QGIS TRAINING MANUAL FOR LOWER SECONDARY LEVEL SCHOOLS





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I. GETTING STARTED WITH QGIS

I.1 Definition of QGIS

QGIS functions as geographic information system (GIS) software, allowing users to analyze and edit spatial information, in addition to composing and exporting graphical maps.

Usefull terminologies

- Attribute : a piece of data relating to a feature , example the name of a settlement or the population of a region
- Attribute table : a table showing the attribute values for all the features in a layer
- **Coordinate reference system**: CRS the sytem used to reference the X and Y coordinates of your data
- Feature : an individual object in your data, example a line , point or polygone
- Layer : a set of data , usually of one type which can be turned on and off , moved above or below other layers, and styled/ labelled
- Line : vector data which has two ends which don't meet, possibly with intermadiate points, for example roads
- Plugin : an optional application which provides additional functionality to GIS
- **Point** : data comprising sets of individual X and Y coordinates , but not joined togetther , example village or hospiatl
- **Polygon** : data comprising one or more closed lines, forming shapes which can be filled , for example land masses, or provinces
- Project : a set of data , styles and print composers within QGIS used to make a map
- Raster : map data which is represented as an image , with pixel valuyes of between 0 and 255
- **Style** : rules used to represent data objects with colour , shapes, icons or charts according to the values of their attributes
- Vector : data which is represented as sets of coordinates , producing lines , points or polygones
- **Shape file**: A shapefile (.shp) is a vector data storage format for storing the location, shape, and attributes of geographic features. A shapefile is stored in a set of related files and contains one feature class.
- A layer file: A layer file (.lyr) is a file that stores the path to a source dataset and other layer properties, including symbology.

I.2 Difference between ArcGIS and QGIS

In this training manual we will be trained on QGIS but not ArcGIS as it is in the syllabus, Both these Software do almost the same work, but we have decided to use QGIS it is the one which is easy for teachers and students to find because it is free to download..

QGIS	ArcGIS
 It is open source Software. It is freely available. It can be installed on different operating Systems. It is not licensed Software. It is developed by all over the world Programmers. 	 It is commercial Software. It is not freely Available. It can only be installed on window System. It is single user Licensed software. It is deployed in secure environment of Esri

I.3 Downloading and installing QGIS in a computer

• Open your browser and type the word QGIS in google search engine

Open your browser:	Grail Images III 🔕
Google chrome, internet explorer,	
Mozilla Firefox	
> Type the word QGIS	Google
Press enter .	Q QGIS O QDS Remove
	O qgis pdf Remove
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• Click on welcome to QGIS Project

The "welcome to QGIS project!" link will appear and then	Google	QGIS	\$ Q	٩
click on it		Q Al 📮 Images 🕑 Videos 🗐 News 🖺 Books 🗄 More	Settings Tool	ools
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		Q www.qgis.org •		
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		You visited this page on 1/20/20.		

• Downloading the set up



- Selecting the QGIS version compatible with your computer
- There are different versions of QGIS, you will choose the one which is compatible with your Windows.
- Some computers have Windows 32 bit other have windows 64 bit, for new QGIS users we recommend **the stand alone installer**.





• Installing QGIS in a computer



You can also visit the following link to install the set up" https://www.youtube.com/watch?v=5GmfCseIh3Y

I.4 QGIS Graphical User Interface (GUI)



The QGIS GUI is divided into five components:

- (1) Menu bar
- (2) Toolbars
- (3) Panels
- (4) Map view
- (5) Status bar

I.4.1 Menu bar

The Menu bar provides access to various QGIS functions using a standard hierarchical menu.

I.4.1.1 Project



I.4.1.2 Edit

Menu Option	Shortcut
ndo Undo	Ctr1+Z
Redo	Ctrl+Shift+Z
Cut Features	Ctrl+X
Copy Features	Ctrl+C
Paste Features	Ctrl+V
Paste features as \rightarrow	
 Add Feature Add Circular String Add Circular String by Radius Move Feature(s) Delete Selected Modify Attributes of Selected Features Rotate Feature(s) Simplify Feature 	Ctrl+.

I.4.1.3 View

Menu Option	Shortcut		
D Pan Map			
Pan Map to Selection			
Doom In	Ctrl+Alt++		
F Zoom Out	Ctrl+Alt+-		
$Select \rightarrow$			
Ratures	Ctrl+Shift+I		
$Measure \rightarrow$			
Statistical Summary			
Zoom Full	Ctrl+Shift+F		
Doom To Layer			
Zoom To Selection	Ctrl+J		
Zoom Last			
2 Zoom Next			
Zoom To Native Resolution			
$Decorations \rightarrow$			
Preview mode \rightarrow			
Map Tips			
New Bookmark	Ctrl+B		
Show Bookmarks	Ctrl+Shift+B		
Refresh	F5		
$Panels \rightarrow$			
Toolbars \rightarrow			
Toggle Full Screen Mode	F11		

I.4.1.4 Layer

Menu Option	Shortcut	г
	Shortcut	-
Mata Source Manager	Ctrl+L	
Create Layer \rightarrow		-
Add Layer \rightarrow		-
Embed Layers and Groups		ŀ
Add from Layer Definition File		-
Copy Style		-
Paste Style		-
Copy Layer		
Paste Layer/Group		
Open Attribute Table	F6	
J Toggle Editing		
Save Layer Edits		
\emptyset Current Edits \rightarrow		
Save As		Ī
Save As Layer Definition File		t
Remove Layer/Group	Ctrl+D	
Duplicate Layer(s)		
Set Scale Visibility of Layer(s)		
Set CRS of Layer(s)	Ctrl+Shift+C	
Set Project CRS from Layer		
Layer Properties		Ī
Filter	Ctrl+F	I
(abe Labeling		Ļ
Show in Overview		
𝕶 Show All in Overview		t
Hide All from Overview		

I.4.1.5 Settings



I.4.1.6 Plugins

Menu Option	Shortcut		
🏠 Manage and Install Plugins			
Python Console	Ctrl+Alt+P		

I.4.1.7 Vector

Menu Option	Shortcut
Coordinate Capture	
Check Geometries	
GPS Tools	
🌠 Topology Checker	
Geoprocessing Tools \rightarrow	Alt+O+G
Geometry Tools \rightarrow	Alt+O+E
Analysis Tools \rightarrow	Alt+O+A
Data Management Tools \rightarrow	Alt+O+D
Research Tools \rightarrow	Alt+O+R

I.4.1.8 Raster

Menu Option	Toolbar
Raster calculator	
Align Raster	
Analysis \rightarrow	
$Projection \rightarrow$	
$Miscellaneous \rightarrow$	
Extraction \rightarrow	
$Conversion \rightarrow$	
Georeferencer	Raster

I.4.1.9 Database

Menu Option	Toolbar
📕 DB Manager	Database
$eVis \rightarrow$	Database
Offline Editing \rightarrow	Database

I.4.1.10 Web

Menu Option	Toolbar
MetaSearch	Web

I.4.1.11 Mesh

Menu Option	Ι
Mesh Calculator	

I.4.1.12 Help

Menu Option	Shortcut	Toolbar
Help Contents	F1	Help
API Documentation		
Report an Issue		
Need commercial support?		
QGIS Home Page	Ctrl+H	
Check QGIS Version		
Q About		
QGIS Sponsors		

I.5 GIS components



I.6 GIS data types

I.6.1 Vector data

Vector data is not made up of a grid of pixels. Instead, vector graphics are comprised of vertices and paths.

The three basic symbol types for vector data are points, lines and polygons (areas). Because cartographers use these symbols to represent real-world features in maps, they often have to decide based on the level of detail in the map. These are images such as streets, rivers, railway lines, lakes, city blocks, and any other features that can be drawn on a map.

I.6.2 Raster Data

Raster Data: These are items, usually images that are composed of pixels. The images may be extracts of satellite images, scanned maps, aerial photographs, or any object that shows pixels when enlarged.

1.7 Data to be used in this training manual

The **sample data** that accompanies this resource is freely available and comes from the following source:

<u>https://www.healthpolicyproject.com/geoHealth/resources/Workbook Exercises and Data.zip</u> Download the prepared dataset and unzip the file. All the necessary data are provided in the **Workbook_Exercises_and_Data folder**.

1.8 Adding your first layer

A layer can be Districts, Sectors, Provinces Etc, To add your first layer you will do the following:

• Open QGIS. You will have a new, blank map.



- click the 🛃 Open Data Source Manager button Untitled Project - QGIS [new] Project Edit View Layer Settings Plugins Vector Baster Database Web Processing Help · # / 目前反·服言以前目の近 四角円周周周周周 10 6 2 @ 👌 🔳 (RR) **Recent Projects** Brows 30 1.0 Favorites Hom Data Source Manager | Browser CeoPac SpatiaLite Browser Browser G C Y I O MSSQL Vector DB2 Favorites + 🗇 /media/TRAVAIL/2019/Controle WMS/WMTS XYZ Tiles di Home @ wcs 101 И 10 WFS CeoPackage C OWS / SpatiaLite Delimited Text PostGIS ArcGisMapServer MSSQL ArcGisFeatureServer 👷 GeoPackage D82 * GeoNode WMS/WMTS XYZ Tiles PostgreSQL @ wcs WF5 MISSOL OWS ArcGisMapServer 082 * GeoNode Layers Virtual Layer 《唐天节三-法律门 😨 WMS/WMTS 😂 wcs WFS R ArcGIS Map Serve ArcGIS Feature Server GeoNode
- Load the Sectors.shp vector dataset:
- a. Click on layer menu
- b. add layer >add vector layer or open data source manager
- c. Click on the Vector tab
- **d.** Enable the **File** source type
- e. Press the ... button next to Vector Dataset(s)
- f. Select the Workbook_Exercises_and_Data\Section_3_1\Data/ Sectors.shpfile in your training directory.
- g. Click Open.

•

🔇 Data Source Manager Browser Vector			\times
Frowser	Source Type		
Vector	File Directory Database Protocol: HTTP(S), do	oud, etc.	
Raster	Encoding	System -	
Mesh	Source		
🔈 🔒 Delimited Text	Vector Dataset(s) XWANDADATA\Section_3_1\Data\Sectors.shp		
GeoPackage			
🍂 SpatiaLite			
♀ PostgreSQL			
MSSQL			
📮 Oracle			
DB2 DB2			
Virtual Layer			
wms/wmts			
🛟 wcs			
💬 WFS			
ArcGIS Map Server			
ArcGIS Feature Server			

h. Click Add. Then Close.





The sectors layer is now there

i. Click on **Project** then **Save** As Save your map as **Exercise_3a.qgs** in the **Workbook_Exercises_and_Data** \Section_3_1 folder

EXERCISE 1 : Repeat the steps above to add Districts.shp and Provinces.shp layers from the same folder (Workbook_Exercises_and_Data \Section_3_1\Data) to the map.

Result:





II. CREATING A BASIC MAP

II.1 Working with Vector Data

The vector model represents the location and shape of geographic features using points, lines and polygons while their other properties are included as attributes (often presented as a table in QGIS).

II.1.1 Viewing Layer Attributes

It's important to know that the data you will be working with does not only represent **where** objects are in space, but also tells you **what** those objects are.

To see all the available data in the districts layer,

- click the 💷 button or
- right click the **districts layer** and
- choose **Open Attribute Table**

It will show you a table with more data about the Districts layer.

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3	-1	0	0	NU	2	KARONGI	OUEST	993.03223439000	301.0000000000	Karongi	0	278944.0000000	
4	-1	0	0	NU	3	RUSIZI	OUEST	958.59222955000	306.0000000000	Rusizi	0	331950.0000000	
5	-1	0	0	NU	4	NYABIHU	OUEST	531.49708992000	304.0000000000	Nyabihu	C	268367.000000	
6	-1	0	0	NU	5	RUBAVU	OUEST	388.33896550000	303.0000000000	Rubavu	0	292653.000000	
7	-1	0	0	NU	6	GAKENKE	NORD	704.06264008000	402.0000000000	Gakenke	0	322043.0000000	
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11	-1	0	0	NU	10	NGOMA	EST	867.74276243000	506.0000000000	Ngoma	0	235109.0000000	
12	-1	0	0	NU	11	NYAMASHEKE	OUEST	1173.99304016000	307.0000000000	Nyamasheke	0	325032.0000000	
13	-1	0	0	NU	12	HUYE	SUD	581.52703544000	204.0000000000	Huye	C	265446.0000000	
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4													
	Show All Features												3 🔳

II.1.2 Reordering the Layers

The layers in your Layers list are drawn on the map in a certain order. The layer at the bottom of the list is drawn first, and the layer at the top is drawn last.



- Click and drag on a layer in the Layers list put districts layer on top of provinces layer.
- Reorder them to look like this:



II.1.3 Removing the Layers



- Select a layer in the Layers list.
- Click on **Remove Layer icon**.

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II.2 Symbology

The symbology of a layer is its visual appearance on the map.

II.2.1 Changing Colors

To change a layer's color

- Right-click on the **districts layer** in the layers list.
- Select the menu item Properties in the menu that appears.
- select the **Symbology**
- Click the **color** select button next to the Color label.
- Choose a color and click **OK**.



II.2.2 Changing Symbol Structure

- Open the Layer Properties window for the districts layer.
- Click Symbology
- Expand the **Fill dropdown** and select the **Simple fill** option.
- Click on the **Stroke style** dropdown. At the moment, it should be showing a **short line** and the **words Solid Line**.
- Change this to **dash dot dot line**
- Click **OK**.

-	cayer Properties - Di	isancis į symborogy	^
Q		Single symbol	-
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~	Symbology		
abe	Labels		
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9	Display	offset	-
*	Rendering	, [
3	Variables	✓ Enable layer (= Draw effects	
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.	Dependencies	Style OK Carriel Apply	Help

II.2.3 Scale-Based Visibility

Sometimes you will find that a layer is not suitable for a given scale. For example, a dataset of all the provinces may have low detail, and not be very accurate at sectors level In our case, we may decide to hide the provinces from view at small scales.

- Open the Layer Properties
- Activate the **Rendering** tab.
- clicking on the checkbox labeled **Scale dependent visibility**:
- Change the **Minimum value to 1:10000**
- Click ok

Q I	Layer Properties - Pro	ovinces Rendering	×
Q		▼ ✓ Scale Dependent Visibility	
i	Information	Momum (exclusive) Maximum (nclusive) S 1: 10000	8
3	Source		2
~	Symbology	Simplify Geometry Note: Heature simplification may speed up rendering but can result in rendering inconsistencies	
abe	Labels	Simplification threshold (higher values result in more simplification)	
۹.	Diagrams	Simplification algorithm Distance	
9	3D View	Maximum scale at which the layer should be simplified (1:1 always simplifies) 1:1	
	Fields	Force layer to render as a raster (may result in smaller export file sizes)	
-8	Attributes Form	Refresh layer at interval (seconds)	
•	Joins	Refresh layer on notification Colly it message is	
ť	Auxiliary Storage		
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III. Classifying Vector Data

Classifying vector data allows you to assign different symbols to features depending on their attributes. This allows someone who uses the map to easily see the attributes of various features.

III.1 Attribute Data

The whole strength of QGIS is that all the objects that are visible on the map also have attributes. Maps in a QGIS aren't just pictures. They represent not only objects in locations, but also information about those objects.

III.2 The Label Tool

Labels can be added to a map to show any information about an object..

III.2.1 Using Labels

Before being able to access the Label tool, you will need to ensure that it has been activated.

- Ensure that the Label item has a check mark next to it
- Click on the **districts layer** in the Layers panel
- Click on the following toolbar button: (abc or rigth click districts layer then properties click (abc
- Change No labels to Single Labels

Q	Layer Properties - Di	Districts Labels	×
Q		🖾 No labels	- 🕎
i	Information	<u> </u>	
Ĵ	Source		
~	Symbology		
ab	Labels]	
1	Diagrams		
Ŷ	3D View		
1	Fields		
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- Click on value
- Select **DISTR_NAME** from the list

🔇 Layer Properties - Distri	icts Labels		
Q	Single labels		-
🧃 Information 📍	Value voc DISTR_NAM	E	•
💸 Source	▼ Text Sample		
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• Click **Apply** and then **ok**.



III.2.2 Changing Label Options

- Rigth clicking on layer you want to formatting
- Click on properties then Click labels .
- Make sure **Text** is selected in the left-hand options list, and then updates the text formatting

Q Layer Properties -	Districts Labels		×
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III.2.3 The problem of the labels overlapping / the Buffer option.

- Open the Label tool dialog.
- Select **Buffer** from the left-hand options list.
- Select the checkbox next to **Draw text buffer**, then choose options to match those shown here
- Click Apply then Ok

<u>ي</u> ا	ayer Properties - I	Distrio	cts L	abels				×
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III.2.4 Address the positioning of the labels in relation to their point markers.

- In the **Label tool** dialog, go to the **Placement tab**.
- Change the value of **Distance to 5mm** and make sure that **around point** is selected

• Click Apply then Ok

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III.3 Classification

Labels are a good way to communicate information such as the names of individual places, but they can't be used for everything. For example, let's say that someone wants to know what each landuse area is used for.

III.3.1 Classifying Nominal Data

- Uncheck sectors layer then select districts layer
- Open the Layer Properties dialog.
- Go to the **Symbology tab**.
- Click on Single Symbol and change it to Categorized
- change the Column or value to **NOMDISTR** and the Color ramp to Random colors.
- Click on **Classify**
- Click **Apply** and Then **OK**.



• Click the arrow before then districts layer in the Layer list, you'll see the categories explained:

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IV. CREATING MAPS

IV.1 Using Print Layout

- Click on the Project / New Print Layout.
- Add title.
- Click **OK**.

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IV.1.1 The Layout Manager

QGIS allows you to create multiple maps using the same map file. For this reason, it has a tool called the **Layout Manager**.

- Click on the **Project / Layout Manager**
- Click the **Create button** and give the new layout the name.
- Give name and Click **OK**.

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IV.1.2 Basic Map Composition

In the **Print Layout** window, check that the values under layout panel or **Composition** - **Paper and Quality** are set to the following:

- **Size:** A4 (210x297mm)
- **Orientation:** Landscape
- Quality: 300dpi

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- Click on the Add New Map button:
- Click and drag a box on the blank page:
- Move the map by clicking and dragging it around
- Resize it by clicking and dragging the boxes in the corners

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IV.1.3 Adding a Title

- Click on this button
- Click on the page, above the map, and a label will appear at the top of the map.
- Resize it and place it in the top center of the page. It can be resized and moved in the same way that you resized and moved the map.
- Click the map to select it
- Hold in Shift on your keyboard and click on the label so that both the map and the label are selected.
- Look for the Align button and click on the dropdown arrow next to it to reveal the positioning options and click Align center:



- Right-click on both the map and the label.
- Select the label by clicking on it.
- Click on the **Item Properties** tab in the side panel of the Layout window.

- Change the text of the label to "RWANDA MAP":
- Use this interface to set the **font and alignment** options

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IV.1.4 Adding a Legend

- Click on this button:
- Click on the page to place the legend, and move it to where you want it:

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IV.1.5 Customizing Legend Items

- In the Item Properties tab, you'll find the Legend items panel.
- Select the provinces and districts entry.
- Delete them from the legend by **clicking the minus** button

You can also rename items

- Select a layer from the same list.
- Click the Edit button: 🥖
- Rename the layers to sector, district province.
- Remove sector and provinces on the legend. You can also reorder the items and change other many font of legend on your map:





IV.1.5 Rename Legend

- In the Item Properties tab, you'll find the Legend items panel.
- Find **Title** type **name**.



Add scale on map



IV.1.6 Exporting Your Map

You'll see the export buttons near the top left corner of the **Layout** window:



These buttons allow you to export the map page to a file.



If you're sending the map to a cartographer (who may want to edit the map for publication), it's best to export as an SVG. SVG stands for "Scalable Vector Graphic"

If you need to send the map to a client, it's most common to use a PDF, because it's easier to set up printing options for a PDF.

For our purposes, we're going to use PDF.

- Click the **Export as PDF** button:
- Choose a save location and a file name as usual.
- Click Save

V. Convert Excel file to .csv and load them in QGIS

V.1 Convert excel file to CSV

- Browse to your **exercise data** folder.
- Open ANC_HIV_2013_2014.xlsx. •
- Click on File
- Click on Save As. Save the new file as District_EC3.csv. .
- Change the Save As type from Excel Workbook to CSV by clicking on the down arrow and • selecting CSV(Comma Delimited).
- Navigate to My Exercises\Data and save the file in the folder.

- Click yes on the next dialog box, which confirms you want to use the CSV format.
- Close the file and exit Excel.

V.2 Load CSV files in QGIS

- Click on **Layer** on the main menu.
- Click on Add Layer
- Add Delimited Text Layer



- Browse to MyExercises
- Select the CSV file you just saved: District_EC3.csv
- Select CSV
- No geometry (attribute only table).

• Click Ok.

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• The CSV file has been added to your layer panel



- Right-click ANC_HIV_2013 and open the attribute table to familiarize you with the data.
- Close the attribute table.

V.3 Link non-geographic data with geographic data

In order to map the data, we must link it to the Eastern Cape district boundaries. We will use the advanced table tools in QGIS to join these data; this is often referred to as 'a **join'**. Once we complete the join, we can save resulting output as a new shapefile.

V.3.1 Load QGIS Processing Toolbox

The QGIS Processing Toolbox is used to run various algorithms for different purposes. The table tools can be found in the Processing Toolbox. We will access the tools and run the Join Attribute Tables algorithm.

Step 1: On the main menu, select **Processing** > **Toolbox**.



Step 2: The Processing Toolbox automatically snaps to your right panel.



Step 3: Expand Vector general.

From the listed table tools, double-click on the Join Attribute by field value tool to open it (see below).



Step 4: We will join the attributes District_EC3 to the sectors layer and create a new shapefile.

The **Input layer** in this case will be the **sectors layer** (the layer to which you will join attributes). The **Input layer** 2 will be **District_EC3** (the join table).

Select Sectors for Input layer and District_EC3 as Input layer 2.

Select Sector_2 as the Table field. This field is from the sectors layer.

Select Sector_2 as Table field 2. This field is from the District_EC3.csv file.

Step 5: Click on Run to run the tool then Close.

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Step 6: Your layer has been added to your map document as **Joined Layer** (Output Layer in previous versions). Please note this is just an "alias" name.



Step 8: Open the Output layer attribute table, scroll right, and scroll through the data. The data has been joined to the sectors layer.

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Step 9: Close the attribute table.

Save your map as Exercise_3a.qgs in the MyExercises folder

- Click on project
- Saves

- File name **Exercise_3a**
- Save as type Select .qgs
- Click save

V.3.2 Create a choropleth map

Mapping the greatest and least values involves mapping features based on quantities. These quantities can relate to discrete data, continuous data, or data summarized by area.

In our case, data is aggregated at sector administrative level. It can be mapped using classes to show variations in quantities across the districts.

Such maps are commonly referred to as **choropleth maps** or **area maps**.

Classes can be created manually or using standard classification schemes. The choice of scheme depends on data value distribution and the purpose of your map. Manual classification can be used to look for specific criteria or thresholds in your data, and when you understand the data well.

Commonly used standard classification schemes include:

- Natural breaks (Jenks): creates classes based on natural groupings of data
- Quantile: each class contains an equal number of features
- Equal Interval: creates classes of equal intervals
- Standard Deviation: creates classes based on the extent to which values vary from the mean
 - Right-click on the .csv files and removes it from the map document.
 - **Turn off** the sectors layer by clicking on the box next to the layer name.
 - Double-click on **Output layer** to open the **properties dialog box.**
 - Click on **Style** in the left panel.
 - Select **Graduated** symbol from the pull down menu.
 - For the classification field (Value), select Positivity.
 - Change the **Classes** from **5 to 3** and select **Natural Breaks** as the classification **Mode**.
 - Select a Color ramp.
 - Click Classify,
 - Click **Apply** then **OK**. Refer to the graphic below.



We would like to view data within a higher administrative level.

There are two administrative layers files in your layer panel, for districts and provinces.

- **Turn on** the Districts layer and drag it above the Output layer (the Output layer will no longer be visible). To make it visible, we will need to change the properties of the Districts layer.
- Double-click on the **Districts** layer to open the **Layer Properties** dialog box.

- Click on **Style** > **Simple fill**.
- Click on **Fill color** and select **Transparent fill**.
- Click on **Stroke style** to change to **solid line**.
- Select a Stroke color black color, or a color of your choice, and click OK.
- Change the **stroke width** to **0.50000**.

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5.3 - 10.8

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✓ Districts
 ✓ □ Joined layer

District_EC3
Sectors
Provinces

 \checkmark

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✓ 0 - 1.4

• Click **Apply** then **OK**.

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VI. References

- 1. https://docs.qgis.org/2.14/en/docs/index.html
- 2. https://docs.qgis.org/3.4/en/docs/training_manual/complete_analysis/index.html
- 3. https://www.healthpolicyproject.com/geoHealth/index.cfm