If it would help, sketch your planned layout on paper first. This will give you an idea of how all the map layout elements look together.
32. To set the page size and orientation, right-click on the blank page and click *Page Properties...* The Page section opens in the Item Properties tab on the lower right side of the window. Choose or set the page size and choose the orientation.

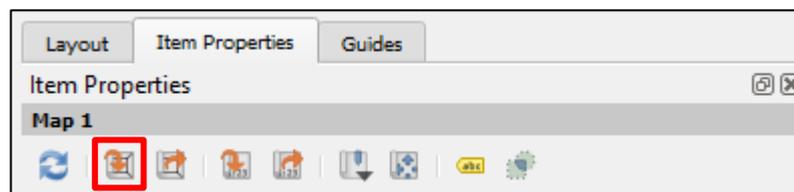


33. To help align the map elements as you are positioning them, you can make the grid visible by clicking *View* from the main menu and activating *Show Grid*.

34. To add your map to the layout, click the *Add Map* button  on the Toolbox toolbar.

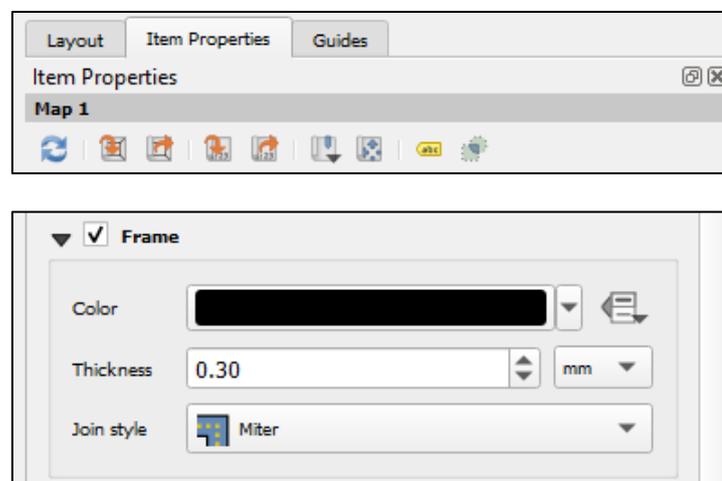
35. Click and drag the cursor on the page to delineate the area you want to position the map area at.
36. You will now see your symbolized data on the map. Check that the focus of your map is at the center of the map area. Adjust it as necessary.

- a. If you just need to pan/move your map, use the *Move item content* button  on the Toolbox toolbar.
- b. If you need to zoom in or out on the map, go back to the main QGIS window (the one where you symbolized your layers) and use the *Zoom In* or *Zoom Out* button on the Map Navigation toolbar. Then go back to the Print Layout window and click *Set Map Extent to Match Main Canvas Extent* button in the Item Properties tab.



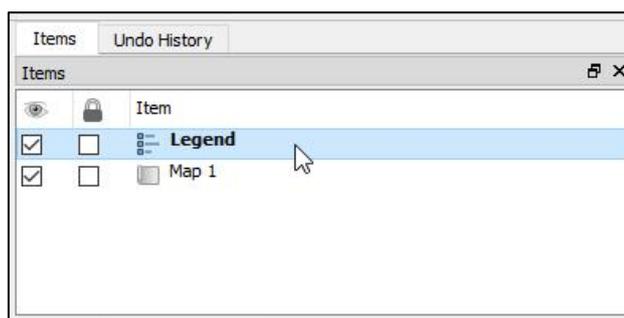
Repeat these steps until you have centered your map.

37. To add a border around your main map area, go to the Item Properties tab and scroll down to the Frame section. Check the box beside Frame. You may then change the frame color, thickness, and style as desired.

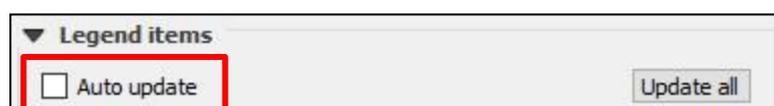


38. To add the legend, click the *Add Legend* button  on the Toolbox toolbar. Click, hold, and drag your mouse to create a box in the location where you want the legend to appear.
39. If the legend box needs to be repositioned, click, hold, and drag it to the correct position. Or click it and use the arrow keys on your keyboard to move it to the correct position.

40. To edit the legend, select the legend by clicking it in the map template or in the Items list.



41. In the Items Properties tab, go to the Legend items section and make sure that the *Auto update* button is unchecked. Doing this will allow you to edit the legend items.

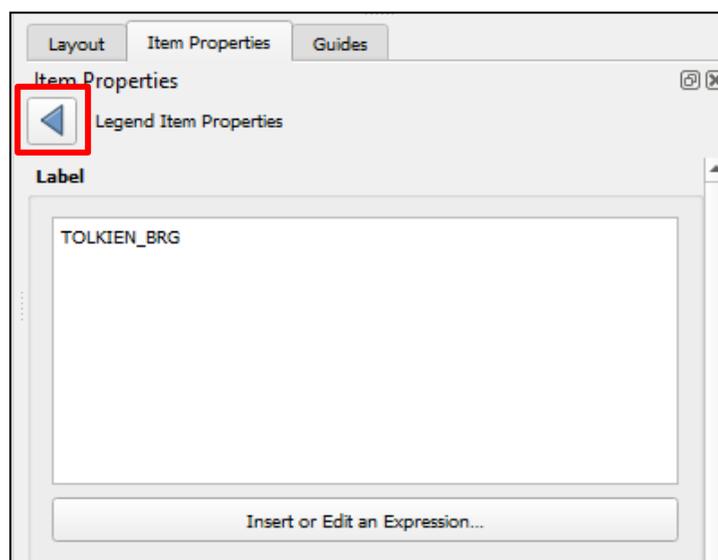


42. To move an item down or up on the legend list, click the item then use the *Down* or *Up* buttons   found below the list.

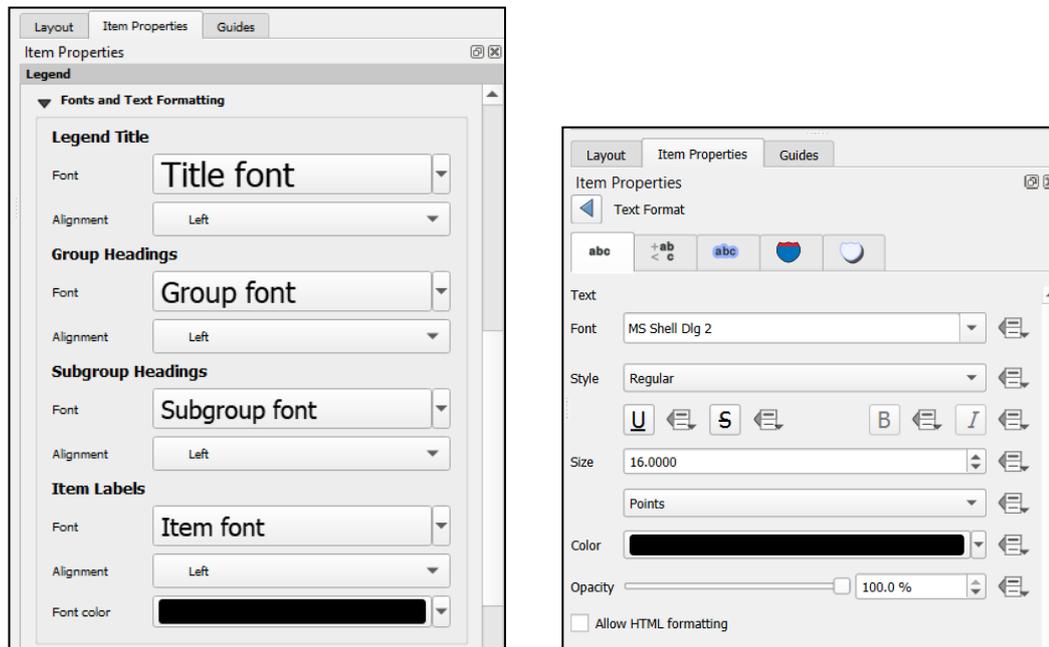
43. If you need to remove a legend item, click the item then click the *Minus* button .

44. If you need to add a legend item, click the *Add* button . Choose the layer you want to add from the list that appears then click *OK*.

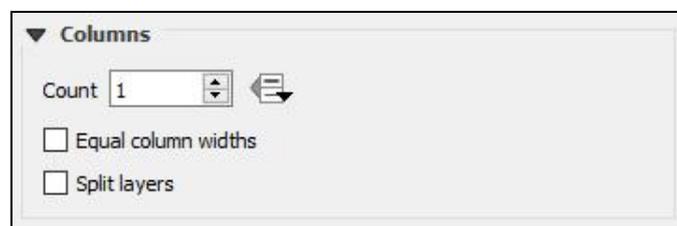
45. To rename a legend item, click it then click the *Edit* button . Edit the name in the box that appears then click the *Back* button  to go back to the Legend Item Properties.



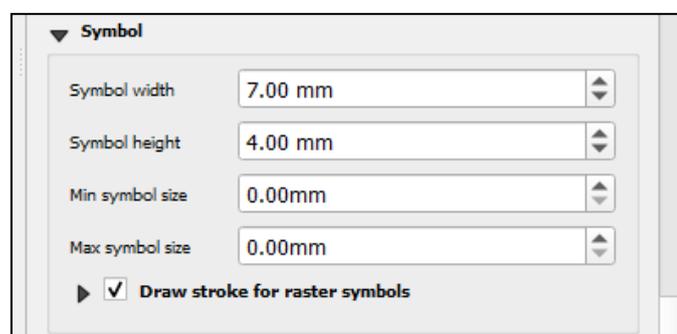
46. You can edit the font of the legend items in the Fonts and Text Formatting section by clicking the Font field of the legend item (Legend Title, Group Heading, Subgroup Headings, etc.) then selecting your desired font type, style, size, and color. Then click the *Back* button  to go back to the Legend Item Properties.



47. In the Columns section, you can specify if you need one or more columns for your legend items.

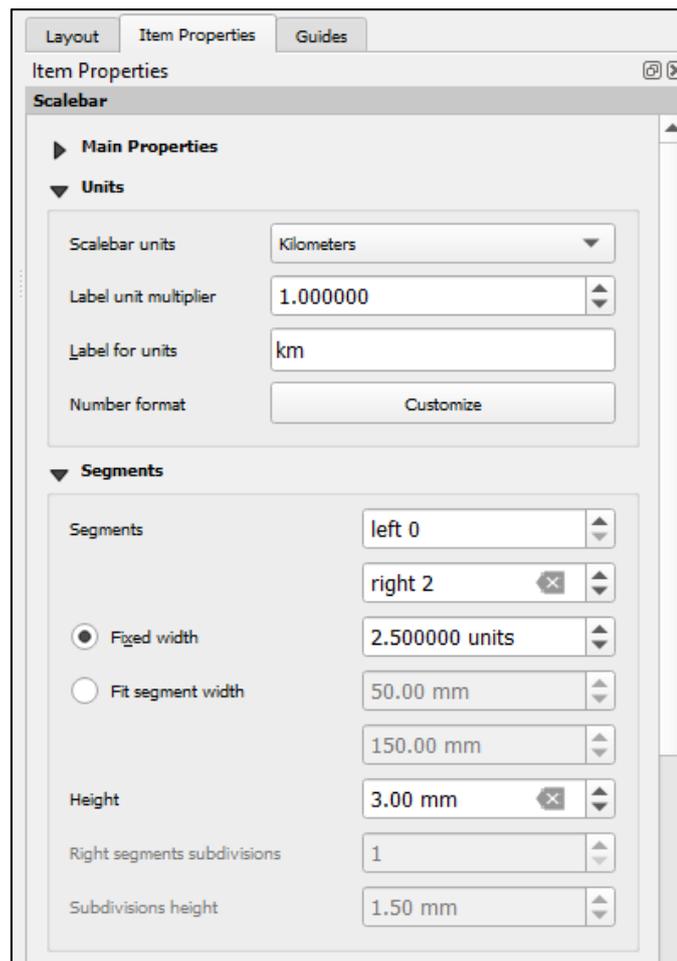


48. In the Symbol section, you can change the width and height of the symbols in the legend.



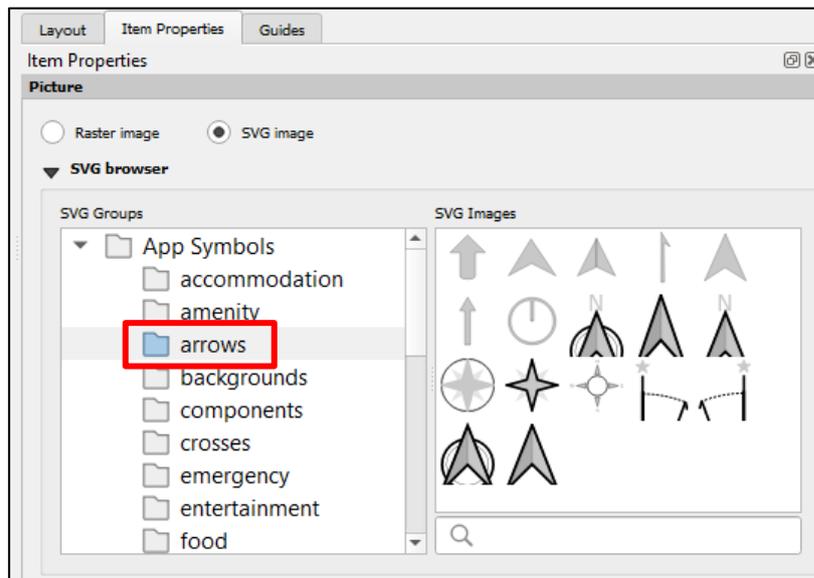
49. To add a scale bar, click the *Add Scale Bar* button  on the Toolbox toolbar. Click, hold, and drag your mouse to create a box in the location where you want the scale bar to appear. To change its position, click and drag it to the desired position.

50. To change the scale bar properties, click on the scale bar to select it. In the Item Properties tab, modify the style, units, segments, etc.



51. To add a north arrow, click the *Add North Arrow* button  on the Toolbox toolbar. Click and drag the cursor where you want to position the north arrow.

52. In the Item Properties tab, expand the *SVG browser* section and click the *arrows* subfolder. Select the north arrow style you want from the available styles.

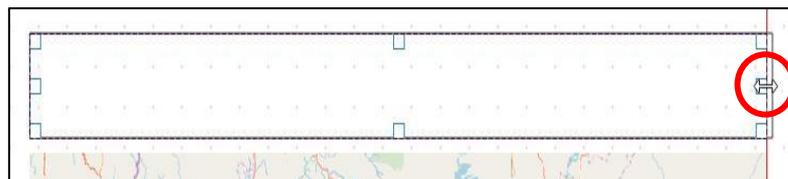


53. To add border/box to position the title, click the dropdown menu on *Add Shape* button



on the Toolbox toolbar and choose *Add Rectangle*.

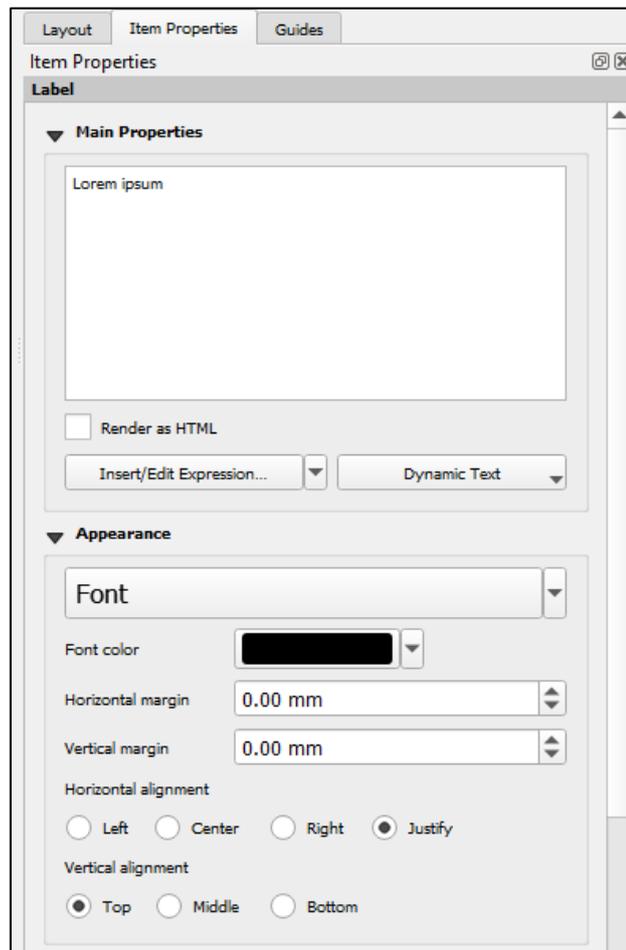
54. Click and drag the cursor in the position you want to create the box/border. To resize the box, click and drag the tiny box at the corners and sides to the correct size.



55. Repeat steps 53 to 54 to add the border/box for the other map elements (map production information, disclaimer, additional information, etc.).

56. To add the title, click the *Add Label* button  on the Toolbox toolbar. Click and drag the cursor inside the title box.

57. In the Item Properties tab, you can change the text in the Main properties section. You can change the font type and color, margin, and alignment in the Appearance section.



58. Repeat steps 56 to 57 to add the text for the other map elements (map production information, disclaimer, additional information, etc.)

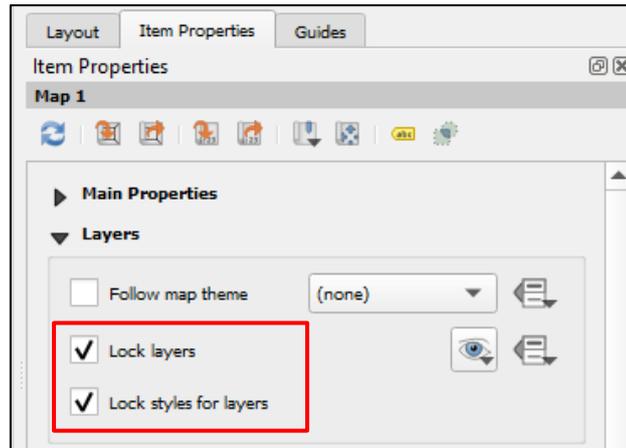
59. To add a logo, click the *Add Picture* button  on the Toolbox toolbar. Click and drag the cursor where you want to position the logo.

60. In the Item Properties tab, click the Raster image radio button and click the *Browse* button. The *Select Image File* dialog box opens. Go to the folder where the logo image file is located, select the image, and click *Open*. Resize and reposition the logo as needed.



61. If you are going to add an inset map to your map layout, first make sure that you are satisfied with how the main map area looks. Make the necessary changes if necessary. When done, click the main map area.

62. In the Item Properties tab, expand the Layers section. Check the *Lock layers* and *Lock styles for layers* item boxes. This ‘locks’ the map in your map layout and any new changes you make in the QGIS main window will not affect it.

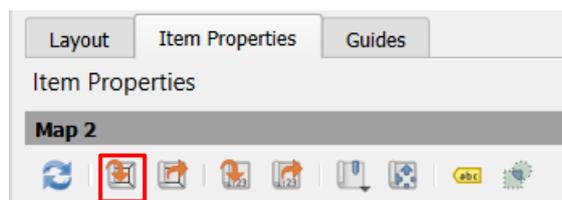


63. Go back to the main QGIS window (the one where you symbolized your layers). Add and symbolize the data for the inset map by following the relevant steps in steps 6 to 28 as necessary.

64. Go back to the Print Layout window. Click the *Add Map* button  on the Toolbox toolbar.

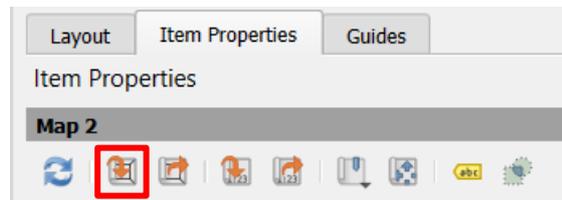
65. Click and drag the cursor on the page to delineate the area you want to position the inset map at.

66. If you do not immediately see the layers in the inset map, click the inset map to make sure it is selected then on the Item Properties tab, click the *Set Map Extent to Match Main Canvas Extent* button. You will now see your symbolized data on the inset map.



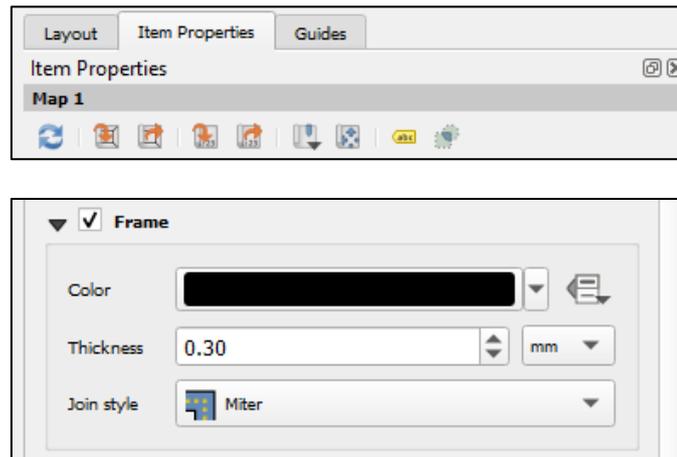
67. Check that the focus of your inset map is at the center of the map area. Adjust it as necessary.

- If you just need to pan/move your map, use the *Move item content* button  on the Toolbox toolbar.
- If you need to zoom in or out on the map, go back to the main QGIS window (the one where you symbolized your layers) and use the *Zoom In* or *Zoom Out* button on the Map Navigation toolbar. Then go back to the Print Layout window and click *Set Map Extent to Match Main Canvas Extent* button in the Item Properties tab.



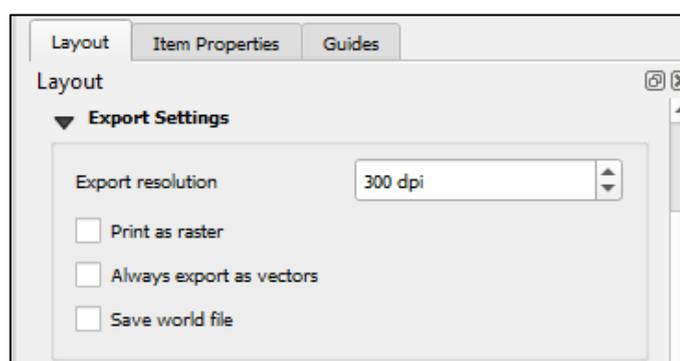
Repeat these steps until you have centered your map.

68. To add a border around your inset map, click on your inset map to select it then go to the Item Properties tab and scroll down to the Frame section. Check the box beside Frame. You may then change the frame color, thickness, and style as desired.



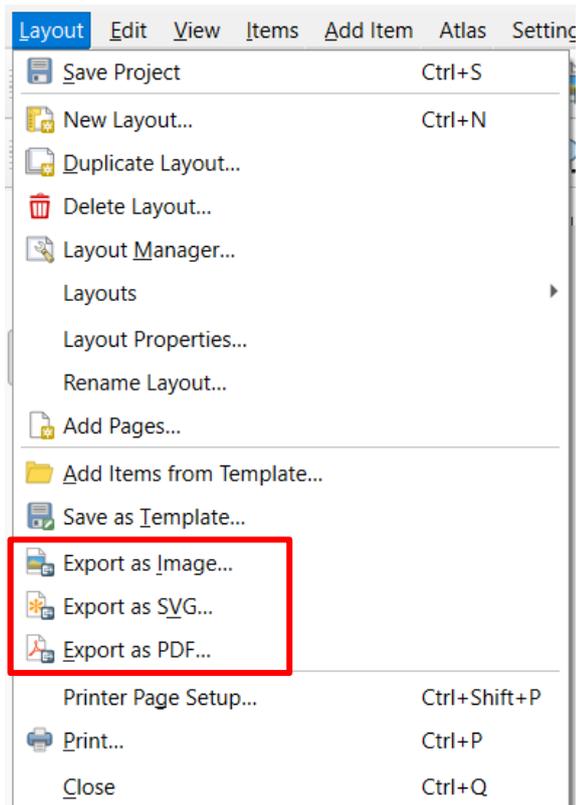
69. Review your map layout and make sure that the elements are complete, and the overall look is clean and balanced.

70. Once you are satisfied with your map, click the *Layout* tab on the right side then expand the *Export settings* section. Make sure that the resolution is set to at least 300 dpi.



71. Click *Layout* from the main menu then choose to export your map as an image, PDF, or scalable vector graphics (SVG) file format.

(Although keep in mind that when exporting to SVG, a message appears warning users of problems in saving in this format using QGIS.)



72. Depending on the format you selected, the Save Layout as or Export to [format] dialog box opens. Go to the folder location you want to save your map layout in.

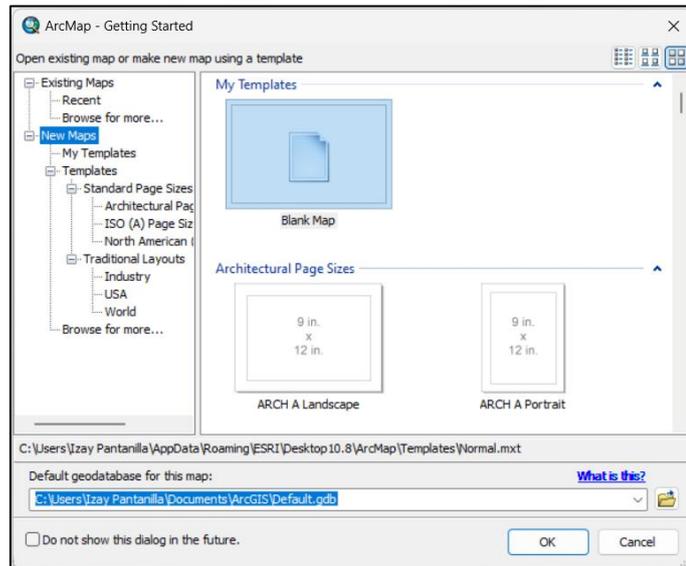
73. Type in the file name for your final map layout. Click *Save*.

You have now successfully created your own thematic map using QGIS.

Annex 4 – Creating a map template in ArcMap

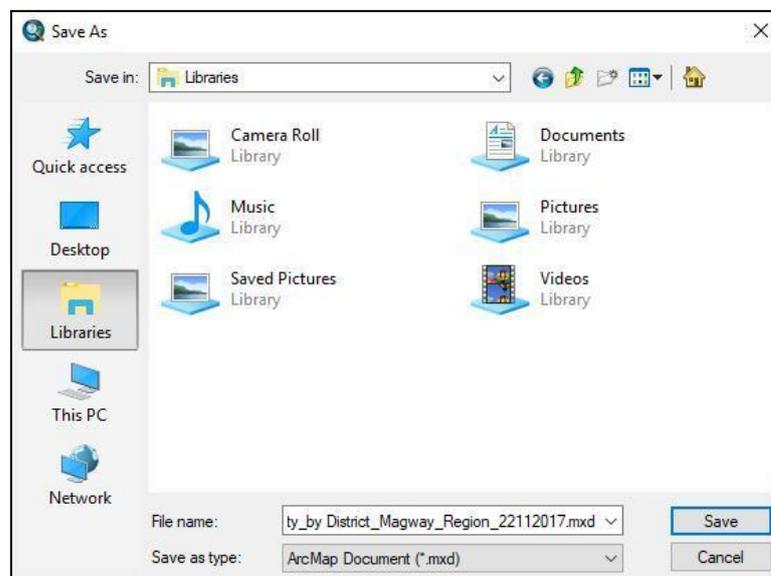
This Annex describes the steps in creating a map template in ArcMap (version 10.8).

1. Open ArcMap.
2. When the ArcMap – Getting Started dialog box opens, click *New Maps* from the left side menu then click the icon for the *Blank Map*. Click *OK*.



3. Save your new ArcMap document by going to the main menu, click *File > Save* or by clicking the *Save* button .

4. Since this is the first time you are saving the ArcMap document, the Save As dialog box will open. Go to this folder location to save your map template: **<install drive>:\Program Files (x86)\ArcGIS\Desktop 10.8\MapTemplates**

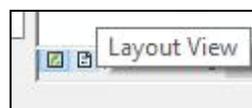
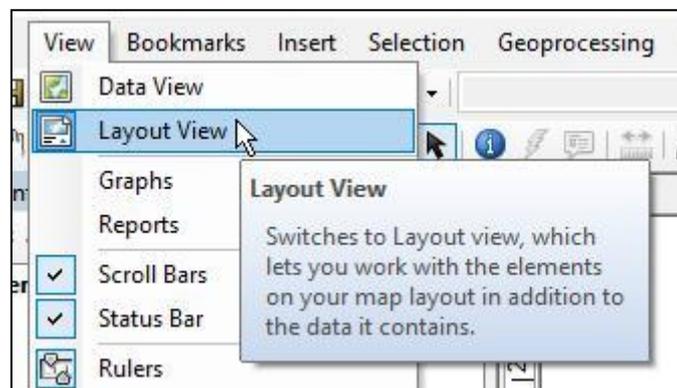


5. Type in the name for your ArcMap document. Click *Save*.

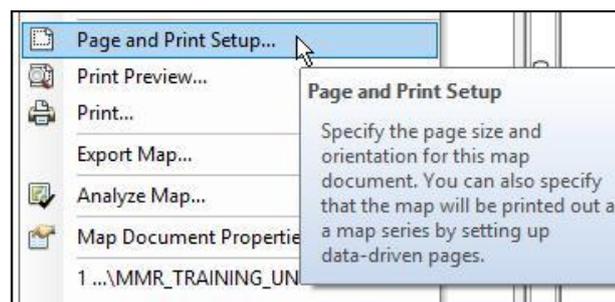
Note: If you get a warning message that you do not have permission to save in the C: drive, save your file in another folder for the moment. Once done with creating the template, copy/move the file to the location specified above.

IMPORTANT NOTE: Remember to periodically save your map document as you go through the next steps. This ensures that your work is saved even if the GIS software or your computer suddenly crashes.

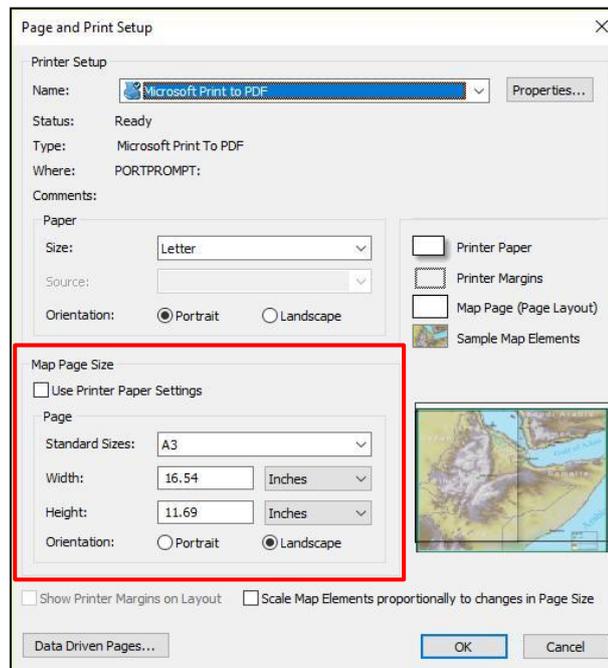
6. Decide on the first map orientation to create a template for. Visualize the placement of the map elements. If it would help, sketch your planned layout on paper first. This will give you an idea of how all the map layout elements look together.
7. Go to Layout View by going to the main menu, click *View > Layout View* or by clicking the *Layout View* button (second button) at the bottom beside the Table of Contents pane.



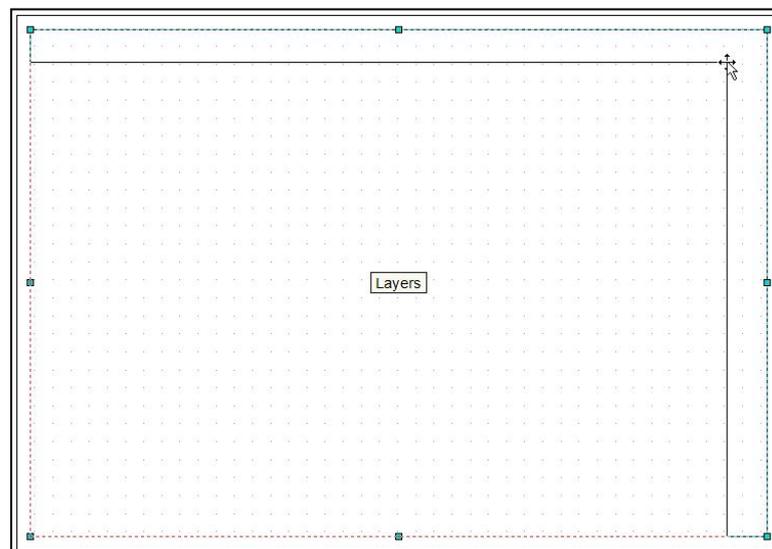
8. To set the page size, go to the main menu, click *File > Page and Print Setup...*



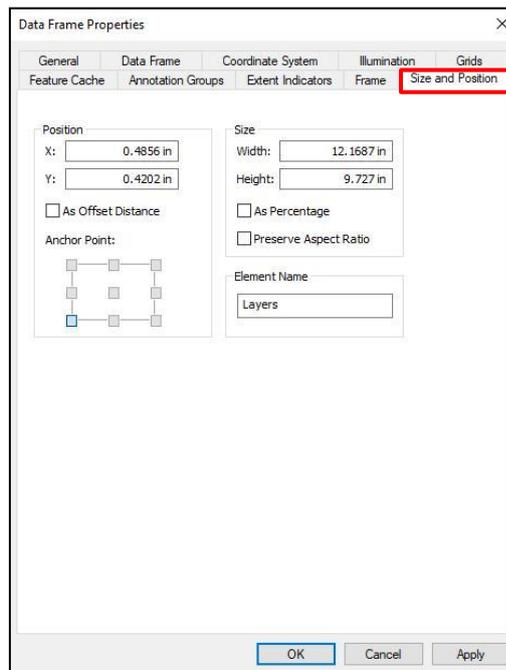
9. The Page and Print Setup dialog box will open. In the Map Page Size section, choose/input the desired paper size and orientation. Click *OK*.



10. To help align the elements as you are positioning them, you can make the grid visible by clicking *View* from the main menu and activating the *Grid*.
11. Once you have an idea of the placement of the map elements, resize the map area accordingly and move it to the desired position in the layout. To resize, click the map area to select it and click and drag the tiny box at the corners and sides to the right size. (The map area initially covers the whole page.)

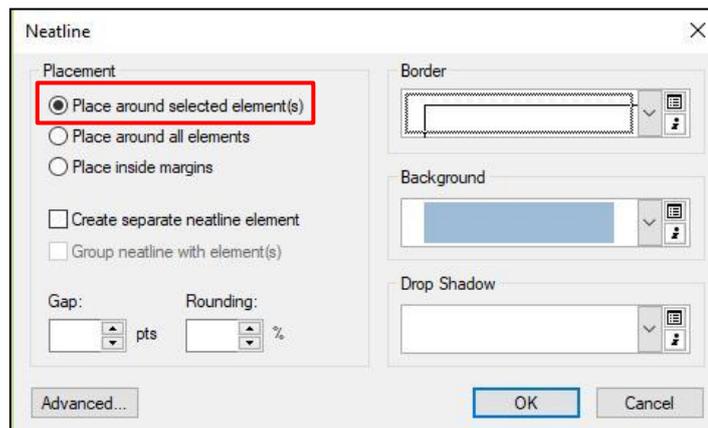


Or you can right-click on the map then choose *Properties*. The *Data Frame Properties* dialog box opens. In the *Size and Position* tab, input the desired size either by the actual measurement or by percentage in the *Size* section. Click *OK*.

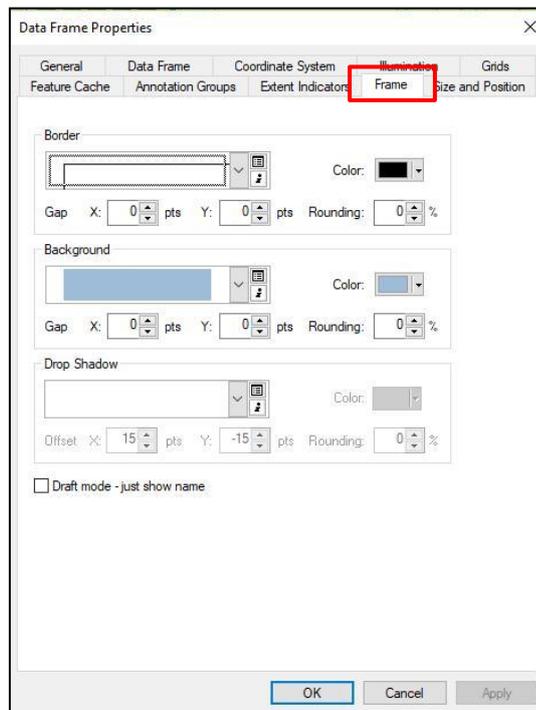


12. To add a border to your map area:

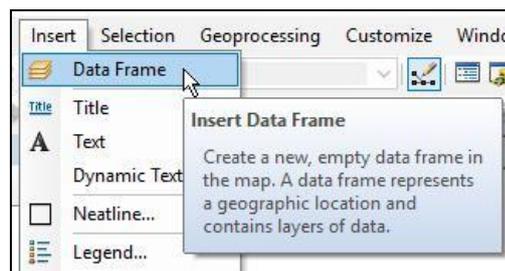
- a. Select the map area by clicking it. From the main menu, click *Insert > Neatline....* The Neatline dialog box will open. In the Placement section, select *Place around selected element(s)*. In the Border section, click the dropdown menu and select the type of border you want. If you want to set a background color for your map area, click the dropdown menu in the Background section and choose the background you want. Click *OK*.



- b. Or you can right-click on the map then choose *Properties*. The Data Frame Properties dialog box opens. In the Frame tab, In the Border section, click the dropdown menu and select the type of border you want. If you want to set a background color for your map area, click the dropdown menu in the Background section and choose the background you want. Click *OK*.



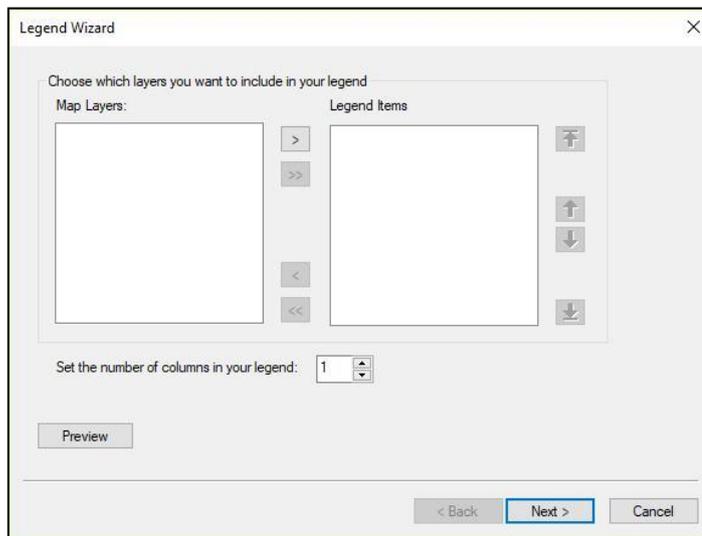
13. To add an area for inset map, click *Insert > Data Frame* from the main menu. A New Data Frame box will appear in the map area.



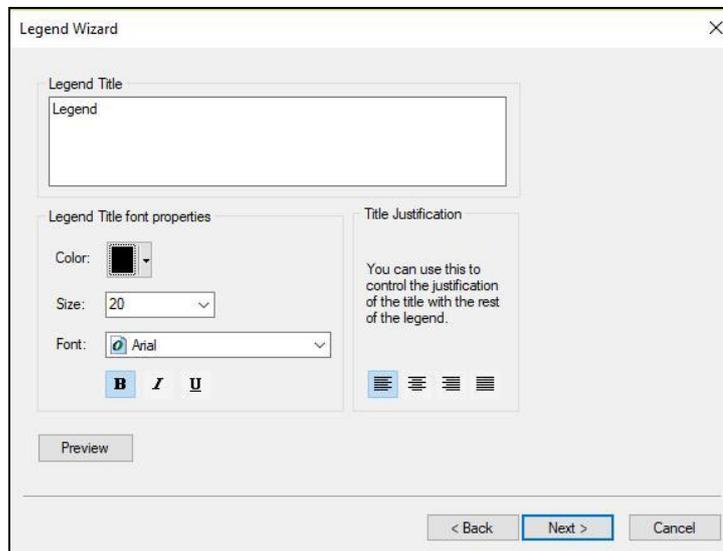
14. Resize and position the New Data Frame box to the desired area.

15. To add a border to the inset map, follow step 12.a or 12.b.

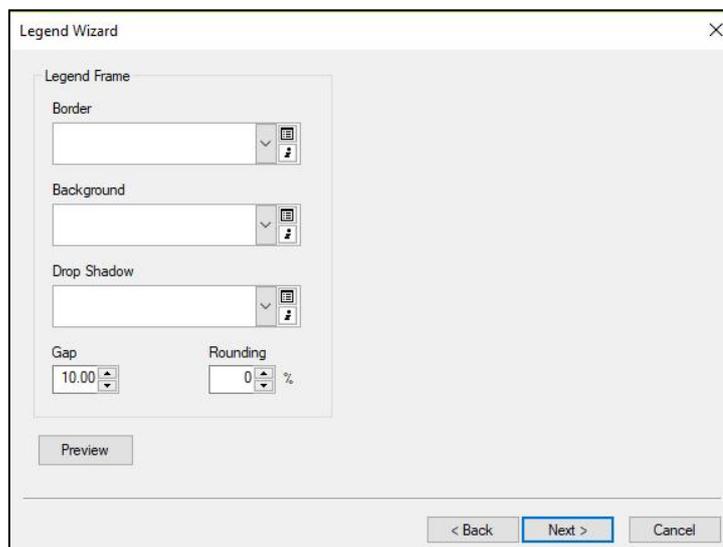
16. To add the map legend, activate the main map area first by clicking it. From the main menu click *Insert > Legend...* The Legend Wizard dialog box will open. The list of map layers will be empty at the moment. Click *Next*.



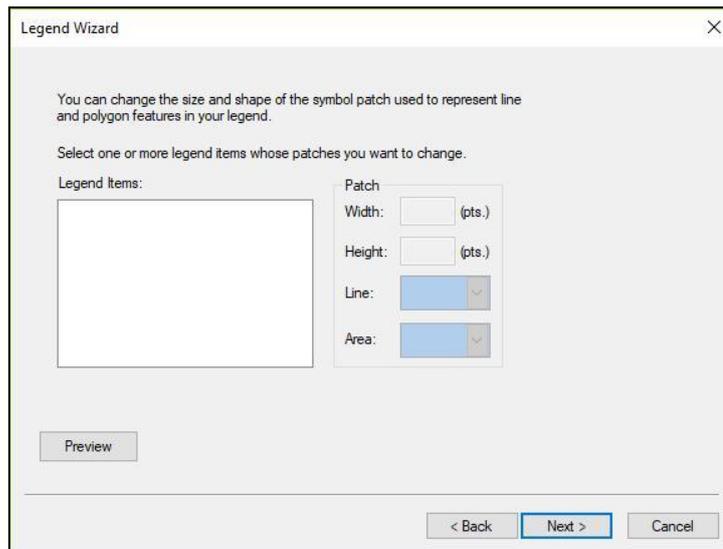
17. Select the color, size, font, and justification of the legend title. Click *Next*.



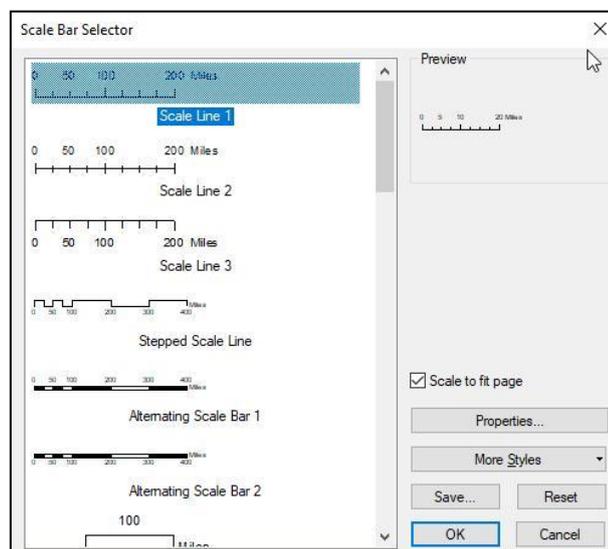
18. You can set the border, background, drop shadow, gap, and rounding of the legend area (optional). Click *Next*.



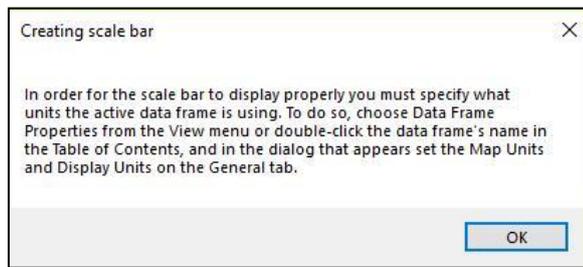
19. Having no symbology patches to change at the moment, just click *Next* on the succeeding window.



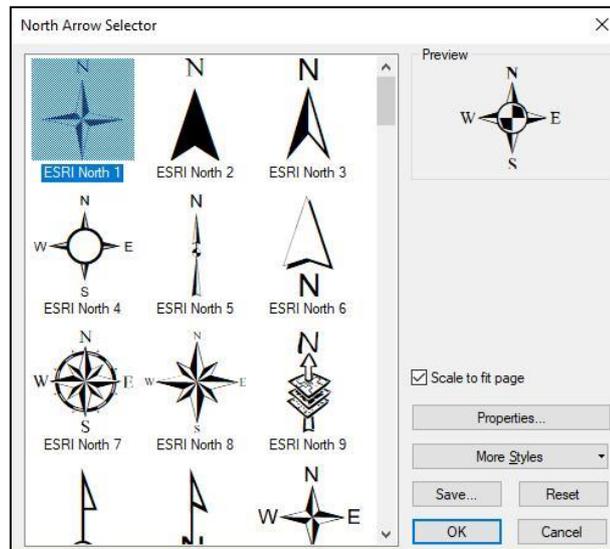
20. Having no items to change the spacing at the moment, click *Finish*. As this is a template, it is just the Legend title and a border around it.
21. Position your legend by clicking and holding it then dragging to the desired position.
22. To add a scale, click *Insert > Scale Bar...* or *Scale Text* from the main menu. Depending on which you choose, the Scale Bar Selector or Scale Text Selector dialog box will open. Choose the scale bar or scale text you want by clicking it.



23. Click the *Properties* button to choose the scale settings. Once set, click *OK*. Then click *OK* on the Scale Bar/Text Selector dialog box.
24. If you choose to add a scale bar, and because you are adding a scale bar without map layers present, a message will appear reminding you that for the scale bar to display properly, you must specify what units the active data frame is using. Click *OK*.

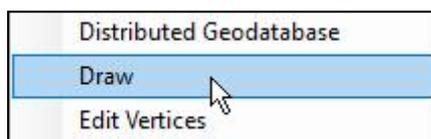


25. To add a north arrow, click *Insert > North Arrow...* from the main menu. The North Arrow Selector dialog box will open. Choose the north arrow style you want by clicking it. Click *OK*.

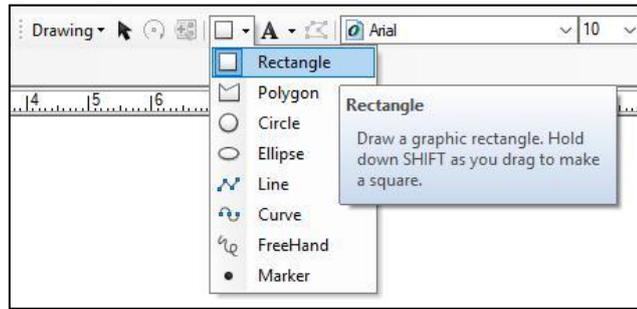


26. Position your north arrow by clicking and holding it then dragging it to the desired position. Resize the north arrow if necessary.

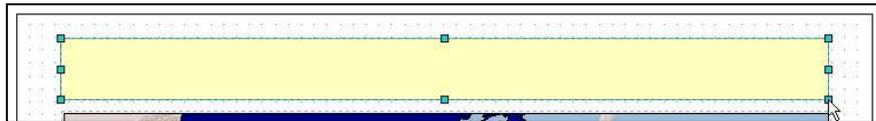
27. To add border/box to position the title, make sure that the Draw toolbar is visible. If this is not the case, right-click on anywhere on the Toolbar area and click *Draw* from the list of toolbars that appears.



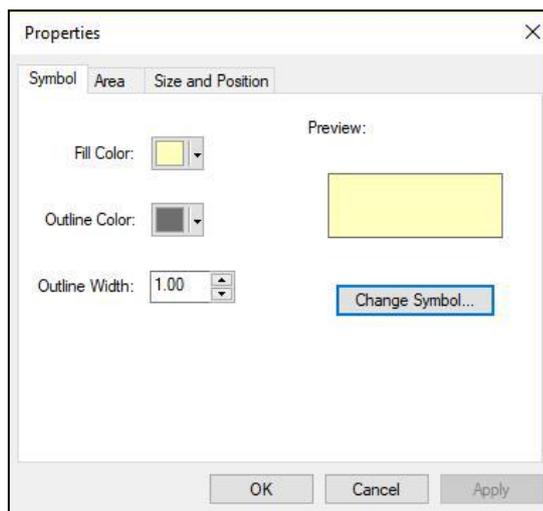
28. Click the dropdown menu and choose *Rectangle*.



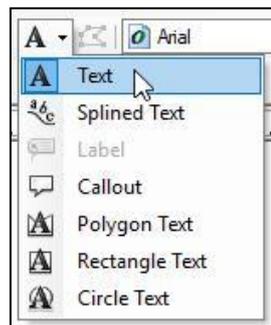
29. Click and drag the cursor in the position you want to create the box/border. To resize the box, click and drag the tiny box at the corners and sides to the correct size.



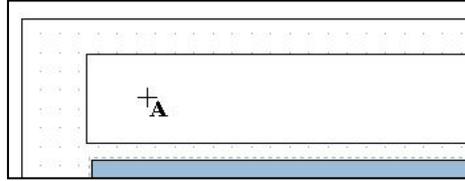
30. To change the fill and outline colors and the outline width, right-click on the box and choose *Properties*. Select the desired fill and outline colors and the outline width. Click *OK*.



31. Repeat steps 28 to 30 to add the border/box for the other map elements (map production date, disclaimer, additional information, etc.).
32. To add a text, click the dropdown menu beside the letter A on the Draw toolbar and choose *Text*.

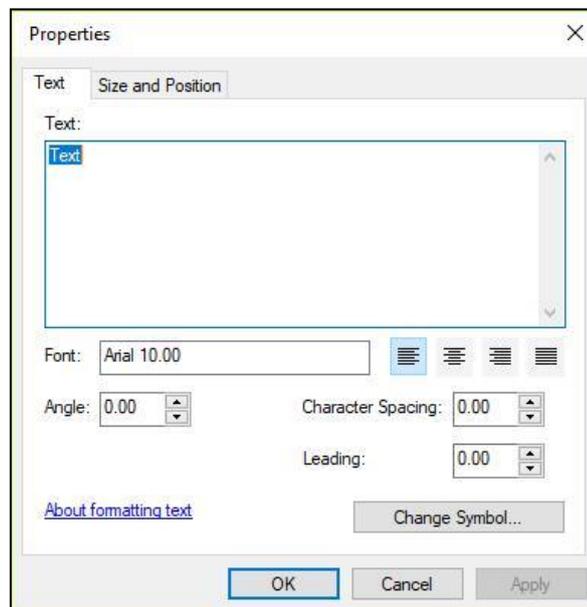


33. Click the Text cursor in the box you want to put the text in.

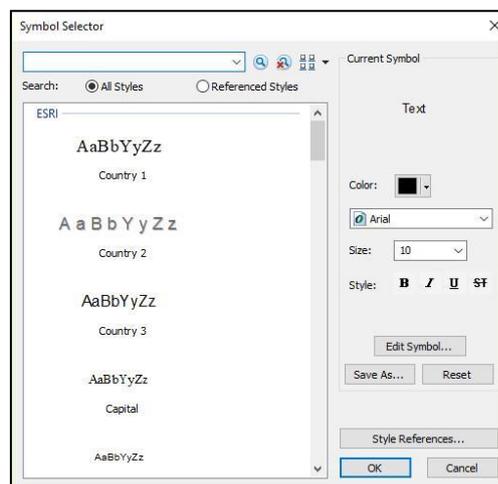


34. To edit the text, click the pointer button  on the Draw toolbar. Double-click the text you want to edit. The (Text) Properties dialog box will open. Enter the necessary text in the box.

As the title changes from one map to another, you can type in “MAP TITLE” as place holder for the moment and this will need to be changed once a new map is created using this template.



35. To modify the font, click the *Change Symbol* button. The Symbol Selector dialog box opens. Make the necessary changes then click *OK*. Then click *OK* on the (Text) Properties dialog box.



36. Repeat steps 32 to 35 to add the text for the other map elements (map production information, disclaimer, additional information, etc.)

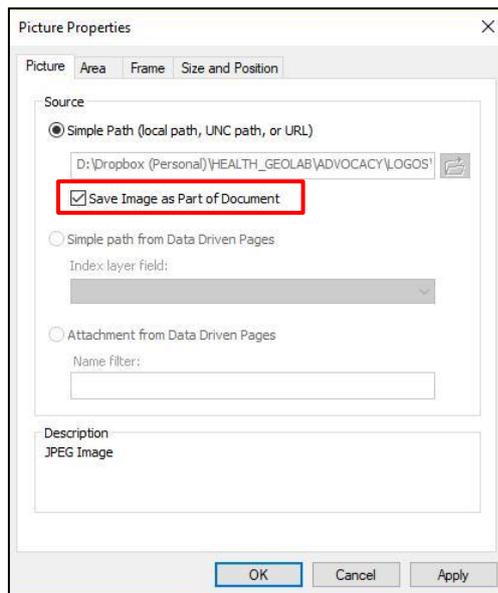
The map production information (except for the map creation date), disclaimer, and copyright would probably remain the same and do not need to be changed from one map to another.

For the other map element texts, create a place holder that you will need to change once a new map is created using this template.

37. To add a logo, click *Insert > Picture...* from the main menu. Go to the folder location of your logo then click *Open*.

38. Resize your logo as necessary and position it where desired.

39. To ensure that the logo remains attached with the template even if the logo image file is moved to a different folder or the template file is used in a different computer, right-click on the logo and choose *Properties...* In the Picture tab of the Picture Properties dialog box, check the box for *Save Image as Part of Document*. Click *OK*.



40. Review your map layout to make sure that the elements are complete, and the overall look is clean and balanced.

41. Once you are satisfied with your map template, click the *Save* button .

You have now successfully created a map template for use in ArcGIS.

Remember to save your template in the folder specified in Step 4 if not already done.

To create a map template for the other orientation, repeat all the steps but choose a different orientation in Step 9.

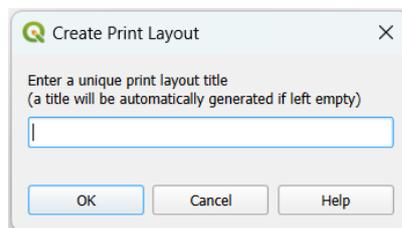
Annex 5 – Creating a map template in QGIS

This Annex describes the steps in creating a map template in QGIS Desktop version 3.34.

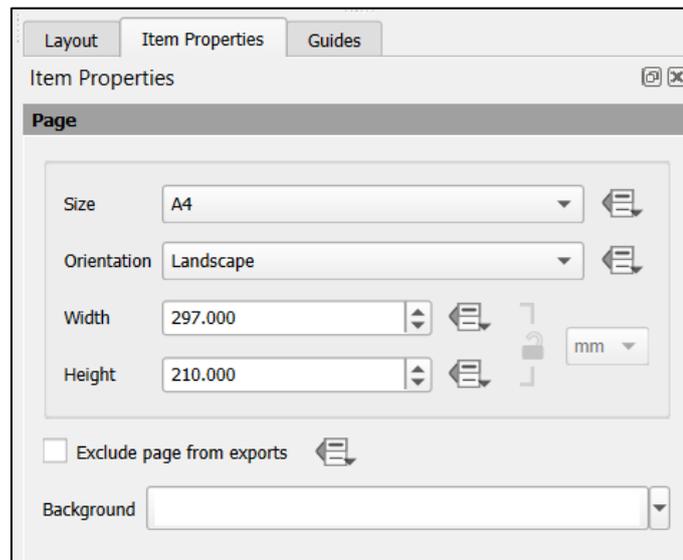
1. Open QGIS.
2. You will later save your work as a map template but to make sure you do not lose your work due to unfortunate circumstances, save your new map document by going to the main menu, click *Project > Save* or by clicking the *Save* button .
3. The Choose a QGIS project file dialog box opens. Go to the folder location you want to save your map document in.
4. Type in the name for your map document. Click *Save*.

Remember to periodically save your map document as you go through the next steps by clicking the *Save* button .

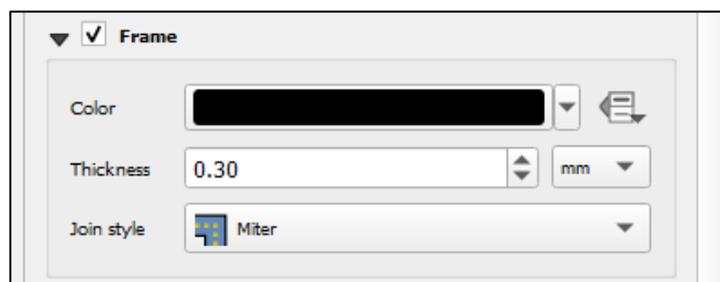
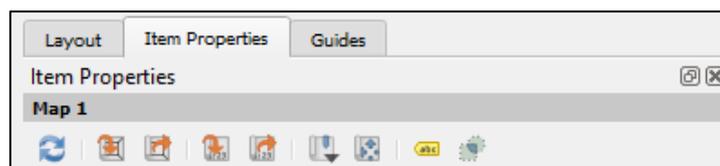
5. From the main menu, click *Project > New Print Layout*. A small dialog box will open asking you to create a unique title for your print layout. If you do not enter a title, one will be generated automatically for you. Enter a title if you want (e.g., Map Template Landscape or Map Template Portrait). Click *OK*. The Print Layout window opens.



6. Decide on the map orientation to create a template for. Visualize the placement of the map elements. If it would help, sketch your planned layout on a paper first. This will give you an idea of how all the map layout elements look together.
7. To set the page size and orientation, right-click on the blank page and click *Page Properties...* The Page section opens in the Item Properties tab on the lower right side of the window. Choose or set the page size and choose the orientation for your map template.



8. To help align the elements as you are positioning them, you can make the grid visible by clicking *View* from the main menu and activating *Show Grid*.
9. To add the map area to the layout, click the *Add Map* button  on the Toolbox toolbar.
10. Click and drag the cursor on the page to delineate the area you want to position the map area at.
11. On the Item Properties tab, scroll down and check the box beside the *Frame* section title. This will create a border for the map area and help you visualize its position. (The default is white background with no border which makes the map area invisible when not selected.)

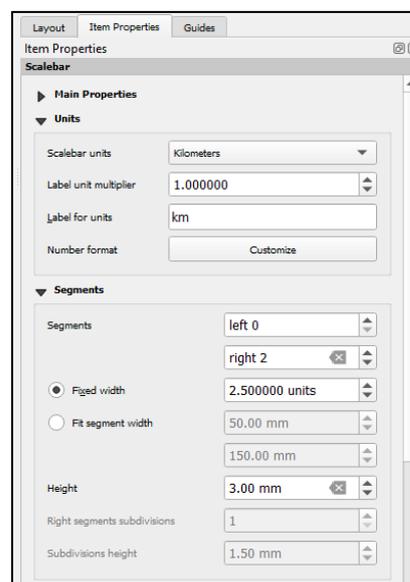


12. To add the legend, click the *Add Legend* button  on the Toolbox toolbar. Click on the map where you want the legend to appear. As this is a map template, it does have any legend items yet. To adjust its position, click and drag it to the desired position.

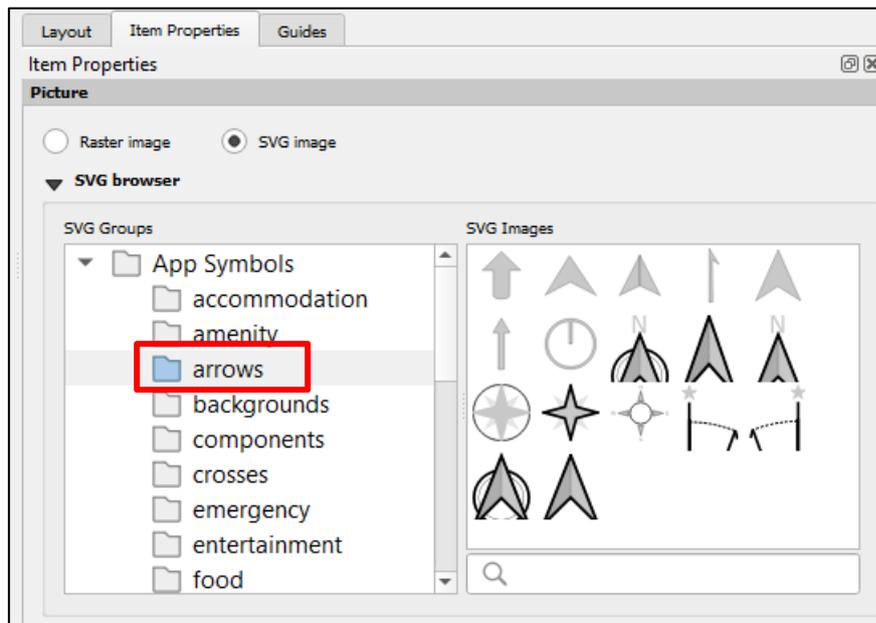
13. In the Item Properties tab, in the Main Properties section, type 'Legend' in the Title field.
14. Still on the Item Properties tab, scroll down and check the box beside the Frame section title. This will create a border around the legend and help you visualize its position. As you do not yet have any legend items, the frame will just be around the legend title.



15. To add a scale bar, click the *Add Scale Bar* button  on the Toolbox toolbar. Click on the map where you want the scalebar to appear. To adjust its position, click and drag it to the desired location.
16. To change the scale bar properties, click on the scale bar to select it. In the Item Properties tab, modify the style, units, segments, etc. to your preferred settings.



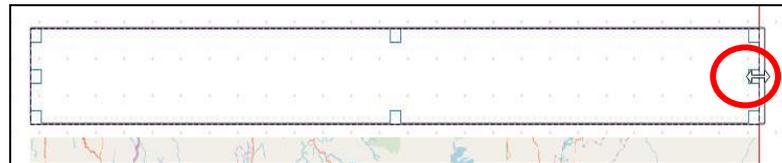
17. To add a north arrow, click the *Add North Arrow* button  on the Toolbox toolbar. Click and drag the cursor where you want to position the north arrow.
18. In the Item Properties tab, expand the *SVG browser* section and click the *arrows* subfolder. Select the north arrow style you want from the available styles.



19. To add border/box to position the title, click the dropdown menu on the *Add Shape*

button  on the Toolbox toolbar and choose *Add Rectangle*.

20. Click and drag the cursor in the position you want to create the box/border. To resize the box, click and drag the tiny box at the corners and sides to the correct size.

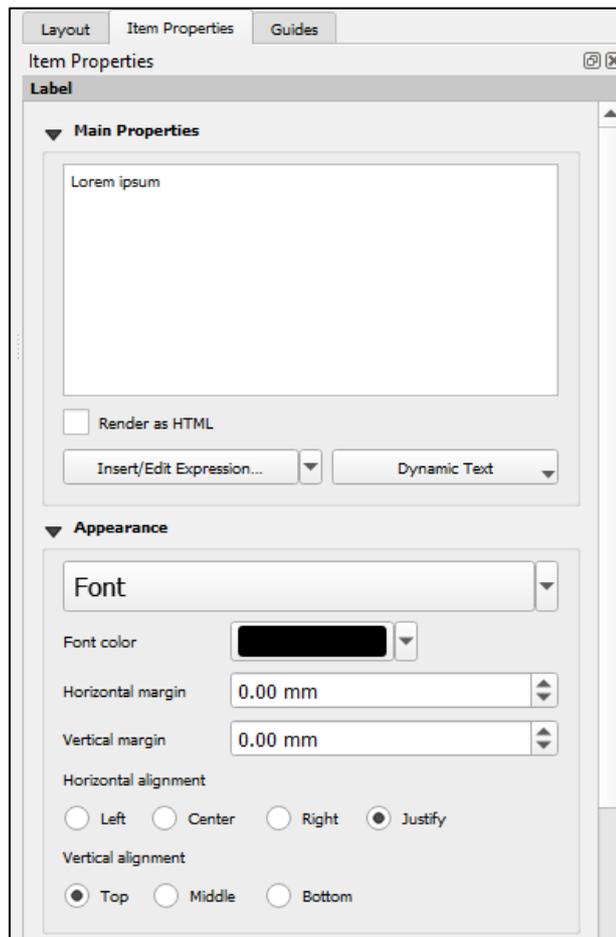


21. Repeat steps 19 to 20 to add the border/box for the other map elements (map production information, disclaimer, additional information, etc.).

22. To add the title, click the *Add Label* button  on the Toolbox toolbar. Click and drag the cursor in the position you want to create the title inside the box.

23. In the Item Properties tab, you can change the text in the Main properties section. You can change the font type and color, margin, and alignment in the Appearance section.

As the title changes from one map to another, you can type in "MAP TITLE" as place holder for the moment and this will need to be changed once a new map is created using this template.



24. Repeat steps 22 to 23 to add the text for the other map elements (map production information, disclaimer, additional information, etc.)

The map production information (except for the map creation date), disclaimer, and copyright would probably remain the same and do not need to be changed from one map to another.

For the other map element texts, create a place holder that you will need to be changed once a new map is created using this template.

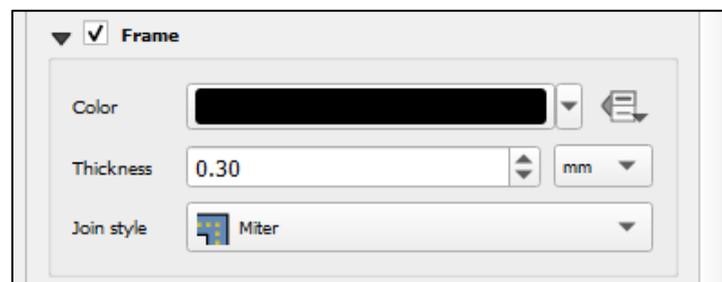
25. To add a logo, click the *Add Picture* button  on the Toolbox toolbar. Click and drag the cursor where you want to position the logo.

26. In the Item Properties tab, click the Raster image radio button and click the *Browse* button. The *Select Image File* dialog box opens. Go to the folder where the logo image file is located, select the image, and click *Open*. Resize and reposition the logo if needed.



Note: QGIS looks for the logo image file in the image source path that is saved in the map template file. If the image file name or location changes, the logo will not appear the next time you open the map template and you will have to browse for its new location path. It is therefore advisable to save the logo image file in the same folder as the map template to make this step easier.

27. To add an inset map area to the template, click the *Add Map* button  on the Toolbox toolbar.
28. Click and drag the cursor on the page to delineate the area you want to position the inset map at.
29. On the Item Properties tab, check the box beside the Frame section title. This will create a border for the inset map and help you visualize its position. (The default is white background with no border which makes the inset map area invisible when not selected.)



30. Review your map layout and make sure that the elements are complete, and the overall look is clean and balanced.
31. Once you are satisfied with your map template, click *Layout > Save as Template...* from the main menu or click the *Save as template* button . The Save template dialog box opens.
32. Go to the folder location where you want to save your template in, type in a file name, and click *Save*.

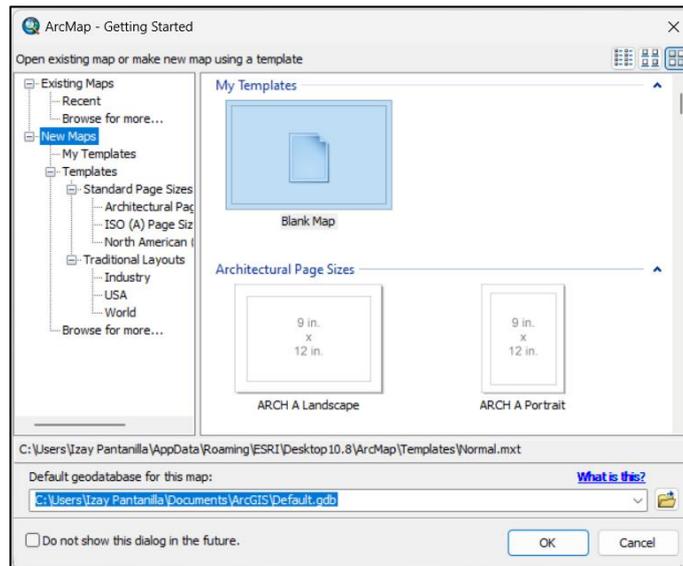
You have now successfully created a map template for use in QGIS.

To create a map template for the other orientation, repeat all the steps but choose the other orientation in Step 7.

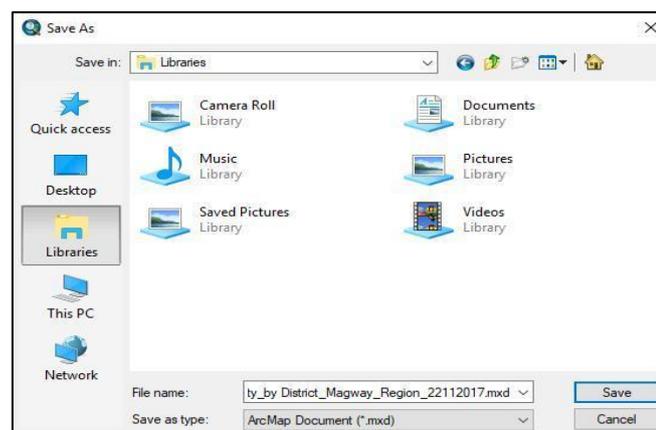
Annex 6 – Creating a thematic map using a map template in ArcMap

This Annex describes the steps in creating a thematic map in ArcMap (version 10.8) using a map template.

1. Open ArcMap.
2. When the ArcMap – Getting Started dialog box opens, click *New Maps* from the left side menu then click the icon for the *Blank Map*. Click *OK*.



3. Save your new ArcMap document by going to the main menu, click *File > Save* or by clicking the *Save* button .
4. As this is the first time you are saving the ArcMap document, the *Save As* dialog box will open. Go to the folder location you want to save your ArcMap document in.



5. Type in the name for your ArcMap document. Click *Save*.

IMPORTANT NOTE: Remember to periodically save your ArcMap document as you go through the next steps. This ensures that your work is saved even if the GIS software or your computer suddenly crashes.

6. From the main menu, go to *File > Add Data > Add Data...* or click the *Add Data* button



to add the prepared data to your map template.

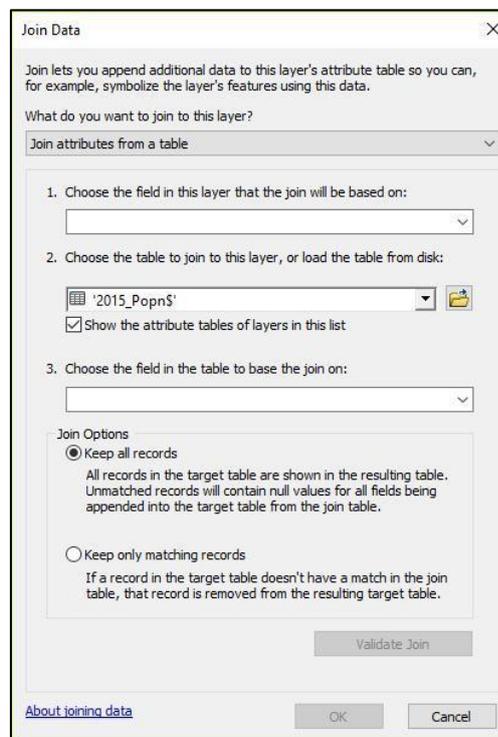
7. Go to the folder location of your prepared data. Select the data you need then click *Add*.

You may add more than one data from the same folder by pressing the Control (Ctrl) key on your keyboard while clicking on the data you need to add.

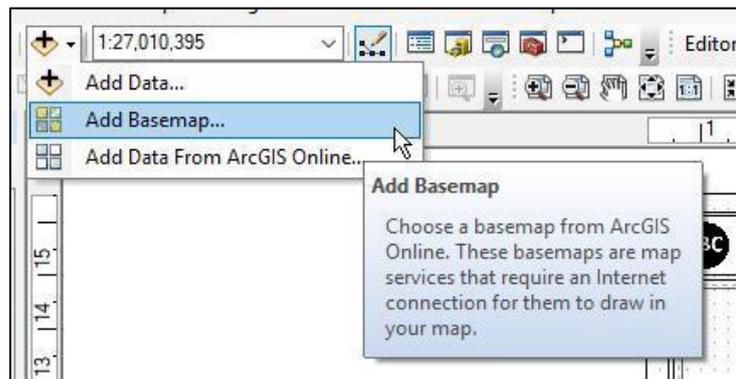
You will have to repeat steps 6 - 7 if your data are in different folders.

Make sure to add both the geospatial and statistical data. Ensure that both use the same coding scheme to uniquely identify each of the geographic objects present in both the geospatial and statistical data as this will allow the statistical data to be joined to the geospatial data.

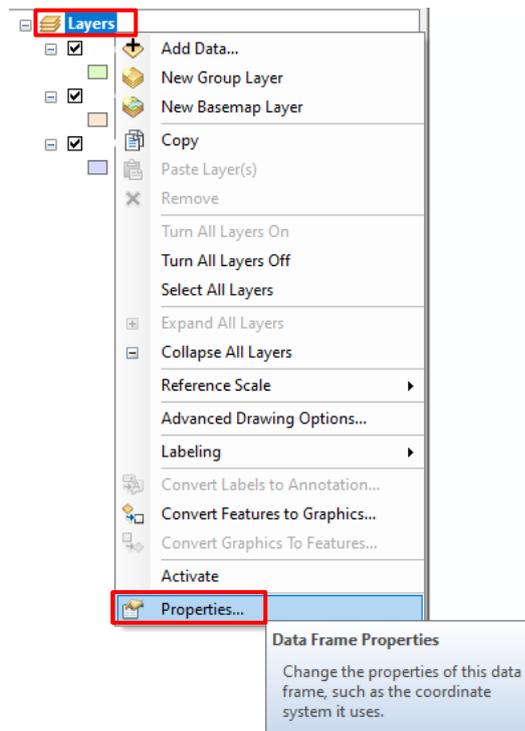
8. To join a geospatial data to a table, right-click on the geospatial data, click *Join and Relates > Join...*
9. The Join Data dialog box opens. Choose the appropriate fields (fields containing the unique identifier) and the correct table to join the layer.



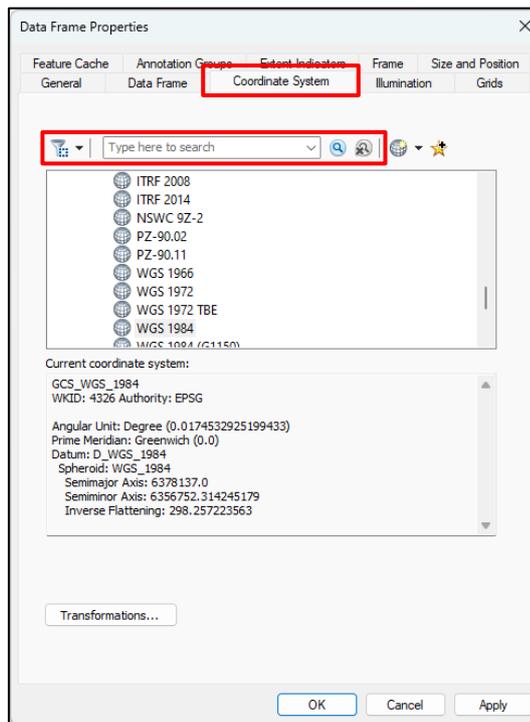
10. Add a basemap by going to *File > Add Data > Add Basemap...* or by clicking the dropdown button beside the *Add Data* button and clicking *Add Basemap...*



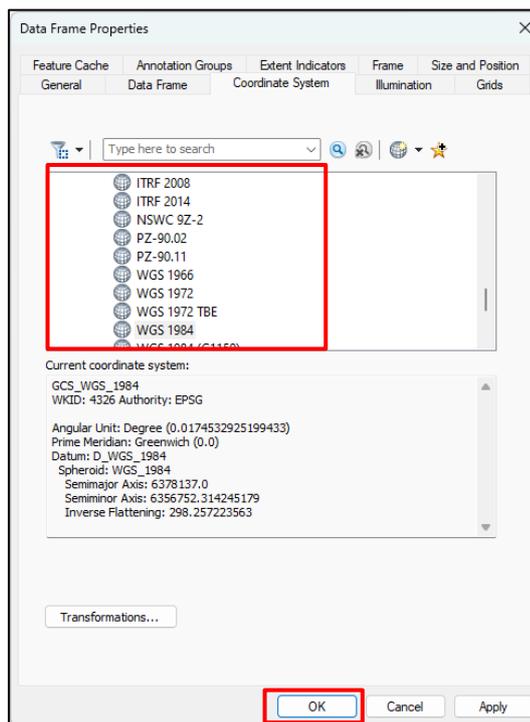
11. Select the appropriate basemap then click *Add*.
12. Decide if the GCS or PCS needs to be adjusted to match the map's purpose. If not, proceed to step 20. If yes, proceed to the next step.
13. Right-click on the name of the data frame you would like to change the GCS or PCS of and choose *Properties...*



14. The Data Frame Properties dialog box opens. Click on the Coordinate System tab. Navigate to the desired coordinate system for your map display. To help narrow down the choices, you can filter the coordinate systems by performing a Spatial Filter, a String Filter, or a combination of the two.

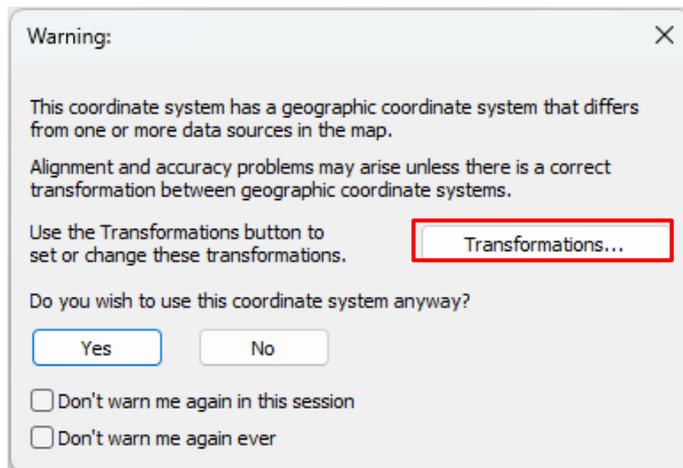


15. Select the desired coordinate system from the list and click *OK*.



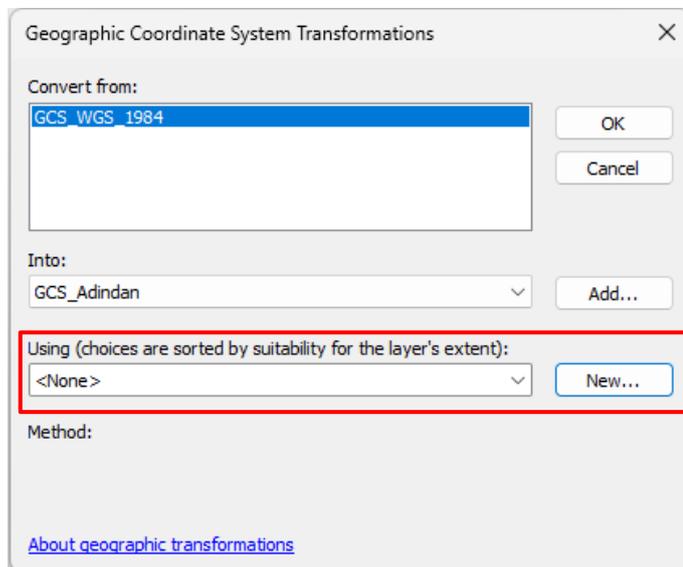
Note: Changing the coordinate system of the data frame does not change the native GCS or PCS of the geospatial data being used to create the map.

16. You will get a warning message when changing from one geographic coordinate system to another. Click *Transformations...* button.

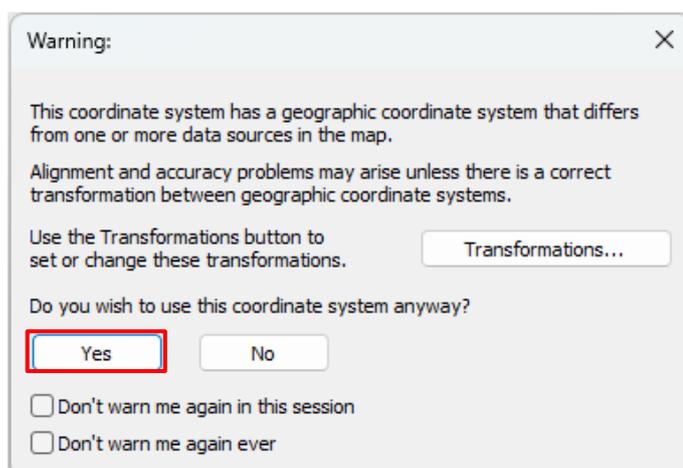


Note: You can learn more about geographic transformation from this source.²⁶

17. Choose the appropriate transformation when available or specify a new one. Click *OK*.

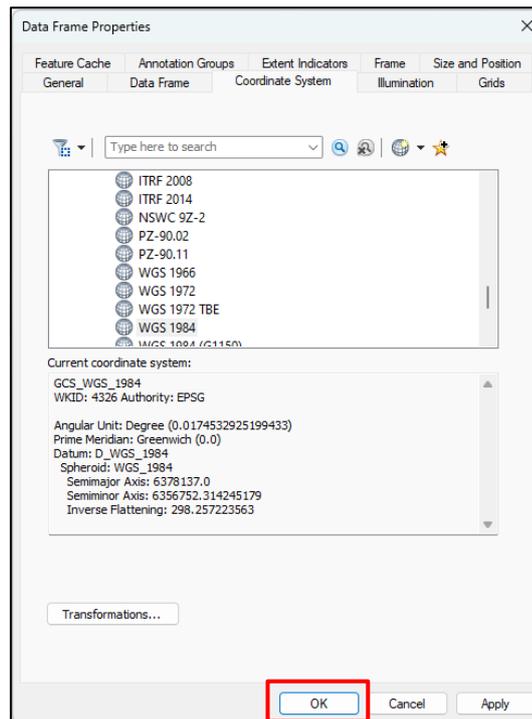


18. Click *Yes*.



²⁶ <https://www.esri.com/arcgis-blog/products/product/mapping/about-geographic-transformations-and-how-to-choose-the-right-one/>

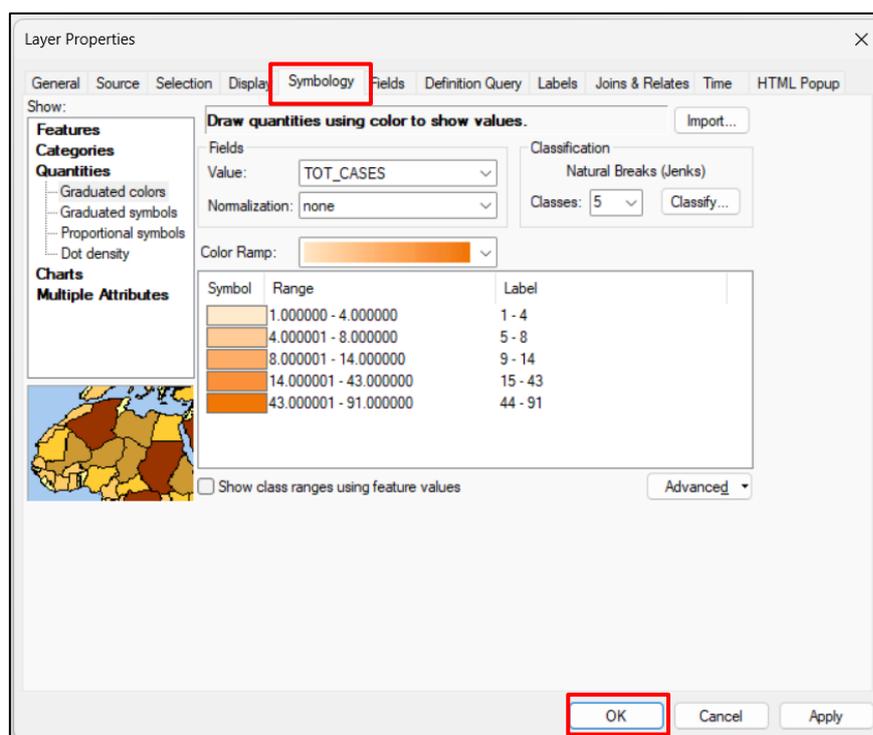
19. Click *OK* in the Data Frame Properties dialog box.



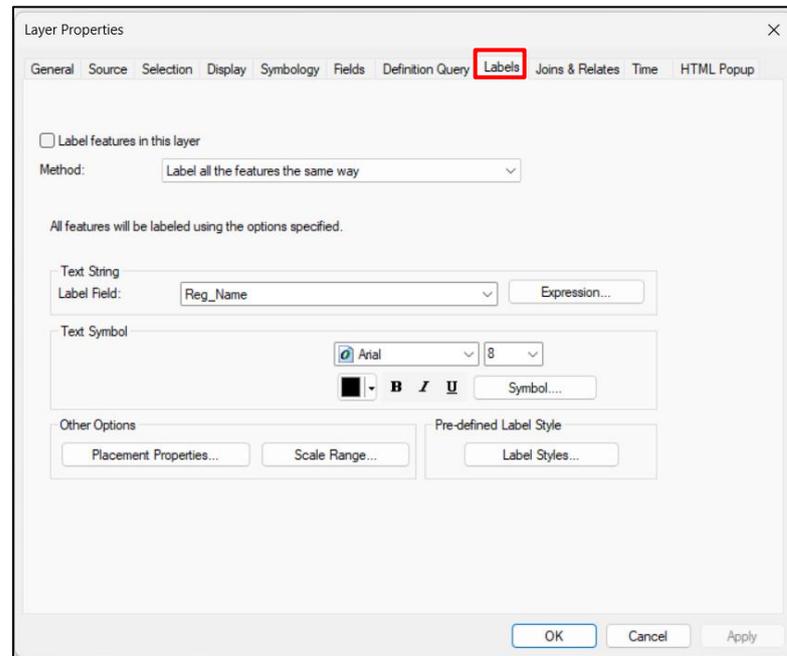
20. Decide on the appropriate mode of representation for your data. (In this example, the data will be presented as a choropleth map.)

21. Symbolize your data by right-clicking on your geospatial layer then click *Properties...*

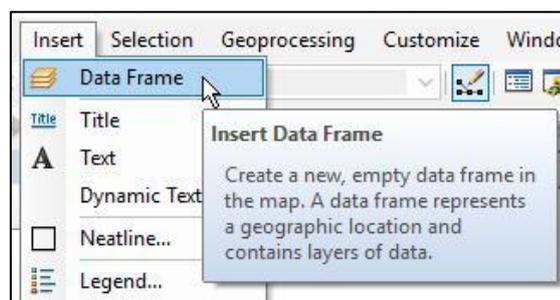
22. The Layer Properties dialog box opens. Go to the Symbology tab. On the left side bar, choose the mode of representation. Adjust the different parameters. Click *OK*.



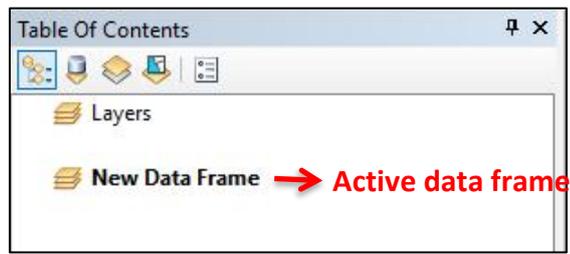
23. If you are not satisfied with how your data is symbolized, you may go back to the Symbology tab to adjust the symbology accordingly.
24. Add labels to your map by right-clicking on the geospatial layer you would like to put a label on then click *Properties...*
25. The Layer Properties dialog box opens. Go to the Labels tab. Check the box *Label features in this layer* by clicking it.



26. In the Label Field, choose the field from your geospatial data that you would like to serve as the label. Alternatively, you may choose to use an expression to label your data.
27. Adjust the font type and size of the label to suit your map. Click *OK*.
28. If you are going to add an inset map and the template you are going to use has a space allocated for one, click *Insert > Data Frame*. A New Data Frame will appear in the Table of Contents.



29. Before adding the data/layer for the inset map, ensure that the New Data Frame is the active data frame. You can tell this by looking at the Table of Contents section. The data frame in **bold** font is the active data frame. To switch from one data frame to another, right-click on the data frame you need to work on and click *Activate*.

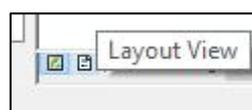
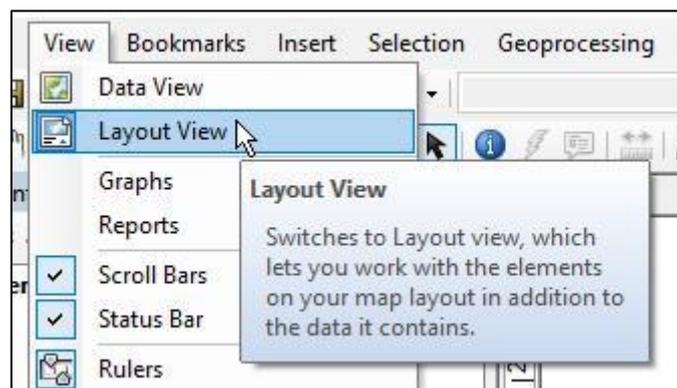


30. Add, symbolize, label (if needed) the data for the inset map by following the relevant steps in steps 6 to 27 as necessary.

31. Once all the data are properly symbolized and labeled, proceed to creating the map layout.

Note: The orientation of the map layout to be created should already be known at this point.

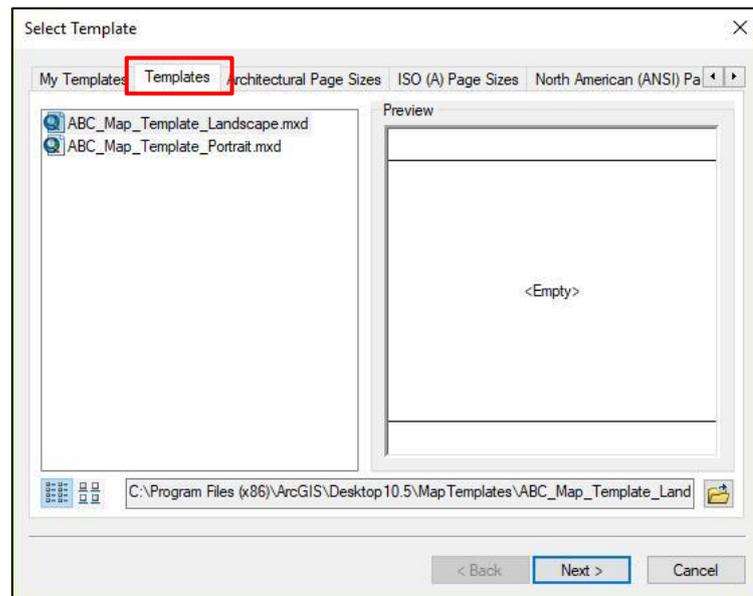
32. Go to Layout View by going to the main menu, click *View > Layout View* or by clicking the *Layout View* button (second button) at the bottom beside the Table of Contents pane. The Layout View immediately shows the data you have symbolized and labeled.



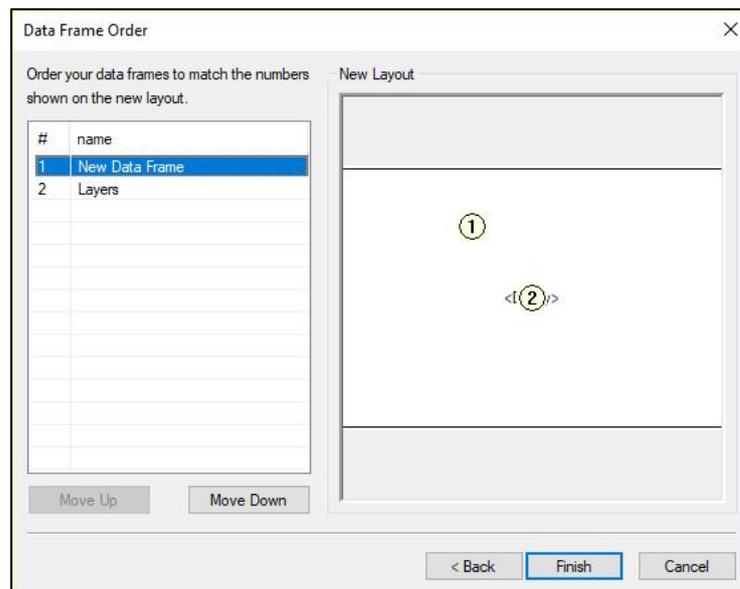
33. To select a predefined template, click the *Change Layout* button  on the Layout toolbar.

If the Layout toolbar is not visible, right-click anywhere on the Toolbar area and click *Layout* from the list of toolbars that appears.

34. The Select Template dialog box opens. To use a template you created, go to the Templates tab and select the appropriate template from the list. Click *Next*.



35. In the next window, order your data frames to match the number shown on the layout by using the *Move Up* or *Move Down* buttons. This applies if you have more than one data frame in your map document (e.g., one main map and one inset) or your template has a space allocated for an inset map. Otherwise, just click *Finish*.



36. You now have your map in your selected map template. Ensure that the focus of your map is at the center of the map area. Move your map if it is not centered by clicking on the main map area and using the zoom in, zoom out, and pan buttons on the Tools toolbar

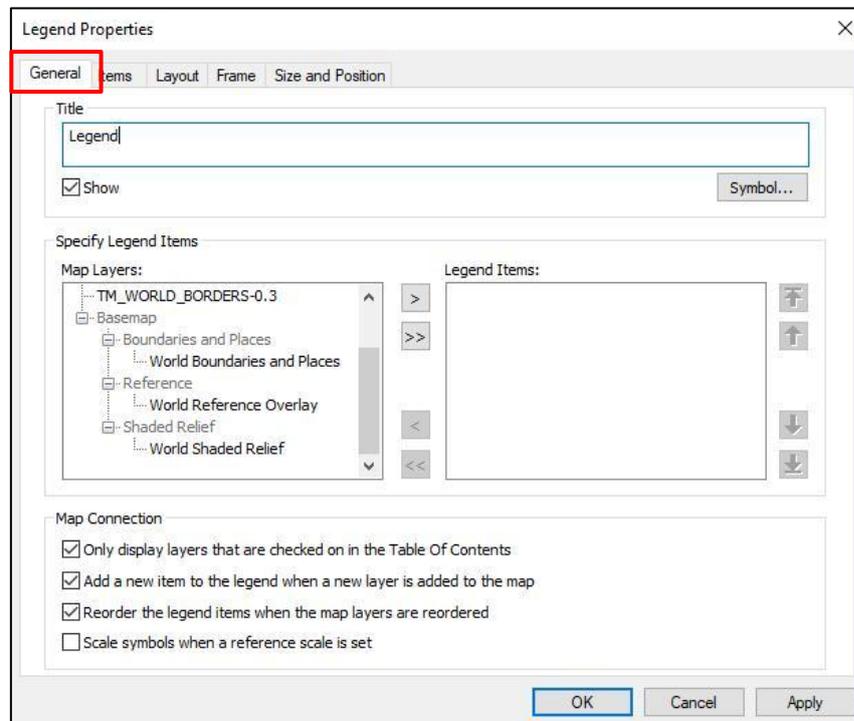


37. Do the same for the inset map (if you have one) by clicking first on the inset map before zooming in and out and panning the map.

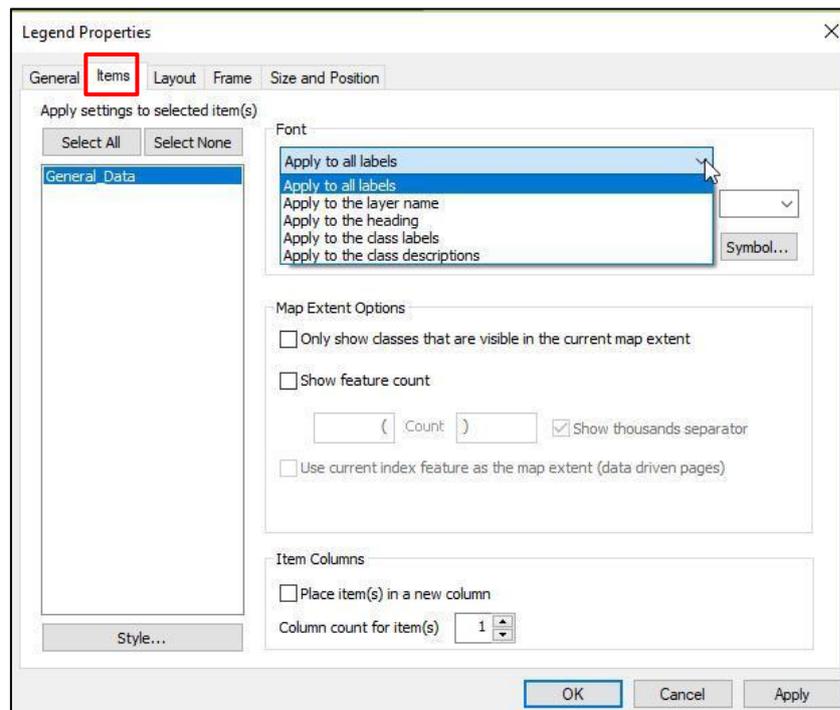
38. To change the legend, double-click on the legend and the Legend Properties dialog box opens.

39. In the General tab, in the Specify Legend Items section, choose the map layer/s you want to appear in the legend then click the forward arrow to add it/them to the Legend Items box.

You may also set how the legend items react when changes are made to the map layers in the Map Connection section.

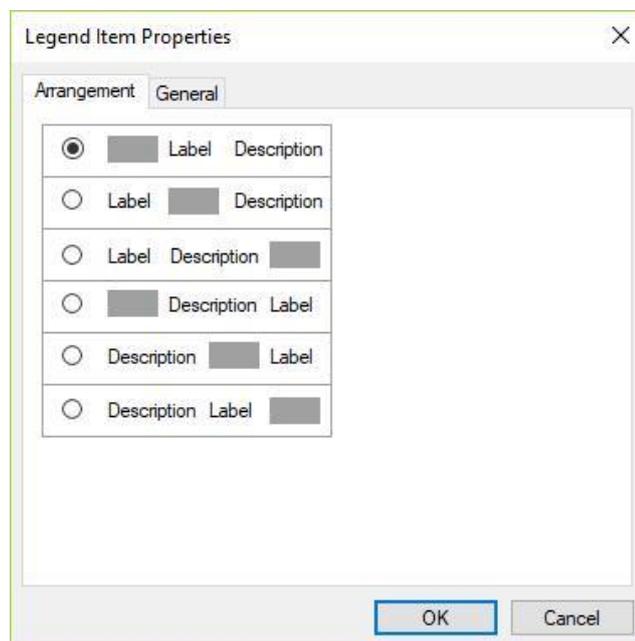
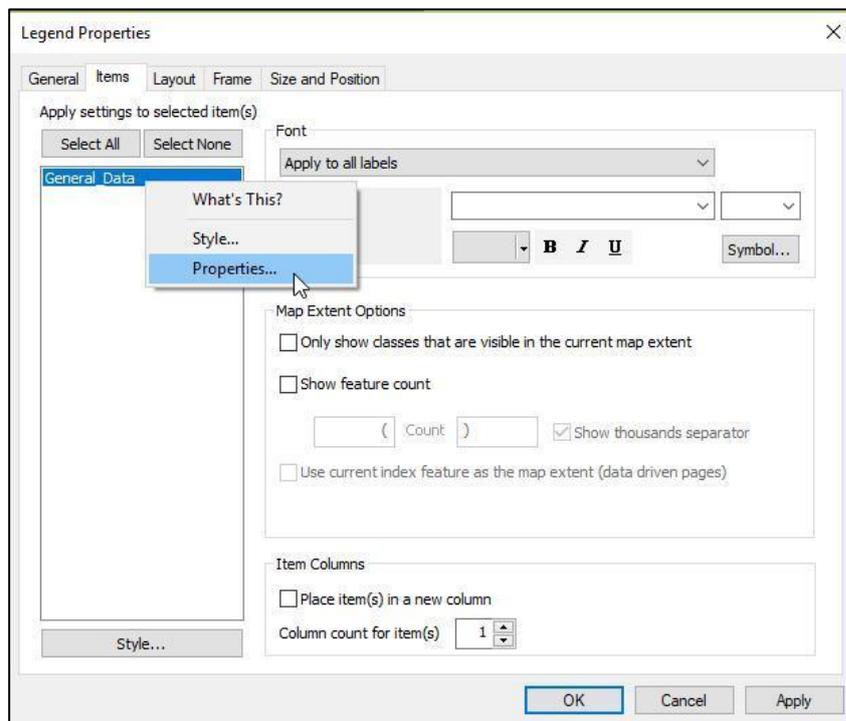


40. In the Items tab, you can change how the label of the map layer appears in the legend.



41. Right-click on the data and click *Properties...* then Arrangement tab to be able to change how the map layer's symbol, label, and description are ordered.

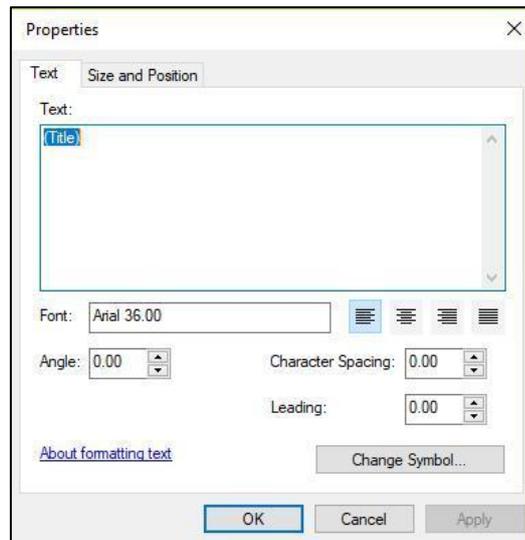
Click the General tab to choose which of the labels of the map layer should appear. Click *OK*.



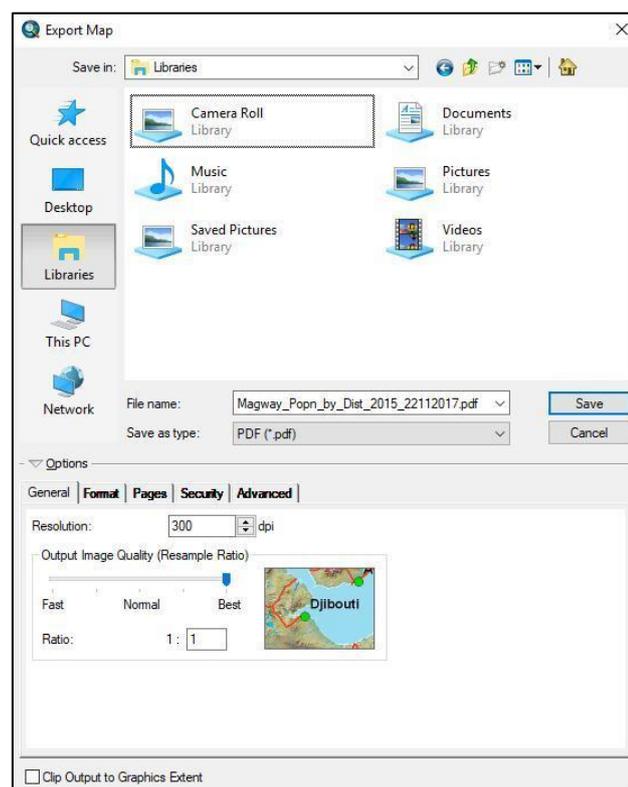
42. In the Layout tab, you can change the gaps between the different items in your legend, change the size of the patch or symbol, allow text wrapping, and set how to fit the legend.

43. Once you have set your legend, click *OK*.

44. Add the title, map production date, project file name, and additional information (if needed) by double-clicking on the text placeholder to modify it. The (text) Properties dialog box opens. Enter the necessary text in the box.



45. To modify the font, click the *Change Symbol* button. The Symbol Selector dialog box opens. Make the necessary changes then click *OK*.
46. Review your map layout to make sure that the elements are complete, and the overall look is clean and balanced.
47. Once you are satisfied with your map, click *File > Export Map...* from the main menu.
48. The Export Map dialog box opens. Go to the folder location you want to save your map layout in.



49. Type in the file name for your final map layout.

50. Select the appropriate file format.

51. In the Options section below (expand if needed), in the General tab, set the resolution to at least 300 dpi. Adjust the other settings as needed for your map.

52. Click *Save*.

You have now successfully created your own thematic map using ArcGIS.

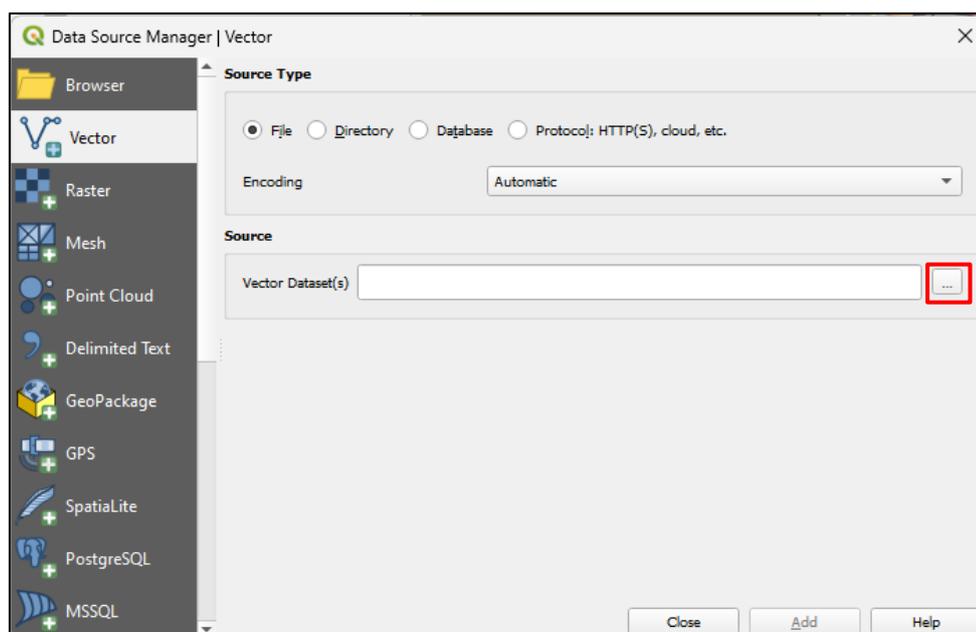
Annex 7 – Creating a thematic map using a map template in QGIS

This Annex describes the steps in creating a thematic map in QGIS Desktop version 3.34 using a map template.

1. Open QGIS.
2. Create a new map document by going to the main menu, click *Project > New*.
3. Save your new map document by going to the main menu, click *Project > Save* or by clicking the Save button .
4. The Choose a QGIS project file dialog box opens. Go to the folder location you want to save your map document in.
5. Type in the name for your map document. Click *Save*.

IMPORTANT NOTE: Remember to periodically save your map document as you go through the next steps. This ensures that your work is saved even if the GIS software or your computer suddenly crashes.

6. From the main menu, go to *Layer > Add Layer > Add Vector Layer* or click the *Add Vector Layer* button  to add the prepared data to your map document.
7. The Data Source Manager dialog box opens. Go to the folder location of your prepared data.



8. Select the data you want to add then click *Open*. (As a shapefile is composed of several files, choose the file with the “.shp” file extension.)

You may add more than one data from the same folder by pressing the Control (Ctrl) key on your keyboard while clicking on the data you need to add.

9. Click *Add*.

You will have to repeat steps 7 - 9 if your data are in different folders.

Make sure to add both the geospatial data and statistical data. Ensure that both use the same coding scheme to uniquely identify each of the geographic objects present in both the geospatial and statistical data as this will allow the statistical data to be joined to the geospatial data.

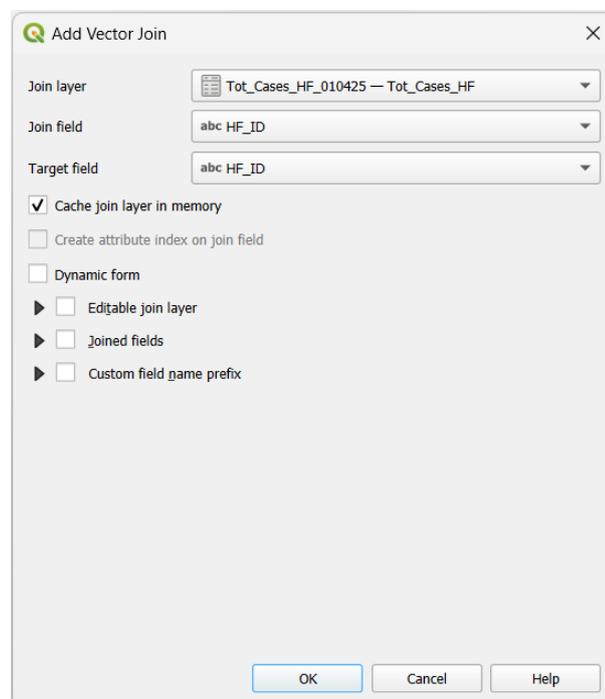
10. Once all the needed data are added close the Data Source Manager dialog box.

11. To join a geospatial data to a table, right-click on the geospatial data, click *Properties*.

12. The Layer Properties dialog box opens. Click *Joins* from the left-hand menu then click

the plus sign  on the bottom left.

13. The Add Vector Join dialog box opens. Choose the layer to join (statistical data) and the join and target fields (fields containing the unique identifier). Click *OK*.



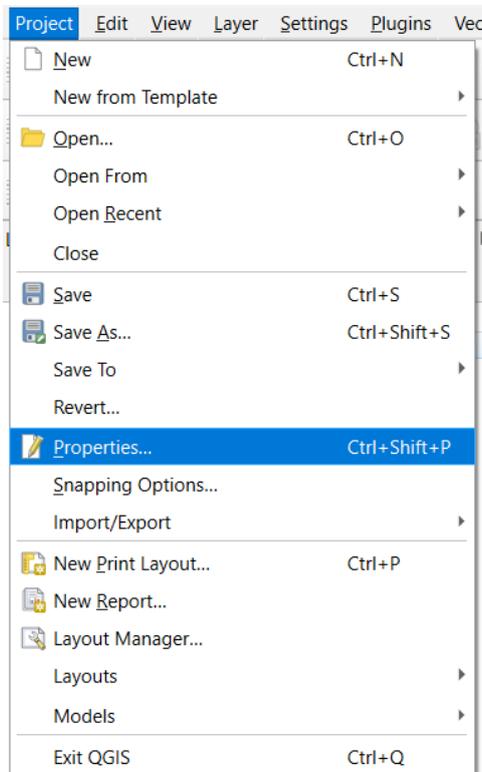
14. Click *Apply* then *OK* in the Layer Properties dialog box.

15. Add a basemap by going to *Web > QuickMapServices* from the main menu or by clicking the *QuickMapServices* button  in the Web toolbar. Select the appropriate basemap.

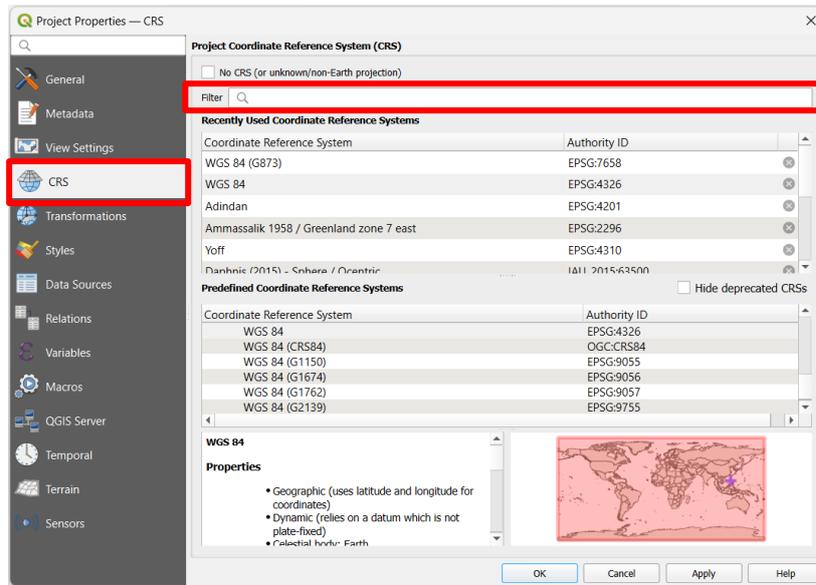
This step will only work if you have installed the Quick Map Services plugin. If this is not the case, click *Plugins > Manage and Install Plugins...* from the main menu. The Plugins dialog box will open. In the Search field, type “QuickMapServices.” Once it appears, click it and click the *Install plugin* button on the lower right side. Wait for the plugin to install then close the plugin dialog box.

16. Decide if the GCS or PCS needs to be adjusted to match the map’s purpose. If not, proceed to step 21. If yes, proceed to the next step.

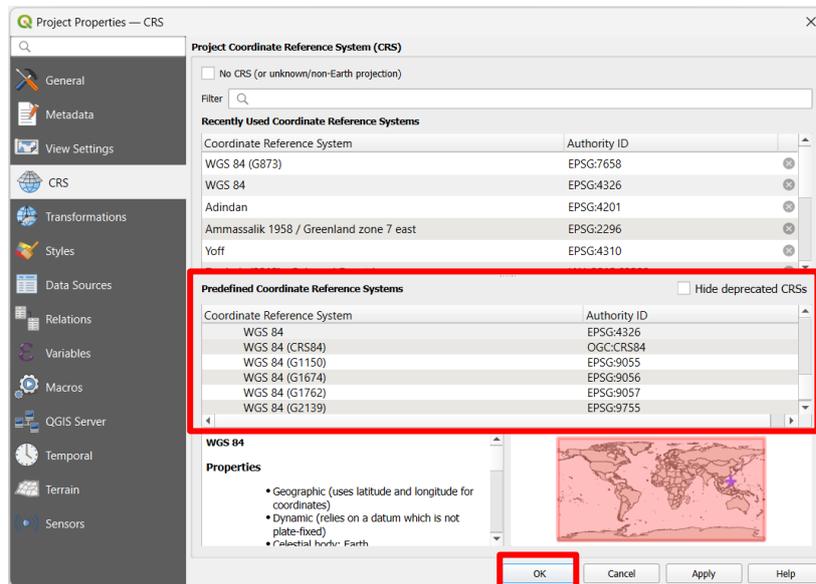
17. From the main menu, go to *Project > Properties...*



18. The Project Properties dialog box opens. Click on the CRS tab. Navigate to the desired coordinate system for your map canvas. To help narrow down the choices, you can filter the coordinate systems by entering the coordinate system you would like to use or key words.

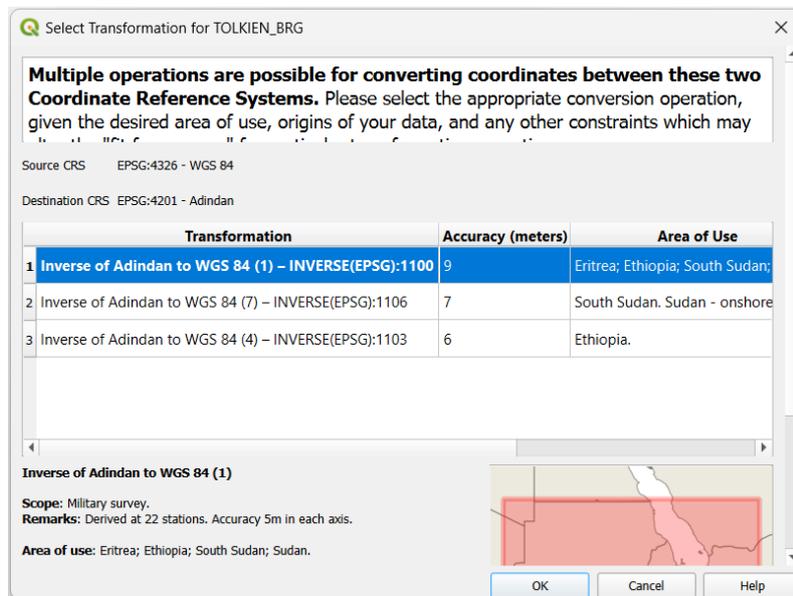


19. Select the desired coordinate system from the list and click *OK*.



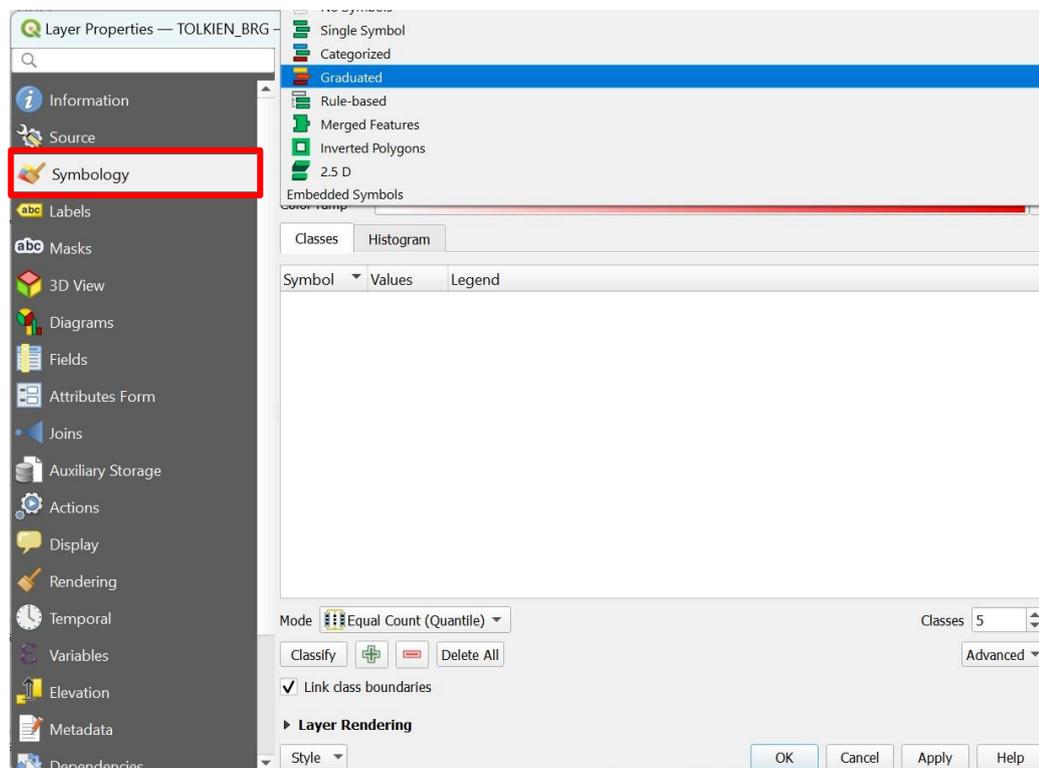
Note: Changing the coordinate system of the data frame does not change the native GCS or PCS of the geospatial data in the data frame.

20. You will be prompted to select a geographic transformation to use when changing from one geographic coordinate system to another (similar to the image below). Choose the appropriate transformation and click *OK*.



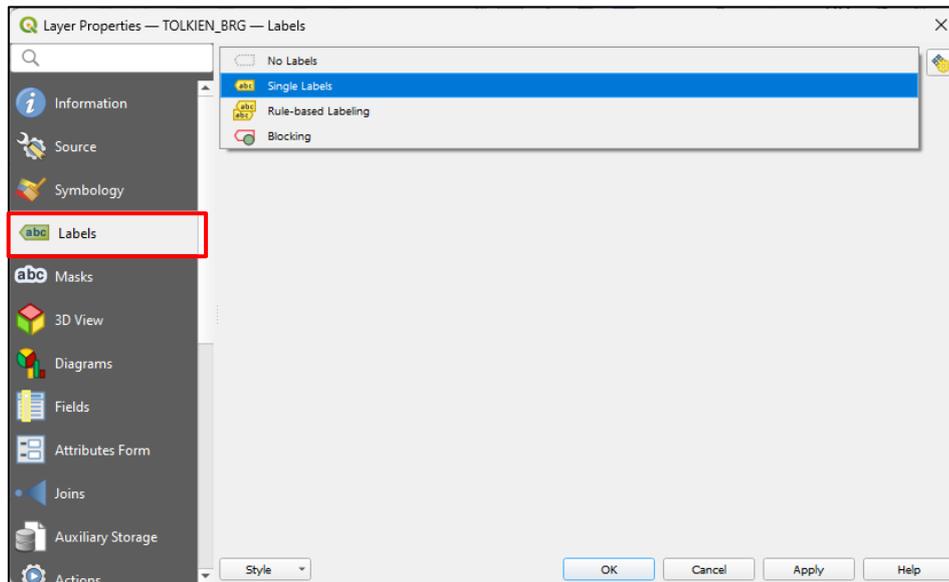
Note: You can learn more about geographic transformation from this source.²⁷

21. Decide on the appropriate mode of representation for your data. (In this example, the data will be presented as a choropleth map.)
22. Symbolize your data by right-clicking on your geospatial data then click *Properties*.
23. The Layer Properties dialog box opens. Click *Symbology* from the left-hand menu. From the dropdown menu, choose how to show your data to correspond to your chosen mode of representation. Adjust the different parameters. Click *OK*.

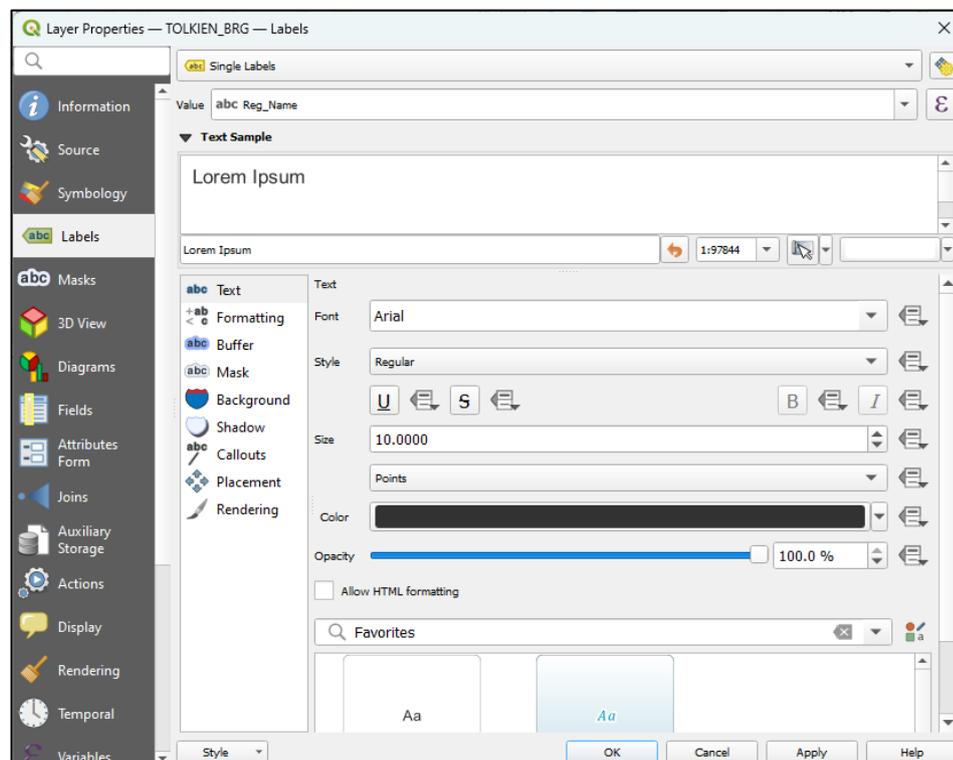


²⁷ <https://www.esri.com/arcgis-blog/products/product/mapping/about-geographic-transformations-and-how-to-choose-the-right-one/>

24. If you are not satisfied with how your data is symbolized, you may go back to the *Symbology* tab to adjust the symbology accordingly.
25. Add labels to your map by right-clicking on your geospatial data you would like to put a label on then click *Properties*.
26. The Layer Properties dialog box opens. Go to the *Labels* tab. From the dropdown list, choose *Single labels*.



27. In the *Value* field, choose the field from the geospatial layer that you would like to use as its label. Alternatively, you may choose to use an expression to label your data.



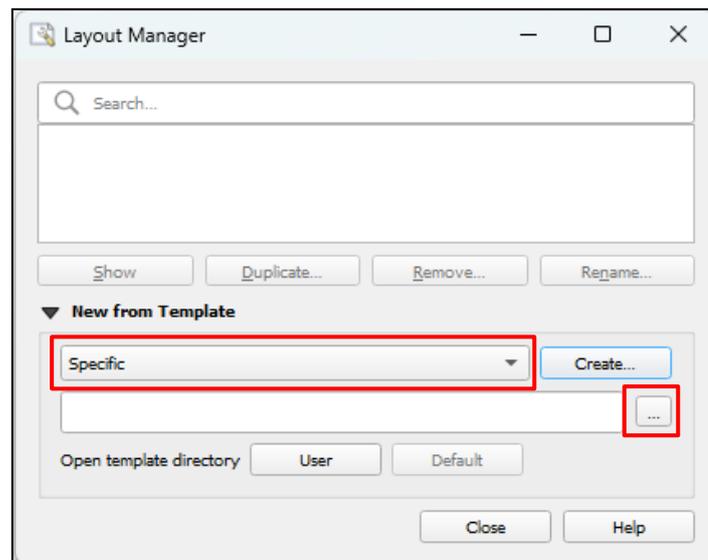
33. Adjust the font type and size and other settings of the label to suit your map. Click *OK*.

34. Once all the data are properly symbolized and labeled, proceed to creating the map layout.

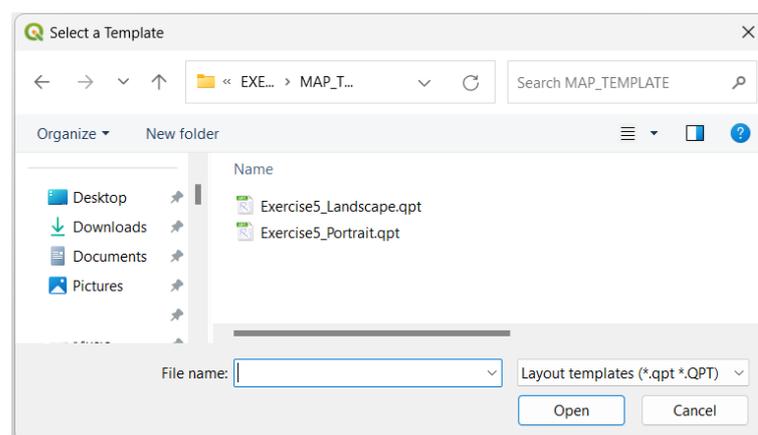
Note: The orientation of the map layout to be created should already be known at this point.

28. To start creating the layout for your map, click *Project > Layout Manager...* from the main menu.

29. The Layout Manager dialog box opens. To choose the template, in the New from Template section dropdown list, choose *Specific* then click the *Browse* button.



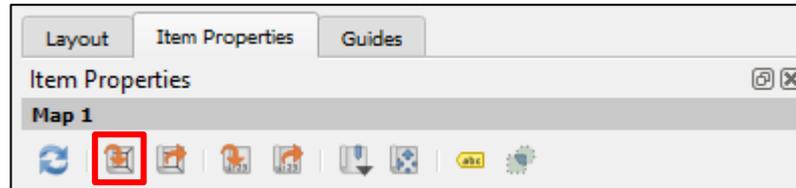
30. The Select a Template dialog box opens. Go to the folder location of your map templates. Choose the template for the map orientation that would best fit your data. Click *Open*.



31. Click *Create* in the Layout Manager dialog box then type in a unique print layout title in the field that appears. (Otherwise, a title will be generated for you.) Click *OK*.

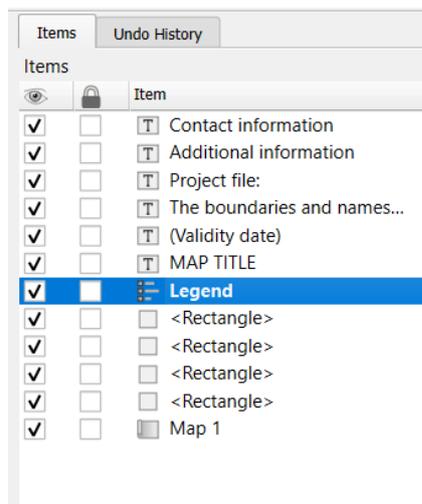
32. The map template will open in a new window and you will now see your symbolized data on the map template. Check that the focus of your map is at the center of the map area. Adjust it as necessary.

- a. If you just need to pan/move your map, use the *Move item content* button  on the Toolbox toolbar.
- b. If you need to zoom in or out on the map, go back to the main QGIS window (the one where you symbolized your layers) and use the *Zoom In* or *Zoom Out* button on the Map Navigation toolbar. Then go back to the Print Layout window and click *Set Map Extent to Match Main Canvas Extent* button in the Item Properties tab.



Repeat these steps until you have centered your map.

33. To edit the legend, click on the legend in the map template or in the Items list.



34. In the Items Properties tab, go to the Legend items section and click the *Update all* button to ensure all legend items are listed.

35. Make sure that the *Auto update* button is unchecked. Doing this will allow you to edit the legend items.

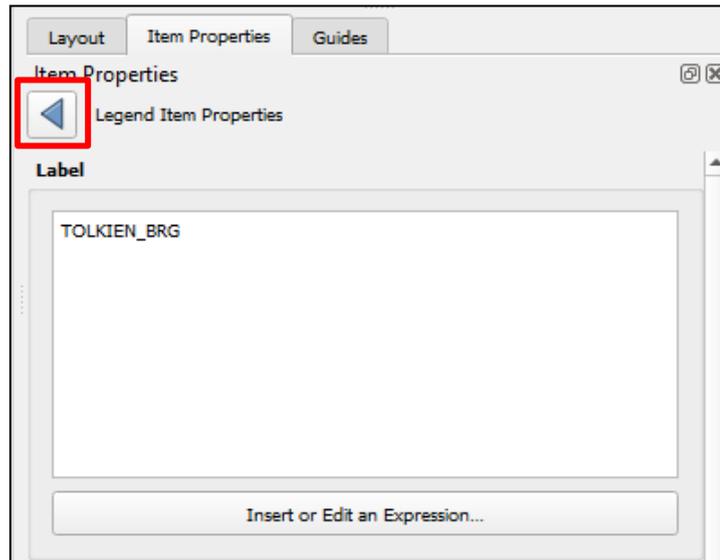


36. To move an item down or up on the list, click the item then use the *Down* or *Up* buttons   found below the list.

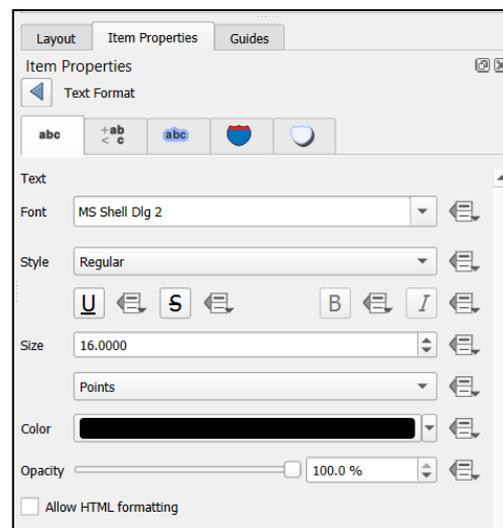
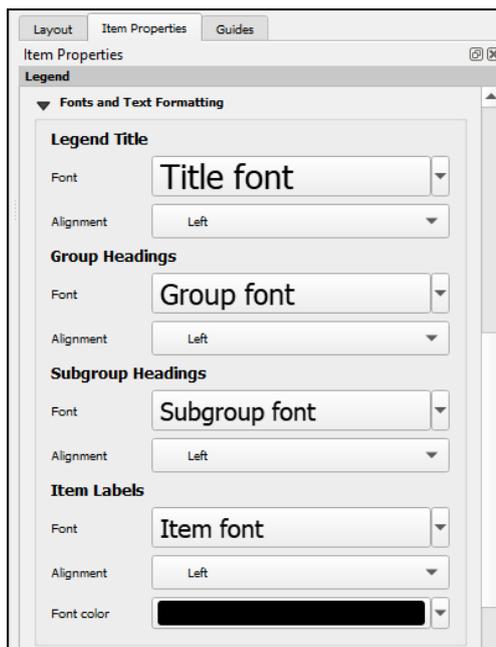
37. If you need to remove a legend item, click the item then click the *Minus* button .

38. If you need to add a legend item, click the *Add* button . Choose the layer you want to add from the list that appears then click *OK*.

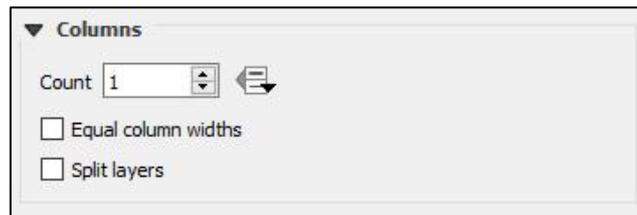
39. To rename a legend item, click it then click the *Edit* button . Edit the name in the box that appears then click *the Back* button  to go back to the Legend Item Properties.



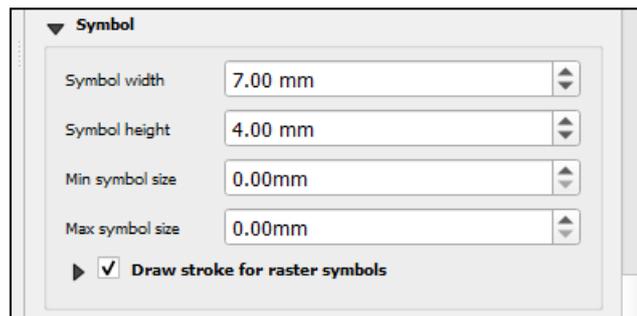
40. You can edit the font of the legend items in the Fonts and Text Formatting section by clicking the Font field of the legend item (Legend Title, Group Heading, Subgroup Headings, etc.) then selecting your desired font type, style, size, and color. Then click the *Back* button  to go back to the Legend Item Properties.



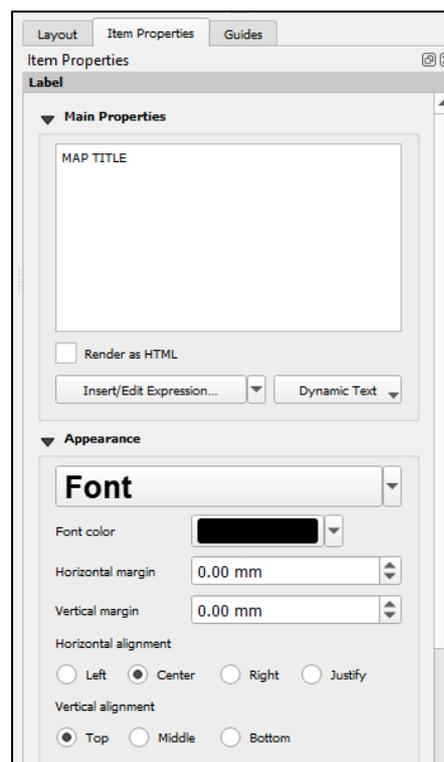
41. In the Columns section, you can specify if you need one or more columns for your legend items.



42. In the Symbol section, you can change the width and height of the symbols in the legend.

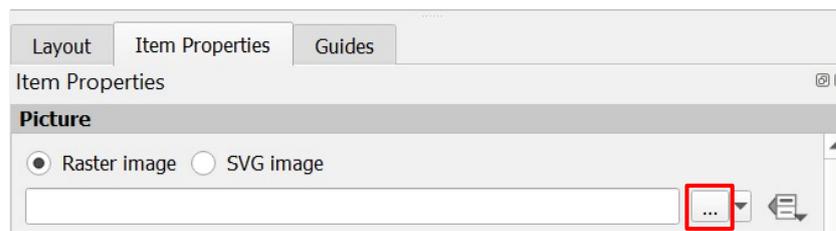


43. If the legend box needs to be repositioned, click, hold, and drag it to the correct position. Or click it and use the arrow keys on your keyboard to move it to the correct position.
44. Add the title map production date, project file name, and additional information (if needed) by clicking on the text to modify them. The Main properties section of the Item Properties tab contains the text box where you can enter the necessary text.

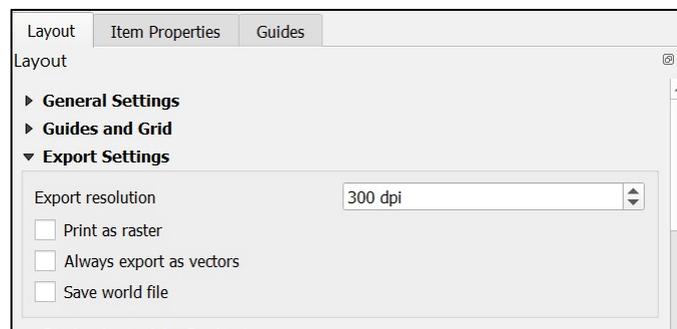


45. You can modify the appearance of the text in the Appearance section.
46. As noted in Annex 5, QGIS looks for the logo image file in the image source path that is saved in the map template file. If the template you are using has a logo positioned but the image is not showing, you will have to browse for the location of the logo image file.

Click the logo or logo placeholder to select it. In the Item Properties tab, click the *Browse* button. The *Select Image File* dialog box opens. Go to the folder where the logo image file is located, select the image, and click *Open*.

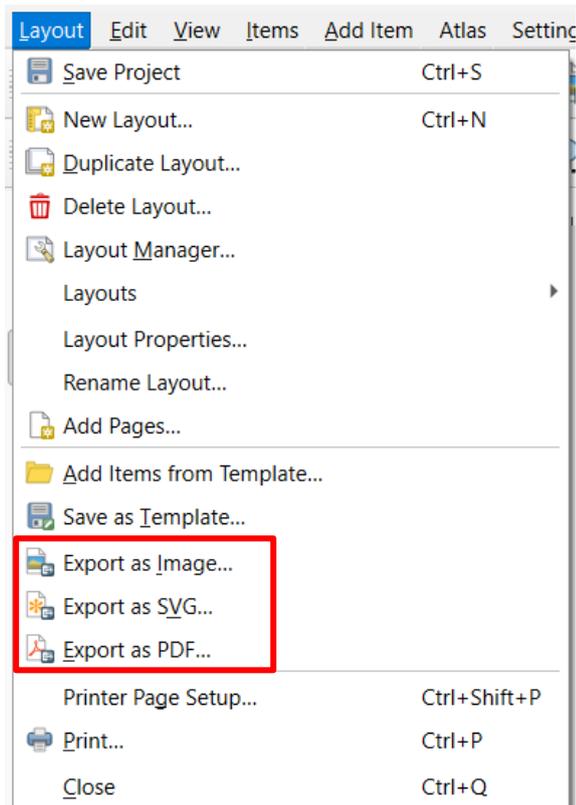


47. Review your map layout and make sure that the elements are complete and the overall look is clean and balanced.
48. Once you are satisfied with your map, click the *Layout* tab on the right side, click the *Layout Properties* then expand the *Export settings* section. Make sure that the resolution is set to at least 300 dpi.



49. Click *Layout* from the main menu then choose to export your map as an image, PDF, or scalable vector graphics (SVG) file.

(Although keep in mind that when exporting to SVG, a message appears warning users of problems in saving in this format using QGIS.)



50. Depending on the format you selected, the Save Layout as or Export to [format] dialog box opens. Go to the folder location you want to save your map layout in.

51. Type in the file name for your final map layout. Click *Save*.

You have now successfully created your own thematic map using QGIS.