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QGIS SOFTWARE USER GUIDE VERSION 1

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1 Introduction

This document is a simplified user's guide to the QGIS software, covering the basic functionalities of the software that are useful for Action Contre la Faim's missions. It begins with a brief description of some mapping concepts and geographic information systems GIS.

The version of QGIS used is v3.22 "Białowieża". It can be downloaded directly from: https://qgis.org/en/site/forusers/download.html. However, it may have stability problems, in which case it is advisable to use the more stable v3.16 version. Most of the basic functions are identical between the two versions.

The layers (Shapefiles and Rasters) used to illustrate this guide are open-source layers, i.e., free of right. The procedures for downloading data will be detailed in the text each time a new layer is used.

A complete manual for using QGIS software is available on the net: https://docs.qgis.org/3.22/en/docs/index.html. It is a good complement to the topics covered in this short manual.

Remarks:

- Earlier and later versions of QGIS remain valid and you can continue to use them if you wish. Most of the basic functionalities are the same and this guide can also help you in their use.
- All the sections framed in green correspond to a succession of exercises that can be completed as progressive training.

2 Introduction to some basic mapping concepts

This chapter briefly explains what mapping is, with theoretical principles and practices. It also mentions the concept of Geographic Information Systems GIS.

For this introduction, the QGIS software does not need to be open, just read to familiarise yourself with the concepts.

2.1 Mapping theory

Cartography is the making and study of maps. It has been an integral part of human history for a long time, perhaps more than 10 000 years. From cave paintings to the ancient maps of Babylon, from Greece to Asia, from the age of exploration to the XXI century, humanity has created and used maps as essential tools to help define, explain and navigate its way around the world.

The map is a document that represents the features of a geographical area, extensive, in a miniaturised version, respecting distances, shapes and elevations (reliefs), showing roads, waterways, places of habitation... This representation of geographical space is based on scientifically established and accepted conventions.

Maps are based on cartographic concepts presented below:

The shape of the earth - geodesy

The earth is not a perfect sphere, it is defined by a geoid which is an equipotential surface of gravity, an irregular surface defined by all the points where gravity is perpendicular and equal to the one at the level of the oceans. In general, the ellipsoid is used as a reference model to approximate the geoid. It is possible to make a local adjustment of the ellipsoid with a geodetic datum.

Coordinate systems

A **coordinate system** is a reference system that uses mathematical rules to specify positions (locations) on the earth's surface.

The coordinate values can be **spherical** (latitude and longitude) or **cartesian** (distances X and Y from a reference point in a defined referential).

A coordinate system is normally defined by a geodetic reference system, ellipsoid and projection and the units are in degrees or metres.

Types of coordinate systems

➢ Geographic coordinate system:

The use of **latitude** and **longitude** to position points on a mathematically simple reference surface that best represents the shape of the Earth.

- Longitude (in degrees) is a spherical coordinate whose origin is the Greenwich meridian and is conventionally noted as positive towards the East, and negative towards the West.
- Latitude (in degrees) is a spherical coordinate whose origin is the equator and by convention is positive towards the North and negative towards the South.
- Geographical coordinates are often expressed in decimal degrees (DD)
  Decimal degrees are similar to degrees, minutes, seconds (DMS), but minutes and seconds are expressed as decimal values. Decimal values make storage and computation easier and faster.

➢ Projected coordinate system:

A graphic image of the world on a plane, such as the Universal Transverse Mercator (UTM) projection. The UTM system is the most widely used in cartography. UTM divides the earth into 60 numbered vertical zones that are 6 degrees in longitudinal width. Burkina Faso lies between zones 30N and 31N, Niger between 31N, 32N and 33N, Senegal 28N, Mauritania 28N and 29N; and Mali 29N, 30N, 31N.

Coordinates of a point are given by the distance X (towards the North) and Y (towards the East), expressed in meters on the earth surface, from the lower-left corner of the UTM zone.

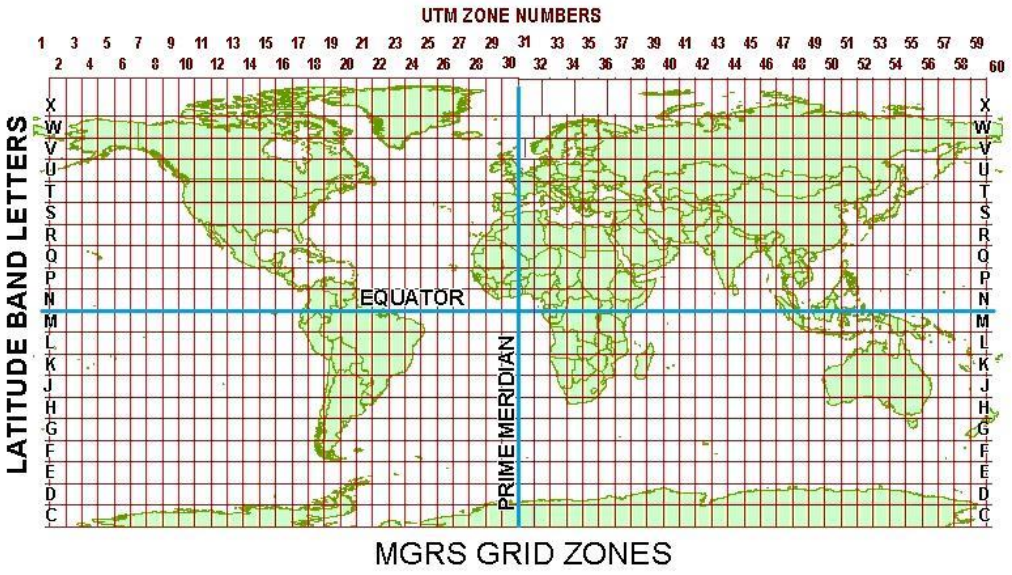


Figure 1 – UTM zones

Map projection

It is necessary to project maps to move from the globe to the plane. There is a multitude of projections respecting four main properties:

- Conformity: conservation of angles around a point
- Equivalent: conservation of surface proportions
- Equidistance: conservation of distances
- True direction: conservation of directions

No projection satisfies all four properties, and it is, therefore, necessary to make compromises.

It is necessary to use an adapted projection before calculating distances or superficies.

The Notion of Scale

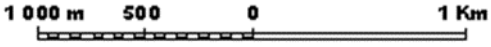
As stated in the definition of the map, it is a miniaturised representation of reality that tries to respect real distances. This miniaturisation is achieved using a scale.

A map scale is the relation between a distance on the map and the actual distance on the ground.

There are different types of scales:

Verbal Scale: "one cm on the map is ten km in the field".

Digital scale: **1:10 000**

Graphical scale: 

Scale of an area:  **Represents 1 km^2**

➢ Small and large scales concept

A small scale represents a large portion of the earth's surface. It allows the representation of large areas. Examples: World map, Map of West African countries, Map of Senegal. (Scale: 1:250 000).

A large-scale map represents a small portion of the geographical space. It provides more detail than a small-scale map. For example, a map of a house, a field of crops, a map of a neighbourhood in Dakar (Scale: 1:5 000).

Calculating the scale of a map:

For example, if 2 cm on the map represents 1 km on the ground the scale is **2 cm = 1 km**, or…

$$\frac{\text{Distance on the map}}{\text{Distance in the field}} = \frac{2\text{ cm}}{1\text{ km}} = \frac{2\text{ cm}}{100\,000\text{ cm}} = \frac{1}{50\,000}$$

Scale: (1:50 000)

NB: Scales do not have a unit (ratio).

2.2 Geographic Information Systems GIS

2.2.1 GIS definitions

GIS is an acronym used for Geographic Information Systems. Many definitions of GIS have been proposed in academic and institutional literature. Among the most widely used are the following:

According to Marble (1983), a GIS is “A system for collecting spatial data”.

Clarkes (1986) defined it as “a computer-aided system for capturing, storing, retrieving, analysing and displaying spatial data in a particular organisation”.

For Burrough (1987), it is “A powerful spatial tool for collecting, storing, retrieving, transforming and displaying real-world data”.

Parker (1988) sees it as “an information technology that stores, analyses and displays spatial and non-spatial data”.

For Arnoff (1989), “A computer system that provides four sets of capabilities for managing geo-referenced data: data input; data management; data manipulation and analysis; and data output”.

According to the US Federal Interagency Coordinating Committee on Digital Mapping (FICCDC, 1988), a GIS is “a computer system of hardware, software, and processes designed to enable the collection, management, manipulation, analysis, modelling, and display of spatially referenced data to solve complex planning and management problems”.

Taking these different definitions into account will allow you to design your own definition of GIS. For this, you will not need many words but only six letters of the alphabet: C, S, R, T, A, V.

C: Collect/record
S: Store
R: Recover
T: Transform
A: Analyse
V: Visualising data (spatial and attributes)

2.2.2 The components of a GIS

According to ESRI (www.esrifrance.fr/societe/sig2.htm), a Geographic Information System consists of 5 major components: hardware, software, data, methods and users.

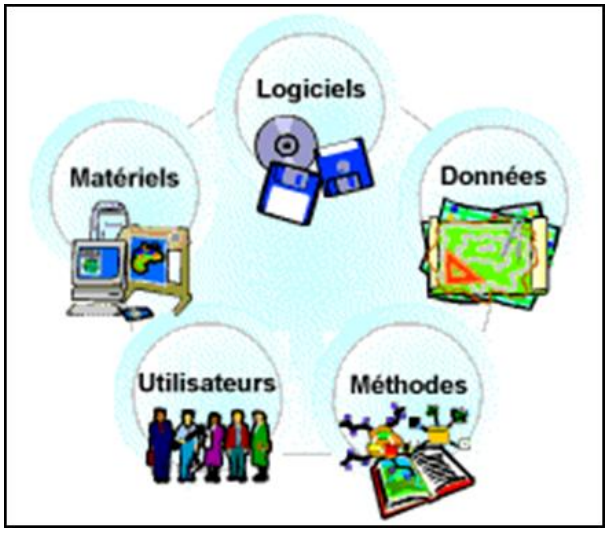


Figure 2 – Geographic Information System scheme

- **Hardware** is used to capture data (**keyboard, scanner...**), display information (**screen**) or store data (**hard disk**).
- **Software** is used to perform analysis, extraction and management of data.
- **Data** is at the heart of the system. All analyses are based on collected and stored data. This collection is done using GPS, scanners, digitisers, existing spreadsheets, or collected from other sources (satellites).
- **Methods** or procedures are designed by GIS specialists to specify the type of analysis the system should perform.
- **Users** refer to GIS specialists and various customers for GIS products.

2.2.3 Uses and users of GIS

What can be achieved with a GIS?

- A GIS system allows the visualisation and analysis of geospatially referenced data.

Who benefits from GIS?

- Anyone who requires analysis of a geographical area. GIS helps in decision making.

Despite the highly advanced features inherent in a GIS, few users push the system to its limits. Some of the applications of GIS, from the simple to the more complex, are listed below.

Single level

- Consultation of data to provide answers to questions such as: Does a certain place exist? Where can we find such and such objects? What is the extent of a phenomenon? Data management and updates: Management of objects and their attributes: changes, additions, deletions, assembly, copy/paste.
- Data creation - Done by importing data or digitising.
- Production of simple map outputs

Intermediate level

- Data overlay about map production. This includes Data interpretation for simple statistical analysis and thematic analyses; Data interrogation using selection, queries and structured queries (SQL).
- Production of elaborate map outputs

Advanced level

- Spatial analysis: Spatial interpolation and advanced statistical analysis based on existing information from neighbouring objects, can detail of missing information be derived from the process?
- Spatial modelling: Mathematical (simplified, schematic) reconstruction of an actual geographical space; Geographical simulations of space for behavioural testing; Modelling can be two-dimensional (to visualise the magnitude of a parameter or spatial feature), but most often such a model is multi-dimensional including a dimension can be spatial (altitude, height or depth), temporal (changes based on a time sequence for a particular area), or any other parameter (to demonstrate the impact of the parameter).

What are the main areas of application of GIS?

- Geographical representation:
  - Thematic mapping: To produce maps for different themes and areas.
- Geographical management:
  - Rural and urban environments. To integrate the study and development of a space or a landscape.
- Inventory and management of natural features:
  - Water management. Irrigation and drainage systems provide water quality control and water management works.
  - Forest management.
  - Management of natural parks.
  - Inventory and management of national monuments and archaeological sites.
  - Inventory and management of natural resources.
  - Inventory and mapping of soil and geological conditions.
- Environment:
  - Impact studies and development of phenomena (desertification ...).
  - Forecasting risks of natural origin and preventing disasters.
- Precision agriculture:
  - Crop management, production estimates and fertiliser dosages.
- Geo-Marketing:
  - Management of sales, stocks, transport logistics.
- Statistics:
  - Demographic studies.

What are the GIS user categories?

- Occasional users:

This type of user mainly uses GIS in reading mode. They review and consult GIS data and maps on the Internet for day-to-day use. They rarely realise that they are using a GIS system.

- Basic users:

This category consists mainly of GIS operators and technicians. They have limited knowledge of the GIS tool which they use routinely, a well-defined task such as map digitisation and the association of related attributes. They generally have a good knowledge of some operations and are less aware of some other elements of the system.

- Intermediate users:

These users can use GIS to solve a theoretical problem. They are capable of planning and implementation operations such as data extraction, queries and interpolation.

- Advanced users:

These types of users can design a strategy for the implementation of a GIS. They can ensure the smooth running of a project and are defined as project managers. Their in-depth knowledge of GIS principles, concepts and functions enable them to effectively use the structure, usability and methods to meet project objectives.

2.2.4 Concept of geographic data

Data is at the heart of any GIS analysis. For this reason, Phil Parent (1988) defined GIS as "a system that contains spatially referenced data that can be analysed and converted into information for specific purposes. The main feature of a GIS is the analysis of data to produce new information".

Based on this definition, a distinction must be made between geographic data and other types of data. Geographic data refers to any data about entities located spatially on the face of the Earth using the coordinates of its location. This dataset can be, for example, drinking water points, roads, railways, parcels of land use types, or political and administrative boundaries.

There are two models for representing geographic data: **vector** model and **raster** model.

Vector model corresponds to a geolocated shape which can be a point, a line or a polygon with an array of associated attributes.

Raster model includes **satellite images**, **aerial photos**, **digital elevation models** (DEMs) and often **scanned** or **digitised** entries from **paper map documents.**

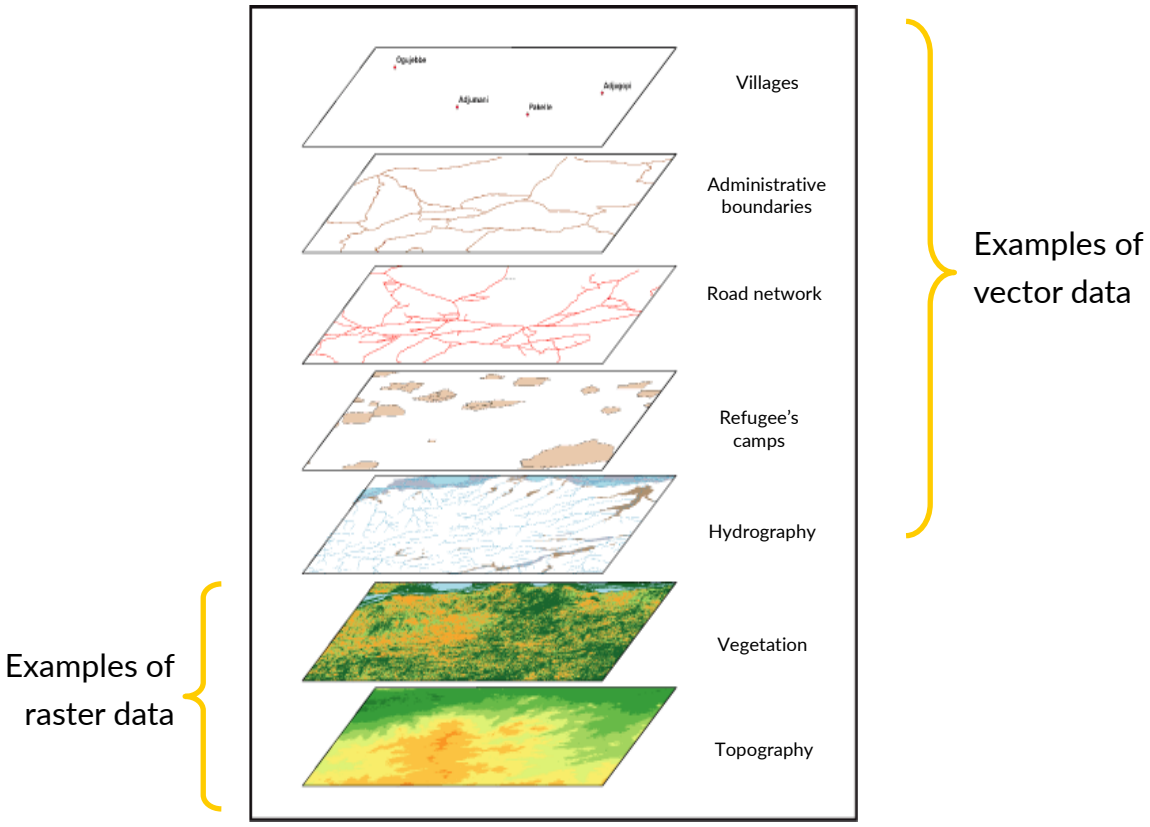


Figure 3 – Examples of vector and raster data

1. Vector data

A GIS represents **vector data** on a map using **points**, **lines** or **polygons**.

Points are used as an abstraction for water points (wells, boreholes, public taps), schools, health centres (CSI, CS hospitals), towns (depending on the scale of the map).

Lines are used to represent waterways (river systems, aqueducts, stormwater drainage), city streets, road types and networks (telephone lines, water pipes, bus lines…).

Polygons represent areas and their boundaries (agricultural land, water bodies, regions, countries, continents).

In vector mode, each entity is linked to an array of data containing information about it. These are its **attributes**. For example, a **point** feature representing traditional wells in a community will have an array linked to it presenting the characteristics of each well for instance depth, water flow, water use, and whether the water is permanent or not.

In the case of **polygon** features such as a state in the USA, the attribute table can contain various information such as the total population of the state, the population for different census years, and the number of households. In short, all the data collected on that state can be linked to the polygon that represents the state for map analysis.

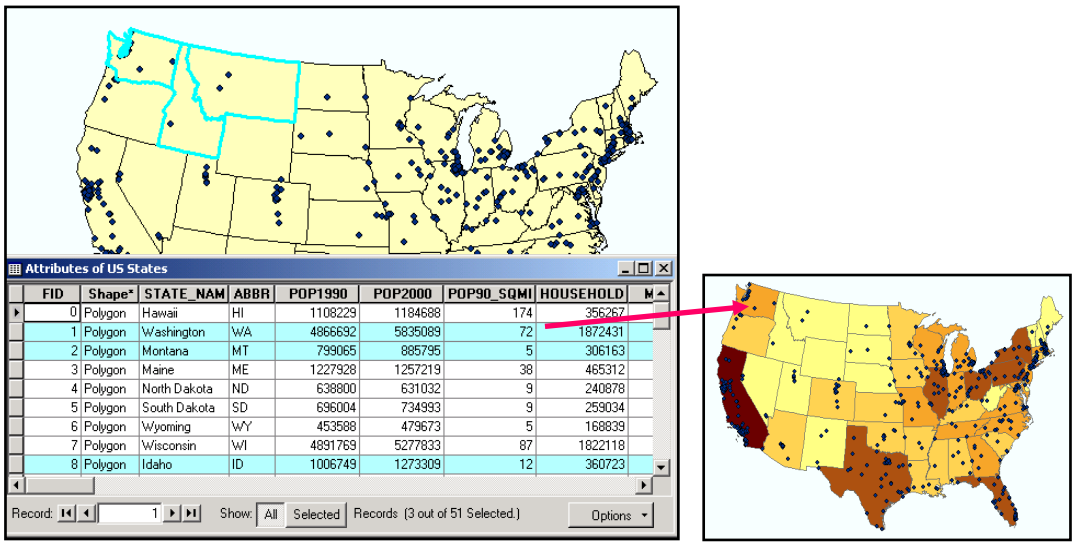


Figure 4 – Example of a polygon with its attribute table (US Map)

Principal advantages of vector data

- More accurate representation of the location of geographical objects
- Ability to store many attributes
- Flexibility for mapping
- Suitable for certain types of analysis, such as area, length and network analysis

Principal disadvantages of vector data

- Vector data could become heavy to handle
- Vector data is not adapted to every kind of information: satellite imageries, meteorological model outputs…

2. Raster data

The **raster** model corresponds to a mesh or grid of regular cells (pixel). Unlike the vector model, each grid cell is represented by a single attribute value.

The raster model can be used to represent point, line and area features like the vector data model. However, the raster data model lacks precision when representing these graphical features. In the graph on the right, the grid cells in green with '3' as the value number represent a polygon feature. The black cell with a label '1' represents a point feature, while the red squares marked with '2' represent a line feature.

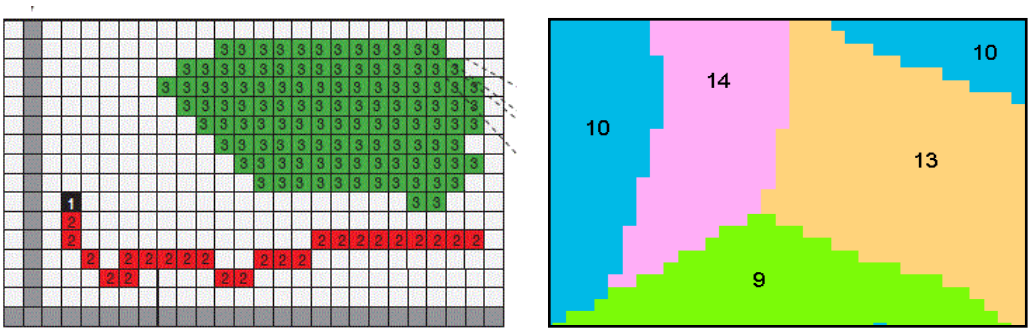


Figure 5 – Examples of raster representation

Principal advantages of raster data

- They are the best way to store continuous values such as elevation or distance;
- Raster analysis is faster and more flexible than vectors for many applications (e.g. hydrological modelling);
- Some analyses are only possible with raster data analysis (Catchment delineation);
- The raster allows the visualisation of large geographical areas (satellite images).

Principal disadvantages of raster data

Raster data has some disadvantages compared to vector data, among these:

- The boundaries of the entities are blurred (see figure below)
- Lack of precision in the representation of features

3 Introduction to QGIS

QGIS is a free and open-source Geographic Information System software developed by volunteers and is constantly evolving. It aims to be an easy-to-use GIS software, providing common features. QGIS is distributed under the GNU GPL license, which allows the source code to be openly studied and modified. QGIS allowing to:

- Visualise data (including vector and raster data)
- Create, edit, manage and export data
- Analyse data
- Create maps

The best tools to learn the software are curiosity and patience. Never hesitate to look for answers to your questions on the internet, the QGIS user's community is huge and prolific.

3.1 Downloading and Installing QGIS

To download QGIS, you need to have an internet connection and go to: https://qgis.org/en/site/forusers/download.html. Depending on the characteristics of the computer on which the software is to be installed, it is advisable to download the 32 or 64-bit version of the latest version of QGIS. As already mentioned in the introduction, this version may not be stable on some older computers. In this case, it is certainly possible to use the older version QGIS 3.16 which can be downloaded from the same site. However, this version will not offer all the functionality of a newer version.

Once QGIS is installed, go to the start tab on your computer and type QGIS in the search bar. There are several options, select QGIS3.xx Application and click on it. The program will open and the first time you use it, it will give you two options, choose "Clean start".

Once launched, QGIS will present you with an interface like other GIS software

3.2 QGIS main interface

When QGIS starts, the interface looks like the figure below. The interface can be divided into 6 main areas, numbered 1 to 6 in Figure 6, which are:

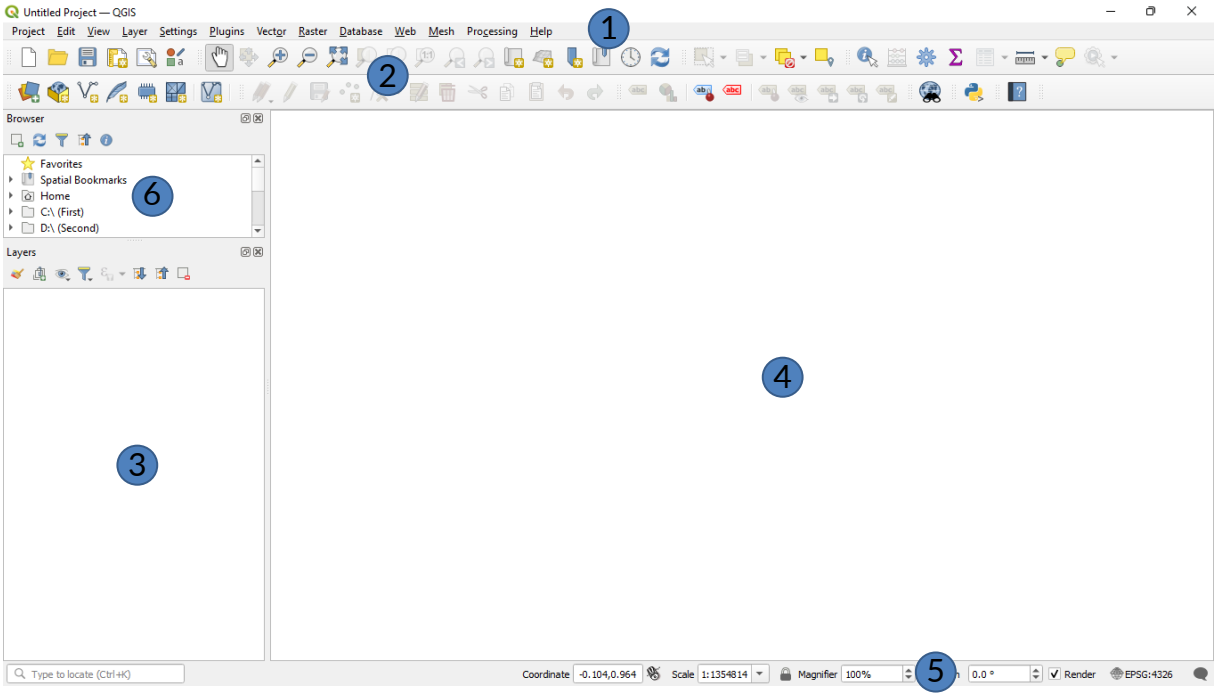


Figure 6 – QGIS interface

1. The menu bar gives access to different QGIS features.
2. The toolbar provides access to most menu functions. Each toolbar can be moved as required and each tool has a tooltip that is displayed when we place our cursor over it.
3. The panels are provided by default by QGIS. There are two panels: a table of contents showing the layers displayed on the map and the directory showing the location of the layers on the computer.
4. The central part of QGIS where maps are displayed.
5. The status bar provides generic information about the map and the map view: the coordinates of the represented space, the map scale, the projection system.
6. The Browser allows you to navigate through the computer's folders and data services.

It is possible to manage the type and number of panels and toolbars to be displayed. To do this, go to the "View" menu and click on Panels or Toolbars.

3.3 Create a project, save it, close it and open it

QGIS works with projects. QGIS cannot work on several projects at the same time. It is necessary to save your project using the Project > Save project as... 

To load a project previously saved in a QGIS session, go to Project > Open 

If you want to open a blank session, go to Project > New 

Activity: Open a new project
Before you start working, you are asked to create a project, give it a name, e.g., ACF_Training_GIS.qgz and save it in an appropriate folder.

A project will then reference layers by their path. If a layer used in a project is moved, renamed or deleted, the project will not be able to find it anymore. Therefore, it is advisable to create a folder with the project inside and all the layers that refer to it.

3.4 General QGIS tools

QGIS has tools for zooming and moving to an area of interest. The button  allows you to move around the map and the buttons  and  are used to zoom in and out on the map.

 Zoom in on the map with the mouse wheel. It is necessary to place the cursor in the display area of the map and if you roll the wheel forward, it will zoom in. Move around the map with the arrows and the space bar or simply by holding down the mouse wheel.

The Measure tool  allows you to measure distance, area and angles. The tool  allows you to obtain information on an element of a layer, either an entity of a vector layer or a pixel of a raster layer. To obtain the information of the desired layer, it is necessary to select the layer in the panel area by simply clicking on it.

3.5 Adding raster or vector layers to a project

In QGIS, it is easy to add raster and vector layers. Different layers are available in the training dataset, in the folder Data/:

A raster layer Data/GeoSahel/BiomassAnomaly2021.tif corresponding to the biomass production anomaly map for season 2021 over the west and central Africa. This layer is produced by the ACF Pastoral Early Warning System and can be downloaded directly from the GeoSahel website at this link: http://geosahel.info/Viewer.aspx?map=Analyse-Biomasse-Finale

Administrative vector layers over the west and central Africa produced by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA): wca_admin0_ocha.shp, wca_admin1_ocha.shp, wca_admin2_ocha.shp and the cities of the west and central Africa: wca_pplp_ocha.shp The shapefiles can be downloaded directly from the Humanitarian Data Exchange (HDX) website: https://data.humdata.org/dataset/west-and-central-africa-administrative-boundaries-levels

To add the shapefile layer, click on menu Layer > Add layer > Add vector layer  , and then browse the selected folder and choose the file with extension .shp standing for shapefile.

To add the raster layer Anomalie_biomasse_2021.tif click on the icon Layer > Add layer > Add a Raster layer  , and then browse the selected folder and choose the file with an extension .tif standing for GeoTIFF.

To add a layer, it is possible to drag it from its folder by sliding from the Browser panel to the Layers panel. Be careful to correctly insert .shp or .tif files.

Several simple manipulations can be done on the layers. For example:

- To centre the map on a layer, right-click on the layer > Zoom to Layer(s) 
- To duplicate a layer, right-click on the layer > Duplicate Layer 
- To delete the layer, simply: right-click on the layer > Delete Layer 

On the QGIS interface, the order of display of the layers in the layer window corresponds to the order of appearance in the main window. Therefore, you will not be able to see the boundaries of the regions wca_admbnda_adm1_ocha if the country's layer wca_admbnda_adm0_ocha is above. To reorder the layers, simply select them and move them.

Activity: Add layers onto the project

- ✓ *Add the layers wca_admbnda_adm0_ocha.shp, wca_admbnda_adm1_ocha.shp, wca_admbnda_adm2_ocha.shp, wca_pplp_ocha.shp and BiomassAnomaly2021.tif to your project*
- ✓ *Uncheck wca_admbnda_adm1_ocha, wca_admbnda_adm2_ocha, wca_pplp_ocha and BiomassAnomaly2021*
- ✓ *Zoom in on the wca_admbnda_adm0_ocha.shp layer*
- ✓ *Reorder the layers as shown in* Figure 7

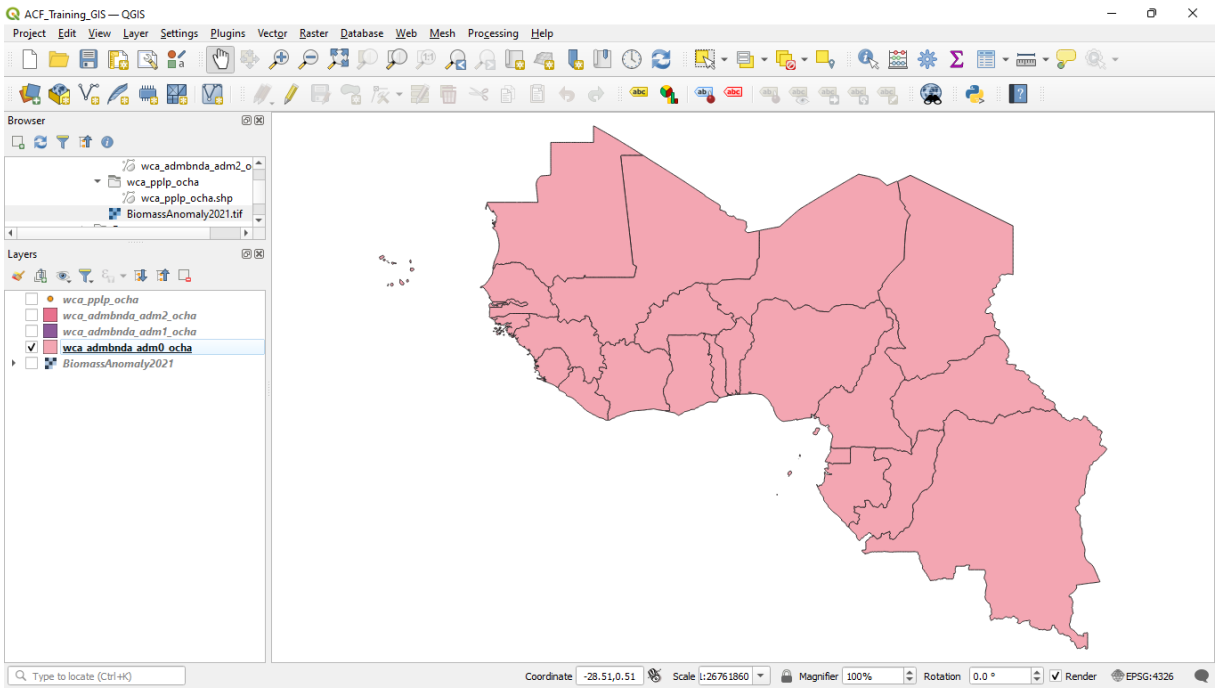


Figure 7 – Layers added to QGIS project

4 Vector data

Vector data is generally used to make maps. How to add vector layers in the shapefile .shp format has already been discussed earlier. This section details how to process and display vector data.

4.1 Properties of the layers

Each layer, whether vector or raster, has a set of properties to explore. To display the properties of a layer: Right-click on the layer > Properties or double click on the layer. The properties of the layers are the following: Information, Symbology (Style, Labels, ...), Fields, etc. Many actions can be performed from the layer properties, such as changing the display symbology or the labels.

4.2 Attribute tables

All vector layers have an attribute table that adds a data table to the spatial features. To access it: right-click on the layer > Open Attribute Table  . This opens a new window that displays the attributes of all features in the layer. Each row represents an entity with its attributes distributed in several columns. Each entity can be searched, moved and edited. The buttons at the top of the attribute table are used to call up features, the most useful of which are:

-  Activate the editing mode and stop the editing mode when finished
-  Save changes
-  Add an entity
-  Delete selected entities
-  Selecting entities using an expression
-  Select all
-  Deselect all
-  Move the selection to the top
-  Zoom the map to the selected lines
-  Delete a field
-  Add a field
-  Open the field calculator

Attribute values can be edited manually once the session is in edit mode . It is then possible to double click on a box and change the value. It is also possible to add a new empty field and then fill the field values manually .

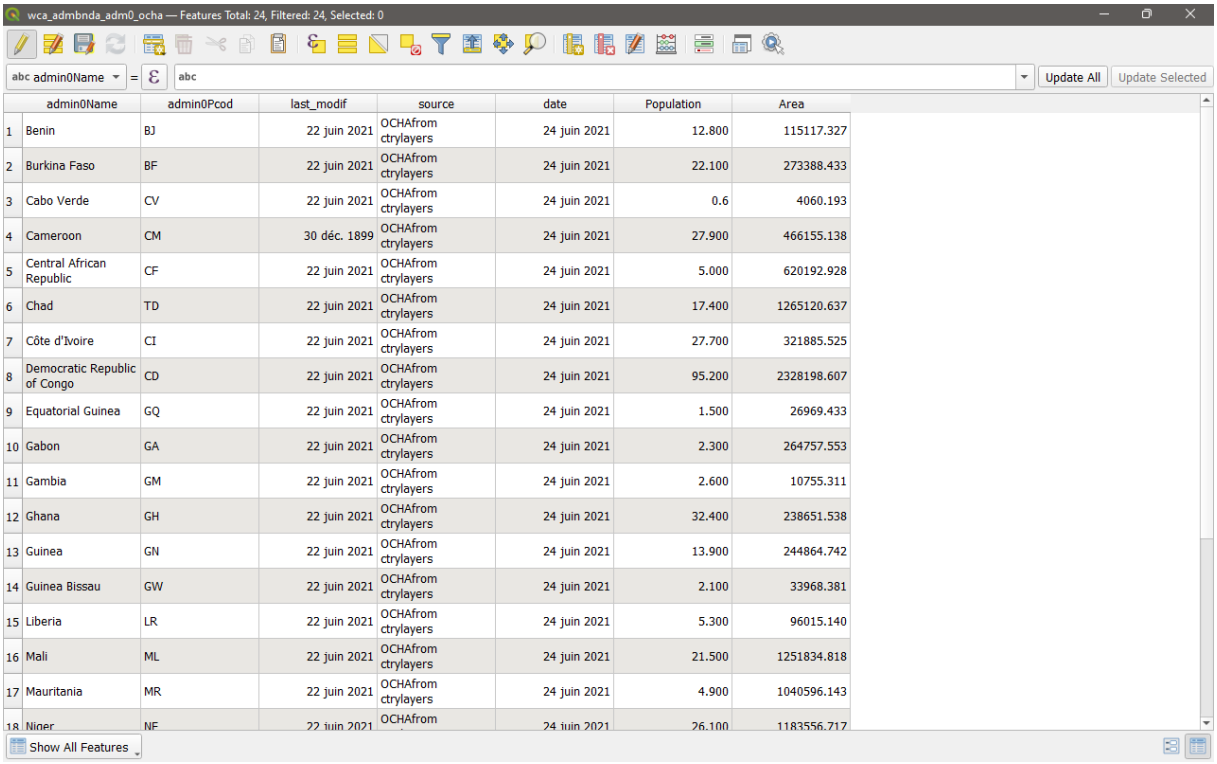
Activity: Add attribute information with the population of each country

- ✓ *Right-click on the wca_admbnda_adm0_ocha layer and open the attribute table*
- ✓ *Activate an editing session in the attribute table, then add a field and name it "Population", select the type Decimal number (as a real number)*
- ✓ *Add manually the populations in millions of all countries concerned, namely: Benin 12.8, Burkina Faso 22.1, Cabo Verde 0.6, Cameroon 27.9, Central African Republic 5.0, Chad 17.4, Côte d'Ivoire 27.7, Democratic Republic of Congo 95.2, Equatorial Guinea 1.5, Gabon 2.3, Gambia 2.6, Ghana 32.4, Guinea 13.9, Guinea Bissau 2.1, Liberia 5.3, Mali 21.5, Mauritania 4.9, Niger 26.1, Nigeria 216.7, Republic of Congo 5.8, Sao Tome and Principe 0.2, Senegal 17.7, Sierra Leone 8.3, Togo 8.7*
- ✓ *Save changes and exit edit mode*

The button **Field Calculator** in the attribute table allows calculations to be made based on the attribute values, but also to use functions to, for example, calculate an area or length of an entity. The results can be stored in a new column of the attribute table or in a column that is updated. When the field calculator button is clicked, a window opens. If the layer is not in edit mode, a window opens to warn you to switch to edit mode. This is because no changes can be made without having activated editing. The field calculator provides a comprehensive interface for creating expressions. It is very similar to the window for selecting attributes based on an expression. The applications of this tool are enormous and are not all detailed here. For more information, please refer to the full QGIS manual.

Activity: Add attribute information with area in km^2 for each country

- ✓ *Start an editing session by clicking on the pencil*
- ✓ *Enter the field calculator and add a field, named 'Area' of Decimal number type*
- ✓ *Calculate the area using formula $Area / 1000000*
- ✓ *Save the changes and exit*



	admin0Name	admin0Pcod	last_modif	source	date	Population	Area
1	Benin	BJ	22 juin 2021	OCHAfrom ctrylayers	24 juin 2021	12.800	115117.327
2	Burkina Faso	BF	22 juin 2021	OCHAfrom ctrylayers	24 juin 2021	22.100	273388.433
3	Cabo Verde	CV	22 juin 2021	OCHAfrom ctrylayers	24 juin 2021	0.6	4060.193
4	Cameroon	CM	30 déc. 1899	OCHAfrom ctrylayers	24 juin 2021	27.900	466155.138
5	Central African Republic	CF	22 juin 2021	OCHAfrom ctrylayers	24 juin 2021	5.000	620192.928
6	Chad	TD	22 juin 2021	OCHAfrom ctrylayers	24 juin 2021	17.400	1265120.637
7	Côte d'Ivoire	CI	22 juin 2021	OCHAfrom ctrylayers	24 juin 2021	27.700	321885.525
8	Democratic Republic of Congo	CD	22 juin 2021	OCHAfrom ctrylayers	24 juin 2021	95.200	2328198.607
9	Equatorial Guinea	GQ	22 juin 2021	OCHAfrom ctrylayers	24 juin 2021	1.500	26969.433
10	Gabon	GA	22 juin 2021	OCHAfrom ctrylayers	24 juin 2021	2.300	264757.553
11	Gambia	GM	22 juin 2021	OCHAfrom ctrylayers	24 juin 2021	2.600	10755.311
12	Ghana	GH	22 juin 2021	OCHAfrom ctrylayers	24 juin 2021	32.400	238651.538
13	Guinea	GN	22 juin 2021	OCHAfrom ctrylayers	24 juin 2021	13.900	244864.742
14	Guinea Bissau	GW	22 juin 2021	OCHAfrom ctrylayers	24 juin 2021	2.100	33968.381
15	Liberia	LR	22 juin 2021	OCHAfrom ctrylayers	24 juin 2021	5.300	96015.140
16	Mali	ML	22 juin 2021	OCHAfrom ctrylayers	24 juin 2021	21.500	1251834.818
17	Mauritania	MR	22 juin 2021	OCHAfrom ctrylayers	24 juin 2021	4.900	1040596.143
18	Niger	NE	22 juin 2021	OCHAfrom	24 juin 2021	26.100	1183556.717

Figure 8 – Attribute table of country layer

4.3 Layer symbology - vector formatting

4.3.1 Type of rendering

It is often necessary to modify the displayed appearance of layers when making maps. To do this, right-click on the layer > Properties > Symbology . It is necessary to choose the type of symbol we want to apply, the 4 most common types of symbols are: single symbol, categorized symbol, graduated symbol and the inverted polygon.

- The single symbol mode allows representing all the entities of a layer in the same way, e.g., country background in a single colour.

- The categorized rendering mode allows displaying the entities of a layer classified by category depending on the attribute table. The categorized rendering allows us to select the attribute (the field of the attribute table according to which we want to display), the symbol (ex: point, square, star, ...) and the colour. It is necessary to click on Classify to generate the classes for all the values of the attribute table.

-  The graduated mode allows the entities of a layer to be displayed with a colour palette according to the value of the attribute. It is also possible to specify the symbol, format, colour and size. It is also necessary to choose the number of classes and the classification method:
    - Equal intervals: all classes have the same size
    - Quantile: all classes have the same size
    - Natural breaks: maximum intra-class variance and maximum inter-class variance
    - Standard deviation: classes constructed based on the standard deviation

-  Inverse Polygon mode allows you to apply a symbol to the outside of a layer. This is useful if you want to give a colour to the outside of your area of interest, for example.

Activity: Display countries in different colours

- ✓ *Right-click on the layer wca_admbnda_adm0_ocha then go to properties, Symbology and choose Categorized rendering*
- ✓ *As Value select the admin0Name field and click on classify*
- ✓ *Change the colours one by one by double-clicking on the Symbol associated with each country*
- ✓ *Click to 'Apply' and check that you are happy with the rendering*

Activity: Display the capital cities with a symbol

- ✓ *Right-click on the layer wca_pplp_ocha and go to Properties, Symbology and Categorized symbol*
- ✓ *As Value select popPlace_1 and click on classify*
- ✓ *Activate only the Symbol corresponding to the National capital by unchecking all the others*
- ✓ *Double click on the symbol associated with the National capital and on the Symbol Selector window choose the symbol 'topo pop capital' and click 'OK'*
- ✓ *Click 'apply' and 'OK'*
- ✓ *Activate layer wca_pplp_ocha and check for the result*

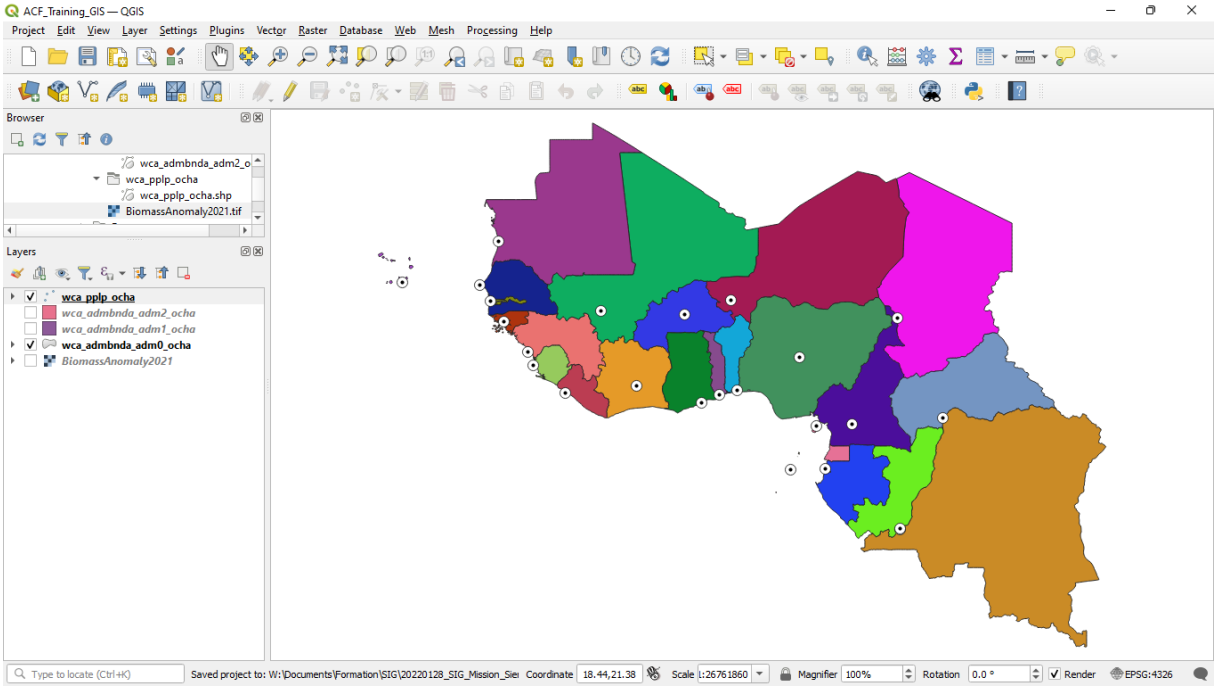


Figure 9 – West and Central Africa countries and capitals

4.3.2 General rendering options

It is also possible to apply rendering options to the entire layer, such as the transparency option, which makes the layers below visible.

4.3.3 Types of symbols

There is a multitude of symbols in QGIS. It is possible to modify the type of symbol, the thickness of the lines/edges of polygons, etc. All these tools are easily accessible, and we will not go into detail. Please refer to the online QGIS manual for further information.

4.4 Adding labels

It is useful when creating maps to display labels. For example, the names of countries or cities so that they are visible on the final map. This labelling menu can be used for polygons (e.g. countries), lines (e.g. roads) and points (e.g. cities). To do this, you need to right-click on the layer > Properties > Labels 

The first step in displaying a label is to choose the labelling method from a drop-down list. Four options are available:

- No label
- Singles Labels: all entities of the layer get the same label format
- Rule-based labelling: entities of the layer get different label formats (size, colour…)
- Blocking: to prevent other labels from overlapping with the entities in the layer

Next, check the Single Labels option for this layer and select the attribute field from which the labels should be taken. The following menus allow you to configure the labelling:

- Text: to define the text style (font, size, colour)
- Formatting: to define a line break
- Buffer and mask: to create a buffer or a mask around the text to make it more visible
- Background: to give a colour to the text background. The size of the coloured area can be set by Size X and Size Y
- Shadow: to have a shadow cast behind the text
- Callouts: to add a line connecting the entity to the label
- Placement: to select the location of the label. The location options vary according to the type of geometry: point, line and polygon
- Rendering: to fine-tune the rendering of the labels, including important option to “Show all labels for this layer (including colliding labels)”

It is also possible to define labels based on an expression, for example, to display the name of a country and below it the area. To do this, click on ε and then enter an expression, following a few simple rules:

- Combine all elements with a concatenation function like concat, + or ||
- Strings need to be written using ‘single quotes’
- The fields of the attribute table need to be written with "double quotes"

Some examples:

- Label based on two fields: country and population:

"Admin0Name" || ',' || "Population" || ' million' → Mali, 21.5 million

- Label based on two fields with one line:

"Admin0Name" || '\n' || "Population" || ' million' → Mali
21.5 million

Activity: Display names of the countries

- ✓ *Right-click on the layer wca_admbnda_adm0_ocha > Properties > Labels*
- ✓ *Select "Single Labels" and select the admin0Name field as Value*
- ✓ *Change the size, font and colour and buffer as you wish*
- ✓ *Then try to reproduce the examples shown above with the name of the country and the population number*

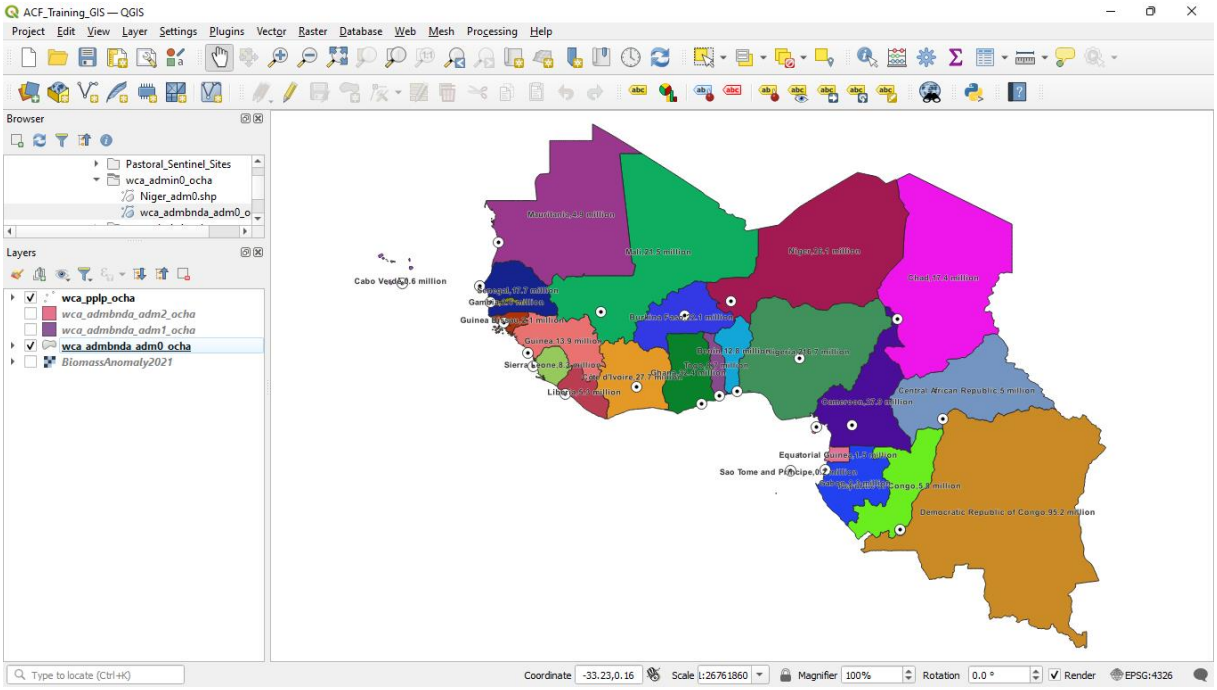


Figure 10 – West and Central African countries population

4.5 Synthesis exercise

To summarise what you have learned about symbology and labels; you are asked to reproduce the map below with the following characteristics:

- ✓ Display countries in grey in the background with a thick border
- ✓ Display country names in uppercase with a buffer
- ✓ Display region boundaries with a thinner border than countries
- ✓ Choose a special symbol for capitals
- ✓ Display city names in red with a buffer and a capital letter on the first letter only

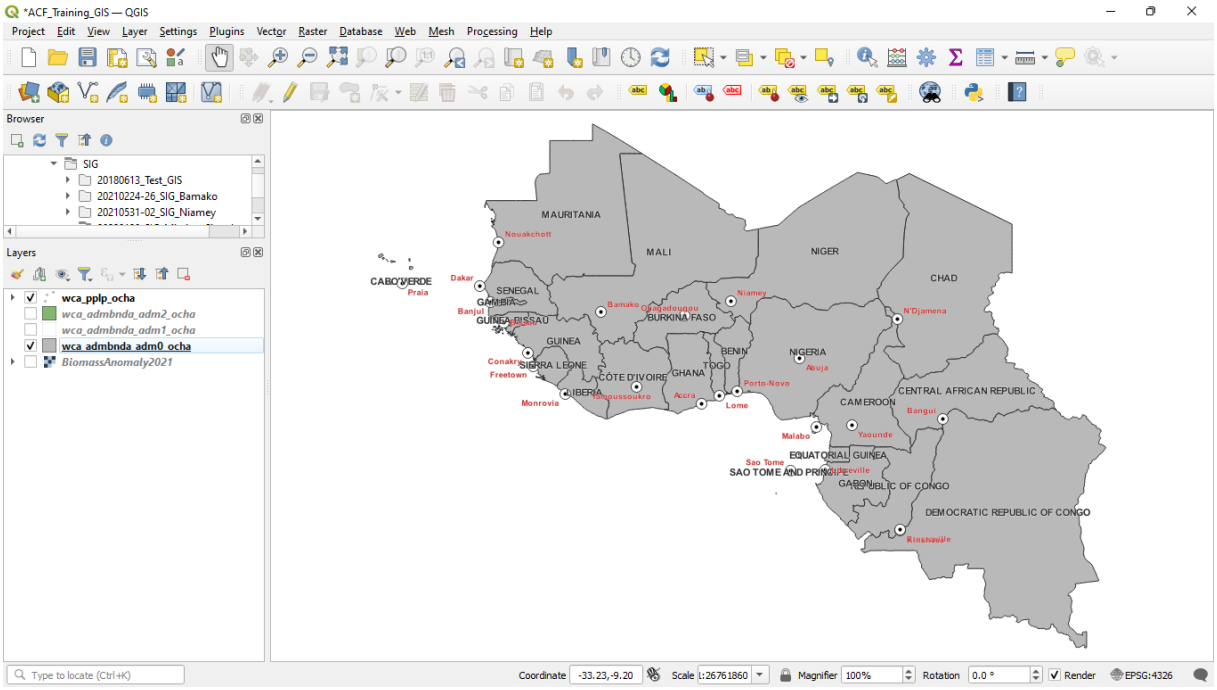


Figure 11 – Symbology and labels exercise result

4.6 Making data queries

QGIS provides several tools for selecting features directly on the display. To select one or more features over a layer, it is necessary to click on the tools bar on "Select Features by area or single click" and then choose the type of selections:

- Select entities with a rectangle or by clicking (default)
- Selecting entities with a polygon
- Freehand selection of entities
- Select entities by a radius
- Deselect all selected entities

Activity: Extract one entity of countries layer

- ✓ *On the Layers panel, select layer wca_admbnda_adm0_ocha as it becomes highlighted*
- ✓ *Activate the select features tool, then select the Niger by clicking on the display*
- ✓ *Export the selected feature by right-clicking on layer checking wca_admbnda_adm0_ocha and Export > Save Selected Features as…*
- ✓ *Choose format ESRI Shapefile, and File name Niger_adm0.shp*
- ✓ *Zoom on the newly created layer automatically added to the project*

The attribute table is linked to the vector layer. Therefore, if you select an entity in the layer using the select feature tool, this entity is also selected in the attribute table. In the same way, when you select a row in the attribute table, the corresponding entity is selected in the layer. To select multiple rows, simply hold down the ctrl key.

It is also possible to select attributes using rules. In this tool, a list of functions allows you to select entities by an expression that is often based on Fields and Values that you must select. An example is shown in Figure 12 and you are asked to perform it.

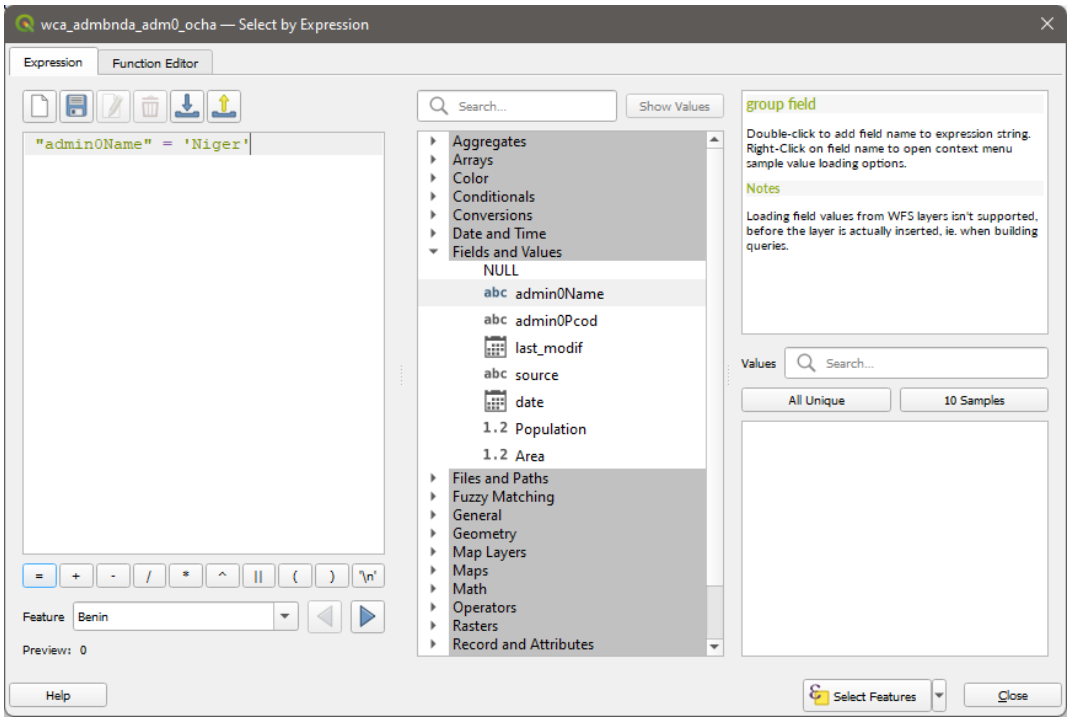


Figure 12 – Illustration of a rule-based selection of entities

Activity: Selection of regions that belong to the country Mali

- ✓ *Open the attribute table of Layer wca_admbnda_adm1_ocha*
- ✓ *Activate the tool "Select features using an expression"*
- ✓ *In the list of functions, pull down the Fields and Values menu and choose admin0Name by double-clicking*
- ✓ *Click on '='*
- ✓ *Click on load all unique values and choose 'Mali'*
- ✓ *The final expression should be "Admin0" = 'Mali'*

4.7 Create a shapefile from a selection of features

When a selection has been made, it is possible to export it to a new database and create a new shapefile. To do this: right-click on the layer containing the selected features > Export > Save Features as. A window opens, you need to indicate the name of the new dataset to be exported and check the "Save only selected features" option.

4.8 Adding data based on a delimited text file

It is common to have a text file (csv, txt, ...) containing point coordinates and to want to import it into QGIS to have a spatial representation. QGIS allows you to import a delimited text file as a vector layer if the text file meets the following 3 conditions:

- The first row of the file contains the field names for each column
- Some fields describe the geometry (coordinates)
- The X and Y coordinates (i.e., longitude and latitude) must be in numerical format

To add this kind of file as a new layer, you can use it in the Menu: Layer > Add Layer > Add Delimited Text Layer. The shows the window that opens. It is necessary to select the file to be imported and then to specify the delimiter, the X field being the longitude and the Y field being the latitude. You also need to define the geometry which is usually Point.

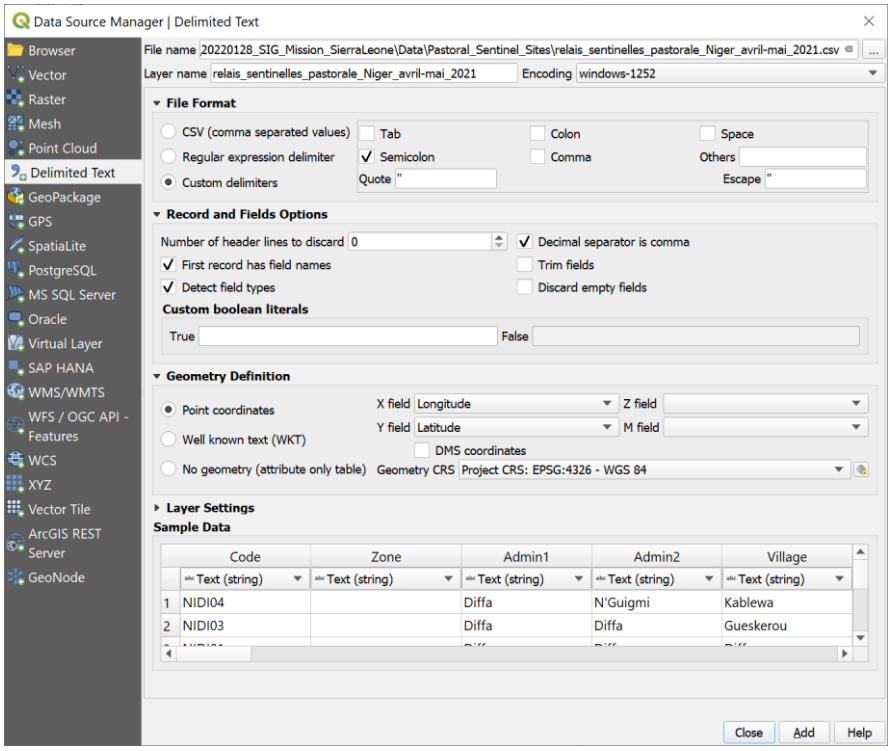


Figure 13 – Window for adding a delimited text file

Activity: Open a text file coming from ACF pastoral surveillance system

- ✓ *In the training folder, find the file: Pastoral_Sentinel_Sites/relais_sentinelles_pastorale_Niger_avril-mai_2021.csv*
- ✓ *Open the file with spreadsheet software like Excel to see what it looks like*
- ✓ *In QGIS, Go to Menu > Layer > Add Delimited Text Layer and search for the file*
- ✓ *Choose the windows-1252 as Encoding*
- ✓ *Choose the column separator as the semicolon*
- ✓ *Choose the comma as the decimal separator*
- ✓ *Make sure that the X and Y fields are checked correctly so that they correspond to the latitude and longitude*
- ✓ *Click on Add to import the file as a Layer*
- ✓ *Observe the location of the sentinel sites to ensure that the import has been carried out correctly*

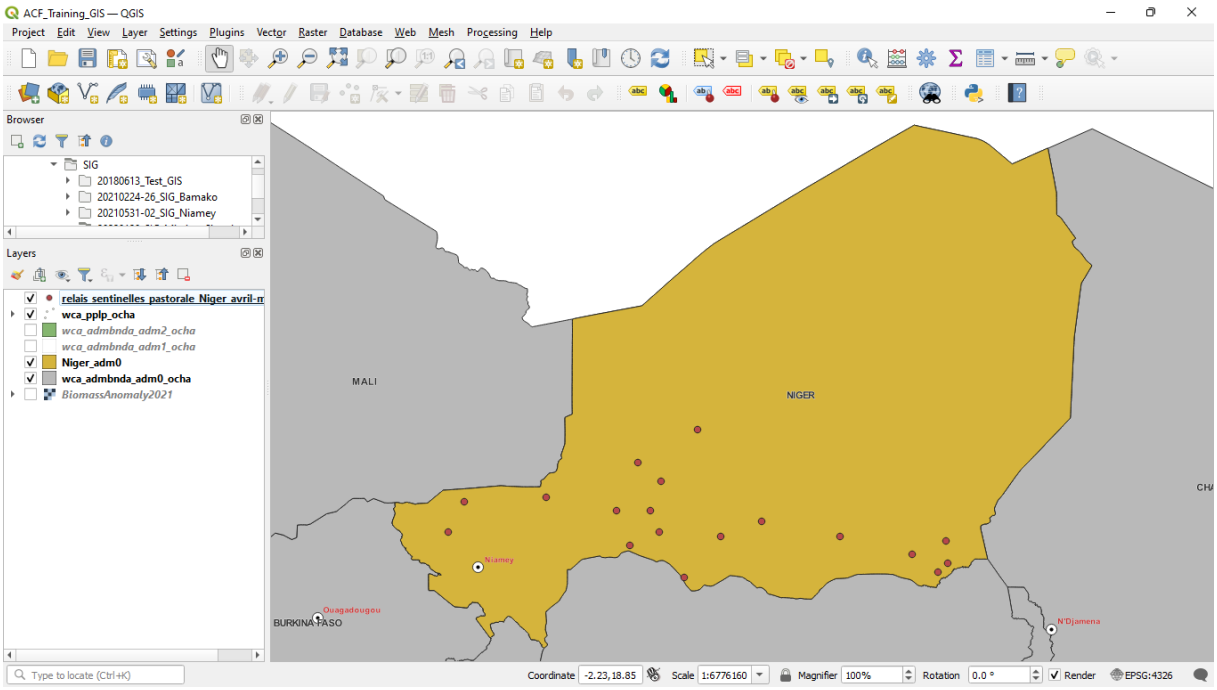


Figure 14 – ACF Pastoral Sentinels location over Niger

4.9 Extracting information and analysing data

Many tools are available in QGIS for processing vector data. They will not be detailed here but documentation is available on the QGIS online documentation. To access the tools, go to the Menu Vector > Tools drop-down menu

- Geoprocessing tools: buffer, union, dissolution, etc.
- Geometry tools: centroid, triangulation, simplification, etc.
- Analysis tools: statistics
- Data management tools: database management
- Search tools: selection by location or by attributes

Activity: Create a buffer of 10 km around each sentinel site

- ✓ *Reproject the layer relais_sentinelles_pastorale_Niger_avril-mai_2021 to UTM projection: Menu Vector > Data Management Tools > Reproject Layer and select EPSG:32632 – WGS 84 / UTM zone 32N as Target CRS, and click Run*
  A new temporary Layer called "Reprojected" is added to the Layers panel
- ✓ *Click on Vector > Geoprocessing Tools > Buffer, and use the layer "Reprojected" as Input Layer, set the distance to 10 km and click Run*
  A new temporary Layer called "Buffered" is added to the Layers panel
- ✓ *Observe the result*

4.10 Filters

The filter tool allows you to show only certain elements that interest you. To access this tool, right-click on the layer > Filter . A window opens with a list of fields from the attribute table on one side, the values of each field on the other and a space to write an expression. In this case, we will simply choose a value for one of the fields: "field_X" = "value_Y". The layer will then show only the vector associated with the selected value. When a layer is filtered, the icon appears next to it.

Activity: Apply a filter on a layer

- ✓ *Right-click on layer wca_admdnda_adm2_ocha and select "Filter" to open the filter Query Builder window* (Figure 15)
- ✓ *Type a query to select only admin2 of Mali*
- ✓ *Look at the effect on the map after activating the layer*

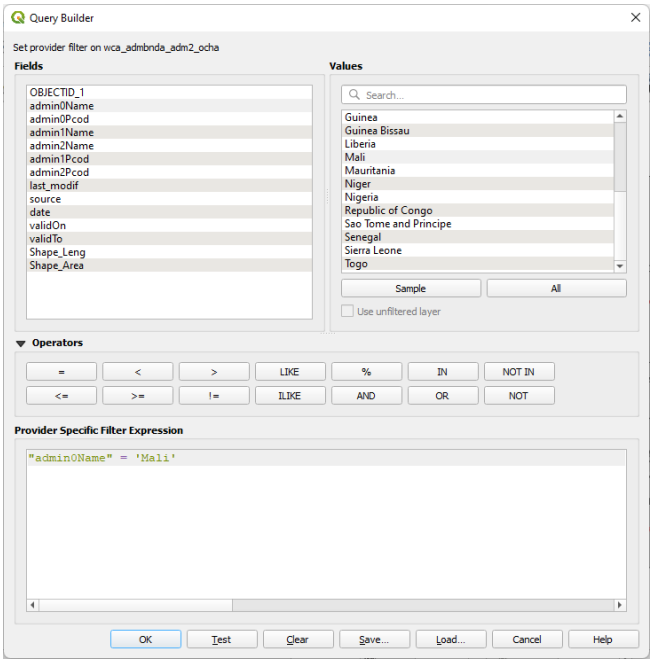


Figure 15 – Filter Query Builder window

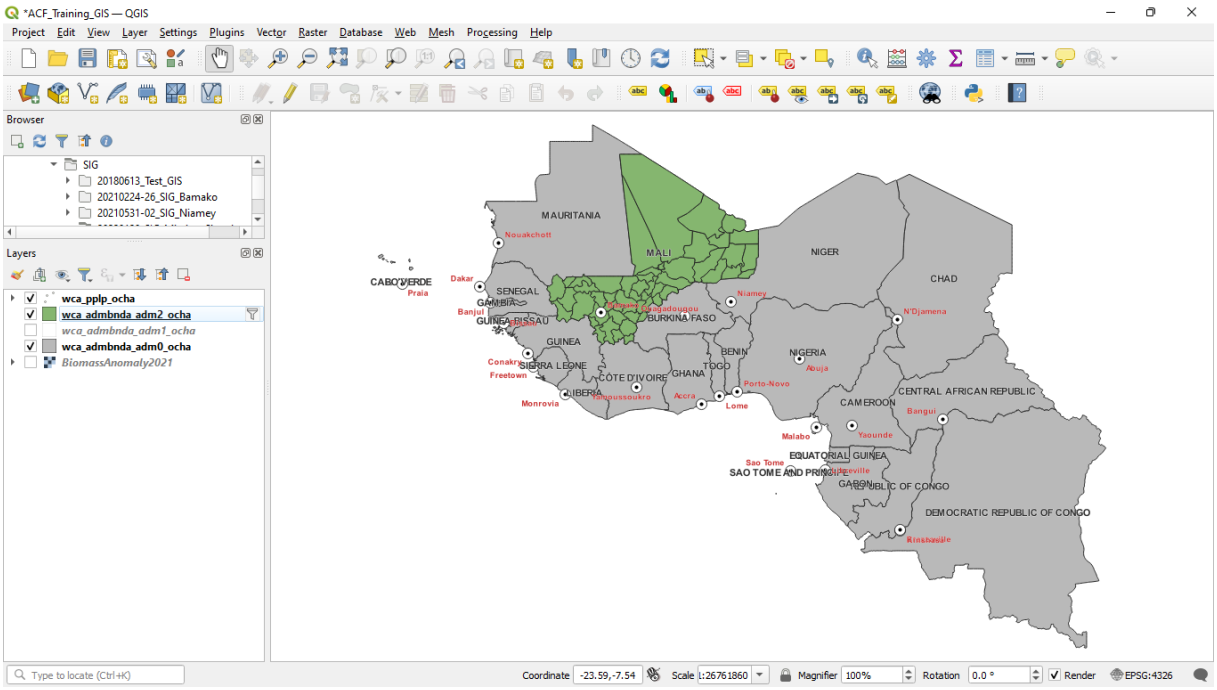


Figure 16 – Administrative boundaries level 2 over Mali

4.11 Joins

4.11.1 Joining by attributes

The joins tab allows you to join a vector layer to an attribute table (e.g., an Excel file). This can be very useful if you have for example a table with data of malnutrition organised by administrative region and you want to link it with the shapefile on administrative regions. To do this, simply right click on the layer > Properties > Join

Then click on the button to add a vector to be joined. It is necessary to define the join layer to be connected to the target layer (the one on which you have opened the properties window). You are then asked to specify the name of the joining field which is the common field for both layers (the name of the administrative regions in the example above). By default, all the information in the table will be joined but it is possible to specify the fields to be joined so that not all the fields are added.

Activity: Add prevalence of Malnutrition on the attribute table

- ✓ *Open the file SMART/Niger_SMART_2016.xlsx with Excel and save it as a Comma-separated values (.csv) file*
- ✓ *In QGIS, add the .csv table by clicking on:*
  Layer > Add Layer > Add Delimited Text Layer
  selecting the option: "No geometry (attribute table only)"
  It might be necessary to define the correct delimiter in File Format
- ✓ *Open the Joins window:*
  Right-click on the layer wca_admbnda_adm1_ocha > Properties > Joins
  And click on 
- ✓ *Perform the join of the added table using the field admin1Pcod in both "Join field" and "Target field"* (Figure 17), *click OK and then Apply*
- ✓ *Verify the result by opening the attribute table*

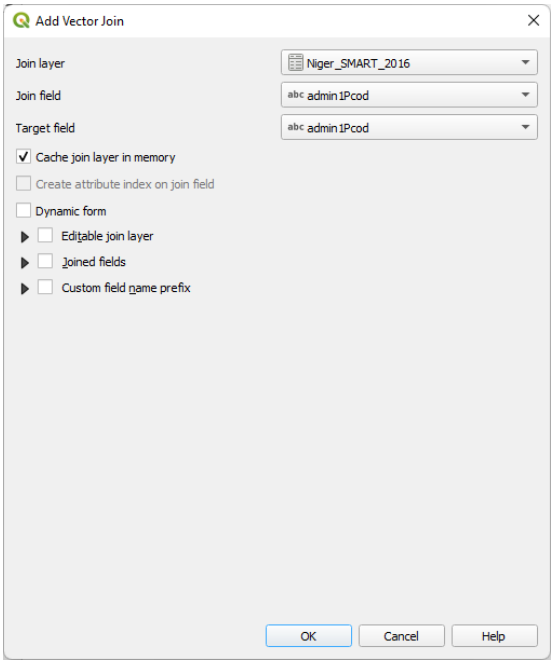


Figure 17 – Add Vector Join window

4.11.2 Spatial connection

The spatial join allows you to add information to a layer according to its spatial location. For example, it is useful to add to a point layer (e.g., schools), the administrative zones to which the entities belong. The tool is available in Vector > Data management tools > Join attributes by location.

4.12 Coordinate conversion

Each layer (shapefile or raster) is defined by a reference coordinate system (RCS). There are, as already stated above, two main types of RCS:

- Geographic coordinate systems: These are recommended when you are interested in precise latitudes and longitudes. They are used in GPS, the most common is the SCR WGS84: EPSG:4326
- Projected coordinate system: these are suitable when you want to know an area, a distance or something else. The most common is the UTM.

It is sometimes necessary to convert a layer from one projection system to another. To know the SCR of the layer: right-click on the layer > Properties > Information > SCR. To reproject a layer, use the reproject tool which is available in: Vectors > Data Management Tools > Reproject Layer…

Activity: Reproject a vector layer

- ✓ *Open the reprojection vector layer tool and select wca_admbnda_adm0_ocha layer as the input layer, select Africa_Albers_Equal_Area_Conic (EPSG: 102022) projection as the target CRS, and then press "Run". A new temporary layer, called Reprojected is added to the project*
- ✓ *Verify the project of this new layer*

4.13 Internet services

4.13.1 Open Street Map data

Open Street Map OSM is a free service of worldwide and up to date data regarding roads and building accessible throw the internet. To use OSM data it is necessary to install the QuickMapServices extension by going to the menu Plugins > Manage and Install Plugins, searching for the QuickMapServices plugin and installing it.

The first use of OSM is to display a background map. For that, you will then be able to display OSM and other data directly from the menu Web > QuickMapServices > OSM > OSM Standard.

A second use is to integrate OSM data as layers in the project:

- On the display window, zoom on the area of interest
- Open the menu Vector > QuickOSM > QuickOSM
- On the QuickOSM menu, select Map preset, click on Urban, and select “Canvas Extent”, then click “Run preset” (Figure 18)
- Check that new layers are added to the canvas

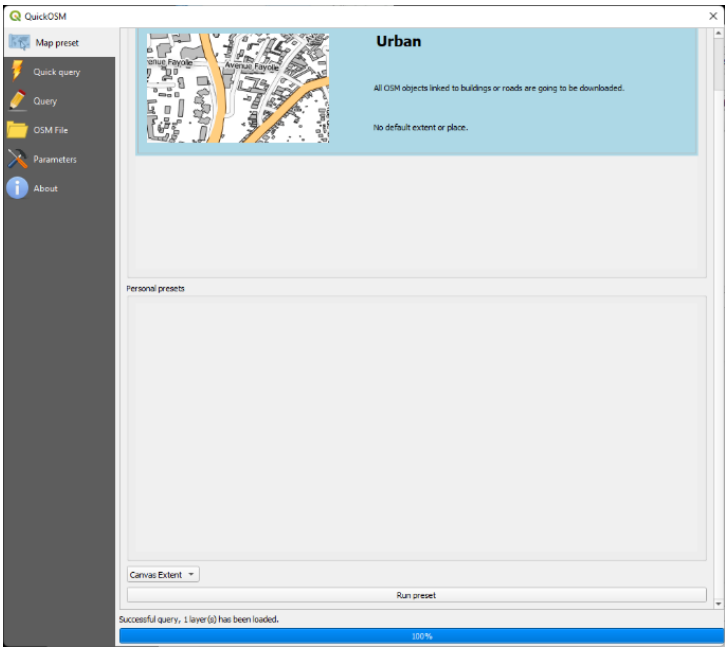


Figure 18 – QuickOSM menu window

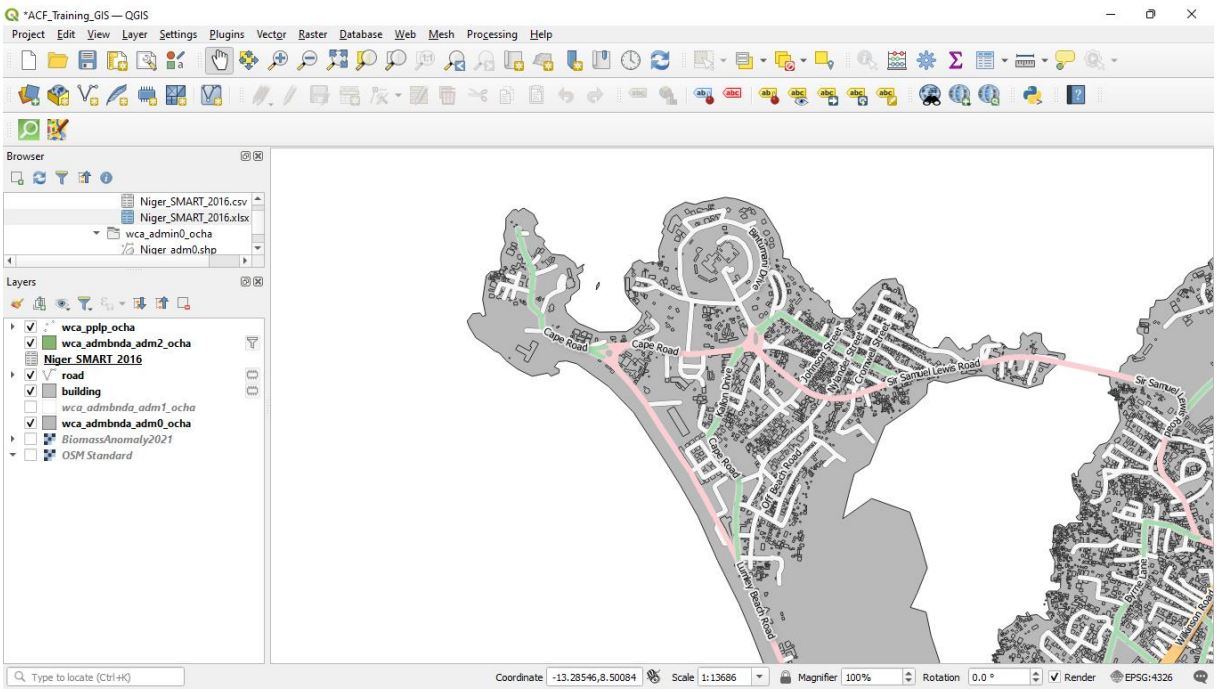


Figure 19 – Open Street Map data over Aberdeen Neighbourhood in Freetown

4.13.2 Satellite imageries

QGIS permits to display of satellite imageries accessible directly from the internet. For that, it is necessary to make a new connection with a satellite data service by clicking on the Browser panel to click right on XYZ Tiles > New connection (Figure 20).

Then you are asked to give the connection a name and enter a URL. The most used URLs are:

- Google Maps: https://mt1.google.com/vt/lyrs=r&x={x}&y={y}&z={z}
- Google Satellite: http://www.google.cn/maps/vt?lyrs=s@189&gl=cn&x={x}&y={y}&z={z}
- Google Satellite Hybrid: https://mt1.google.com/vt/lyrs=y&x={x}&y={y}&z={z}
- Google Terrain: https://mt1.google.com/vt/lyrs=t&x={x}&y={y}&z={z}
- Google Roads: https://mt1.google.com/vt/lyrs=h&x={x}&y={y}&z={z}

While the new connection is established, you could add layers to the project by rick clicking on the XYZ Tiles service name and “Add Layer to Project”. A new raster layer will be added to the project.

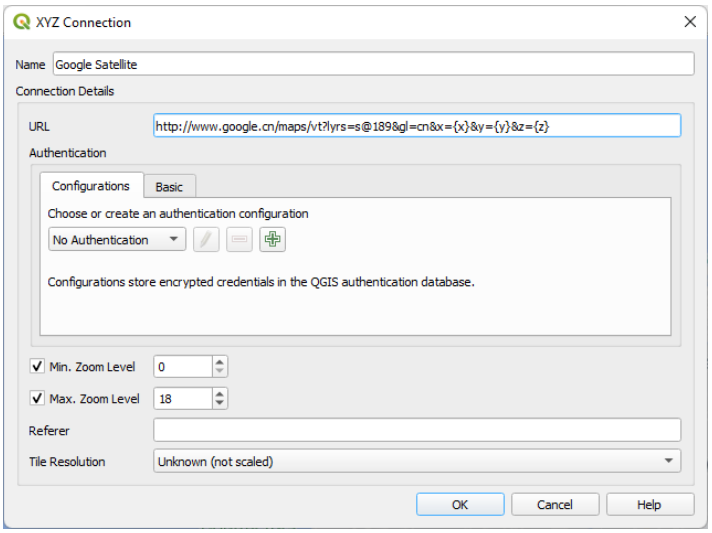


Figure 20 – Example of adding Google Satellite connection to XYZ Tiles

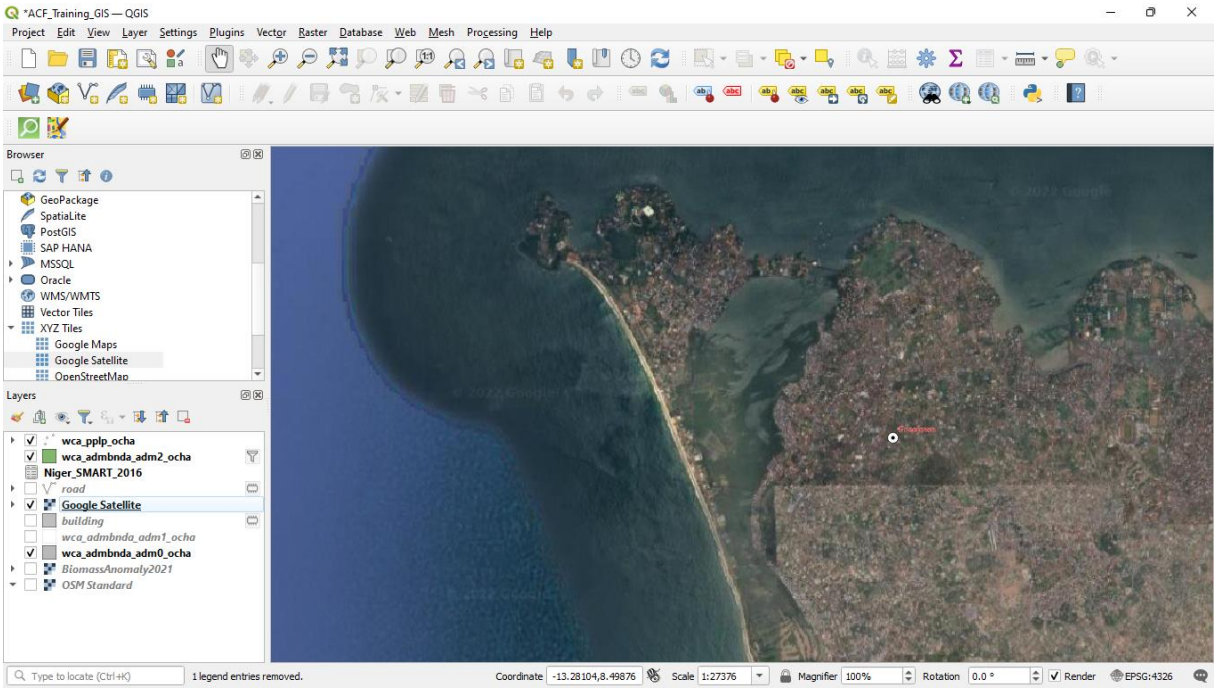


Figure 21 – Google Satellite Image over Aberdeen Neighbourhood in Freetown

4.14 Digitizing

It could be useful to create a new vector layer and add features to it. For example, you may want to indicate on a map the precise location of schools, water points, hospitals, etc.

To do this, start by creating an empty shapefile Layer > Create Layer > New Shapefile Layer. It is necessary to specify whether the vector layer will contain points, lines, or polygons and to give it a file name. Then it is possible to add the names of the various fields which will be present in the layer by specifying the name of the field and the type (string for characters, date for dates, number, integer, etc.).

Once the shapefile is created, it is necessary to add data to the shapefile. To do this, click on the layer and then switch to edit mode using 

Then you can start adding data by doing two things:

- Digitize the geometry (i.e., point, line, polygon)
- Enter the attributes of the attribute table

Useful tools can be found in the editing toolbar

- To add a new feature:
   for a new point,  for a new line and  for a new polygon
- To move the entity:
   To move a point,  to move a line,  to move a polygon
- Entities could be removed by selecting it a pressing “suppr” key
-  To save changes
-  To exit the editing mode

When adding a point, simply go to the area where you want to add it and left-click, and it will be added automatically. For lines and polygons, left-clicking adds segments while right-clicking stops adding segments and finishes the line and polygon.

Activity: Create a polygon vector file from a satellite image

- ✓ *Open New Shapefile Layer tool: Layer > Create Layer > New Shapefile Layer*
- ✓ *Create a new empty vector layer of geometry type of polygons and name it crop_field.shp Layer, and add fields to this empty vector layer and give them names such as ID and Name*
- ✓ *Using the google Satellite Layer, zoom on an agricultural area and start an editing session and add different rice field features based on satellite images or OSM*
- ✓ *Complete the attribute table for these entities*
- ✓ *Save the changes and exit editing mode*

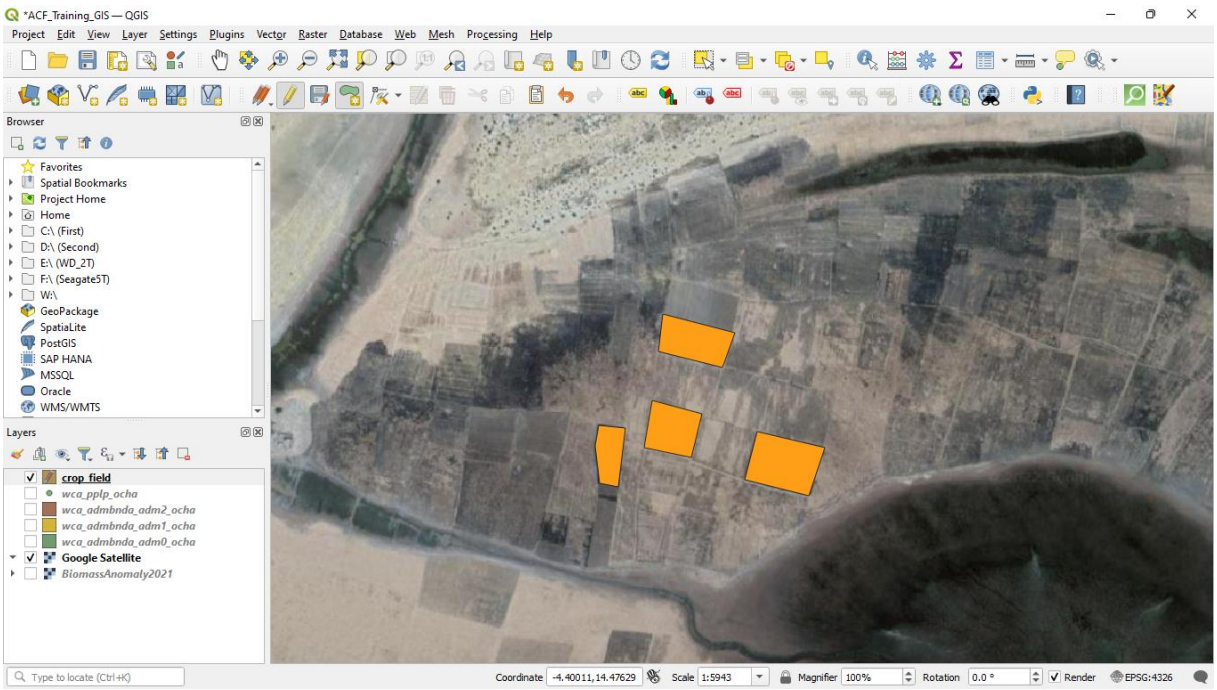


Figure 22 – Digitization of crop parcels in central Mali from Google Satellite imagery

5 Raster data

This section on raster data is introductory. Its purpose is simply to be able to display a raster and change its style. We have already seen earlier how to add a raster layer to the QGIS project. As a reminder, raster layers are often saved in GeoTIFF .tiff format.

5.1 Symbology

In this introduction, we focus only on the display of single-band raster images. This corresponds for example to biomass production and biomass production anomaly images. These images are characterised by a single band that stores for each pixel the value of the layer. For example, the band of a biomass production anomaly image stores for each pixel the value of the anomaly ranging from 0 to 200%.

To adjust the style of a raster layer, right-click > Properties > Symbology It is then possible to select the type of rendering between:

- Multiband color: To be used with a multiband image
- Paletted/Unique values: To affect to each unique value a different colour
- Singleband grey: to give a grey gradient to the layer
- Singleband pseudocolor: To affect each range of values a different colour
- Hillshade: To be used with elevation model to represent relief
- Contours: To be used to represent limits in local variation, as for elevation level lines

When we add a raster layer to QGIS, by default it will be the “singleband grey” but other colour display mode could be selected in the properties.

For the biomass anomaly map, it is necessary to select “singleband pseudocolor” to set the limits between 0 and 200, to choose a discrete interpolation, a continuous classification mode with 10 classes so that each class includes a range of 20% of values. Then, it is necessary to add two additional values by clicking on them to put the values lower than -9998 in off-white and those of -9997 in grey. These values correspond to areas with no data because the biomass is absent. The style window should now look like Figure 23.

Activity: Produce a colour ramp the symbology for a raster layer

- ✓ Edit the symbology of layer Anomaly_biomass_2021.tif and reproduce the colour gradient from red to green as shown in Figure 23
- ✓ Clicking on , permits to add specific colours for values -9998 and -9997 which correspond to desert areas where the calculation of the anomaly was not possible

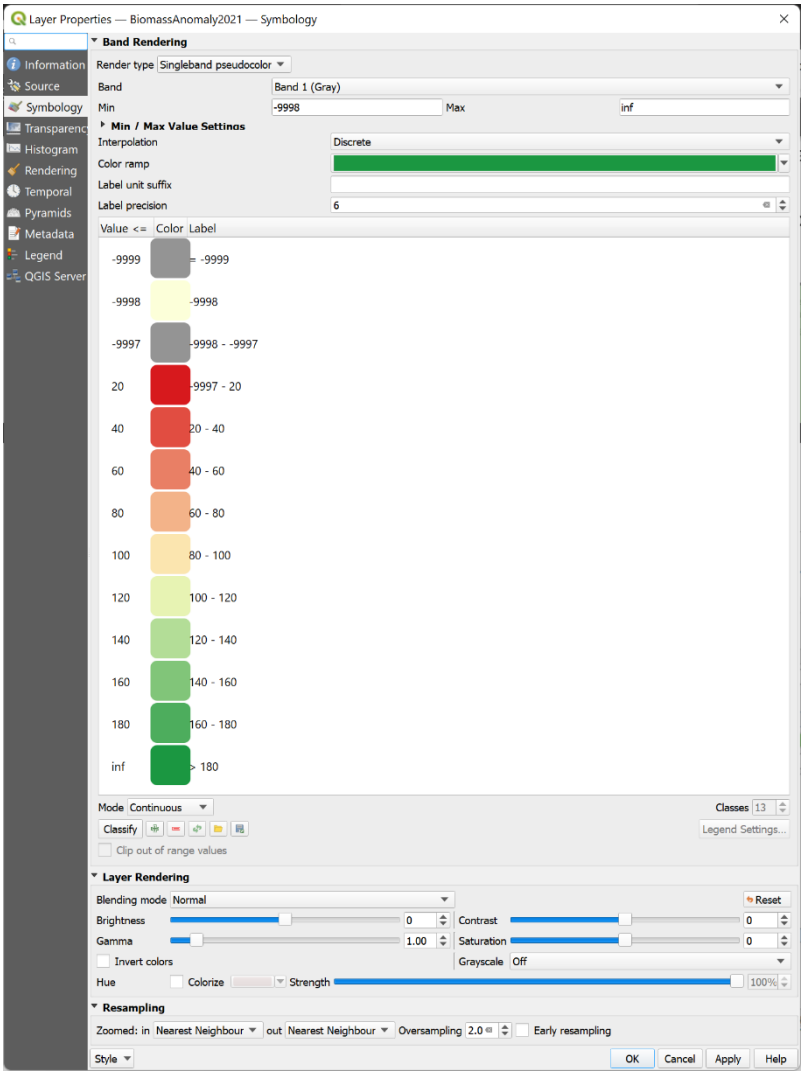


Figure 23 – Symbology used to display the biomass anomaly raster layer

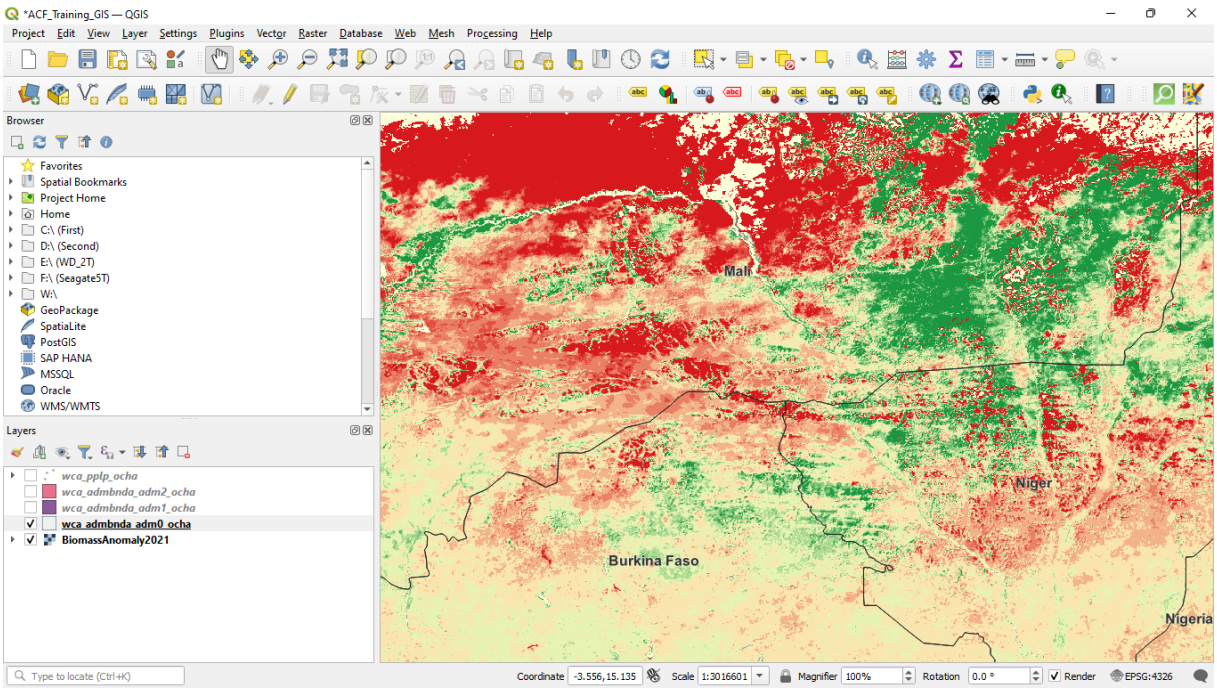


Figure 24 – Annual biomass production anomaly for the year 2021 over the central Sahel

5.2 Pixel value tool

A useful tool for finding out the value of each pixel can be installed. To do this, go to Plugins > Manage and Install Plugins, search for Value Tool and install it.

Once the extension is installed, a new icon appears in the toolbar  . By clicking on it, a window appears, and you need to check Enable to activate the tool. After having selected a raster layer, such as BiomassAnomaly2021, while moving the mouse causes the corresponding pixel value is displayed in the Value Tool extension window.

5.3 Area statistics

The area statistics tool allows the calculation of statistics on raster layers based on areas of interest defined by polygons. Different statistical functions are available such as average, minimum, maximum, etc. To access this tool, open the Processing Toolbox in View > Panels > Processing Toolbox and search for the tool named Raster analysis > Zonal statistics

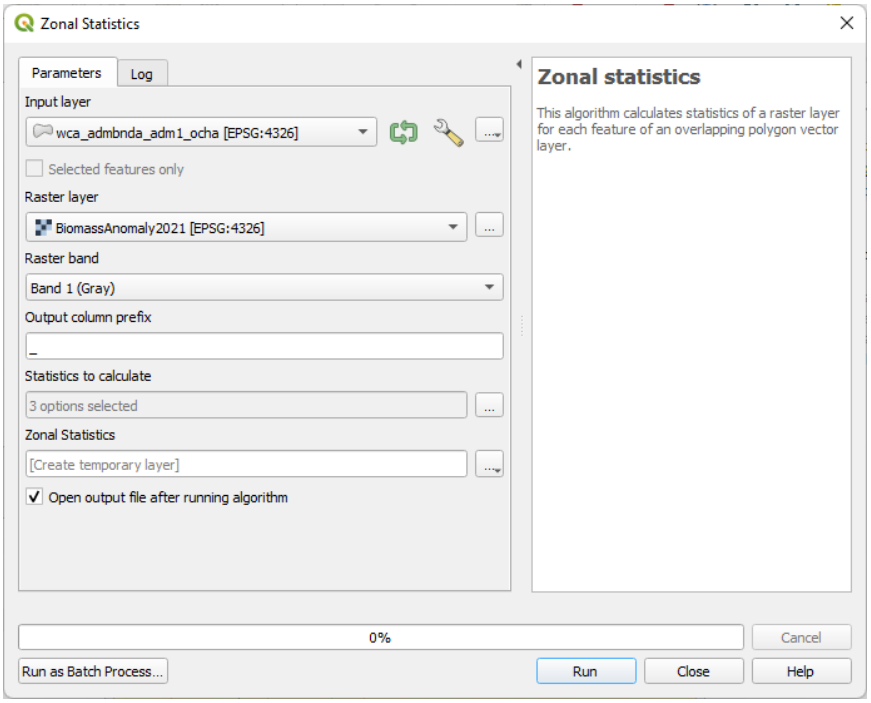
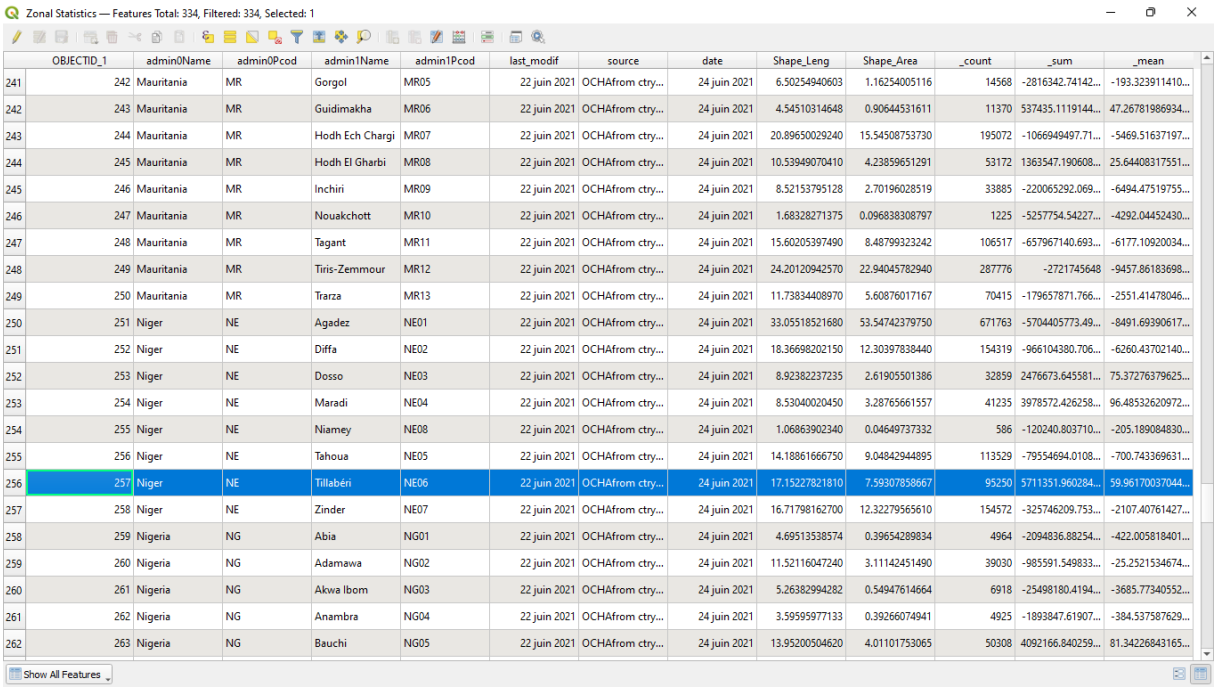


Figure 25 – Zonal statistics tool menu window

Activity: Calculate the average biomass anomaly for the Tillabéry region of Niger

- ✓ Open the area statistics tool and put the raster layer BiomassAnomaly2021 and the vector layer wca_admbnda_adm1_ocha
- ✓ Choose the statistics to be calculated, including 'Mean'
- ✓ Check the results stored in the attribute table of the new vector layer created named Zonal Statistics



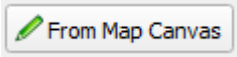
	OBJECTID_1	admin0Name	admin0Pcod	admin1Name	admin1Pcod	last_modif	source	date	Shape_Leng	Shape_Area	_count	_sum	_mean
241	242	Mauritania	MR	Gorgol	MR05	22 juin 2021	OCHAfrom ctry...	24 juin 2021	6.50254940603	1.16254005116	14568	-2816342.74142...	-193.323911410...
242	243	Mauritania	MR	Guidimakha	MR06	22 juin 2021	OCHAfrom ctry...	24 juin 2021	4.54510314648	0.90644531611	11370	537435.1119144...	47.26781986934...
243	244	Mauritania	MR	Hodh Ech Chargi	MR07	22 juin 2021	OCHAfrom ctry...	24 juin 2021	20.89650029240	15.54508753730	195072	-1066949497.71...	-5469.51637197...
244	245	Mauritania	MR	Hodh El Gharbi	MR08	22 juin 2021	OCHAfrom ctry...	24 juin 2021	10.53949070410	4.23859651291	53172	1363547.190608...	25.64408317551...
245	246	Mauritania	MR	Inchiri	MR09	22 juin 2021	OCHAfrom ctry...	24 juin 2021	8.52153795128	2.70196028519	33885	-220065292.069...	-6494.47519755...
246	247	Mauritania	MR	Nouakchott	MR10	22 juin 2021	OCHAfrom ctry...	24 juin 2021	1.68328271375	0.096838308797	1225	-5257754.54227...	-4292.04452430...
247	248	Mauritania	MR	Tagant	MR11	22 juin 2021	OCHAfrom ctry...	24 juin 2021	15.60205397490	8.48799323242	106517	-657967140.693...	-6177.10920034...
248	249	Mauritania	MR	Tiris-Zemmour	MR12	22 juin 2021	OCHAfrom ctry...	24 juin 2021	24.20120942570	22.94045782940	287776	-2721745648	-9457.86183698...
249	250	Mauritania	MR	Trarza	MR13	22 juin 2021	OCHAfrom ctry...	24 juin 2021	11.73834408970	5.60876017167	70415	-179657871.766...	-2551.41478046...
250	251	Niger	NE	Agadez	NE01	22 juin 2021	OCHAfrom ctry...	24 juin 2021	33.05518521680	53.54742379750	671763	-5704405773.49...	-8491.69390617...
251	252	Niger	NE	Diffa	NE02	22 juin 2021	OCHAfrom ctry...	24 juin 2021	18.36698202150	12.30397838440	154319	-966104380.706...	-6260.43702140...
252	253	Niger	NE	Dosso	NE03	22 juin 2021	OCHAfrom ctry...	24 juin 2021	8.92382237235	2.61905501386	32859	2476673.645581...	75.37276379625...
253	254	Niger	NE	Maradi	NE04	22 juin 2021	OCHAfrom ctry...	24 juin 2021	8.53040020450	3.28765661557	41235	3978572.426258...	96.48532620972...
254	255	Niger	NE	Niamey	NE08	22 juin 2021	OCHAfrom ctry...	24 juin 2021	1.06863902340	0.04649737332	586	-120240.803710...	-205.189084830...
255	256	Niger	NE	Tahoua	NE05	22 juin 2021	OCHAfrom ctry...	24 juin 2021	14.18861666750	9.04842944895	113529	-79554694.0108...	-700.743369631...
256	257	Niger	NE	Tillabéri	NE06	22 juin 2021	OCHAfrom ctry...	24 juin 2021	17.15227821810	7.59307858667	95250	5711351.960284...	59.96170037044...
257	258	Niger	NE	Zinder	NE07	22 juin 2021	OCHAfrom ctry...	24 juin 2021	16.71798162700	12.32279565610	154572	-325746209.753...	-2107.40761427...
258	259	Nigeria	NG	Abia	NG01	22 juin 2021	OCHAfrom ctry...	24 juin 2021	4.69513538574	0.39654289834	4964	-2094836.88254...	-422.005818401...
259	260	Nigeria	NG	Adamawa	NG02	22 juin 2021	OCHAfrom ctry...	24 juin 2021	11.52116047240	3.11142451490	39030	-985591.549833...	-25.2521534674...
260	261	Nigeria	NG	Akwa Ibom	NG03	22 juin 2021	OCHAfrom ctry...	24 juin 2021	5.26382994282	0.54947614664	6918	-25498180.4194...	-3685.77340552...
261	262	Nigeria	NG	Anambra	NG04	22 juin 2021	OCHAfrom ctry...	24 juin 2021	3.59595977133	0.39266074941	4925	-1893847.61907...	-384.537587629...
262	263	Nigeria	NG	Bauchi	NG05	22 juin 2021	OCHAfrom ctry...	24 juin 2021	13.95200504620	4.01101753065	50308	4092166.840259...	81.34226843165...

Figure 26 – Statistical values stored in the attribute table

5.4 Geo-referencing tool to assist digitisation

Durant participatory mapping exercise, people draw freehand on a map, and information is therefore produced on paper. It is then necessary to digitise this information to create spatialised data to be used either as a decision support tool or to produce maps.

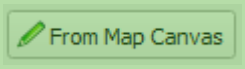
To open the georeferencing tool, click on Raster > Georeferencer, and a window opens on which you can add the layer to be georeferenced using the icon  . It is also necessary to specify the reference coordinate system RCS for the layer (e.g., WGS84, EPSG: 4326). The image is then added to the window. Once the image has been added, ground control points GCP must be added to georeference the map. To do this, two possibilities exist

- You know the coordinates of certain points visible on the map to be georeferenced. In this case, click on a place on the map for which you know the coordinates and enter the coordinates manually.
- You do not know the exact coordinates, but you have opened in QGIS the administrative boundaries or villages that are present on the scanned map. You can then click on an easily locatable place and then select from the map canvas bouton 

and just select the place in the QGIS window that corresponds to the control point.

You need to add several control points, at least a dozen, and spread them well over the map. Once this is done, click on  to start the georeferencing. You need to give a name to the raster layer and leave the other parameters by default (Thin plate spline, nearest neighbour, EPSG:4236 - WGS 84). Then, when you click ok, the georeferencing starts and the layer can be added and used to facilitate the digitisation.

Activity: Georeferencing a scanned map on transhumance corridors over the region of Mayahi in Niger

- ✓ In the canvas, display layer wca_admbnda_adm2_ocha and zoom on the department of Mayahi (region of Maradi) in Niger
- ✓ Open the Georeferencer menu windows
- ✓ Select the file Mayahi/Mayahi_Corridors.png to be georeferenced
- ✓ Plot a point along the region boundary in red, click on 

and select the same point on the canvas
- ✓ Repeat the operation for a dozen a point along the whole region boundary

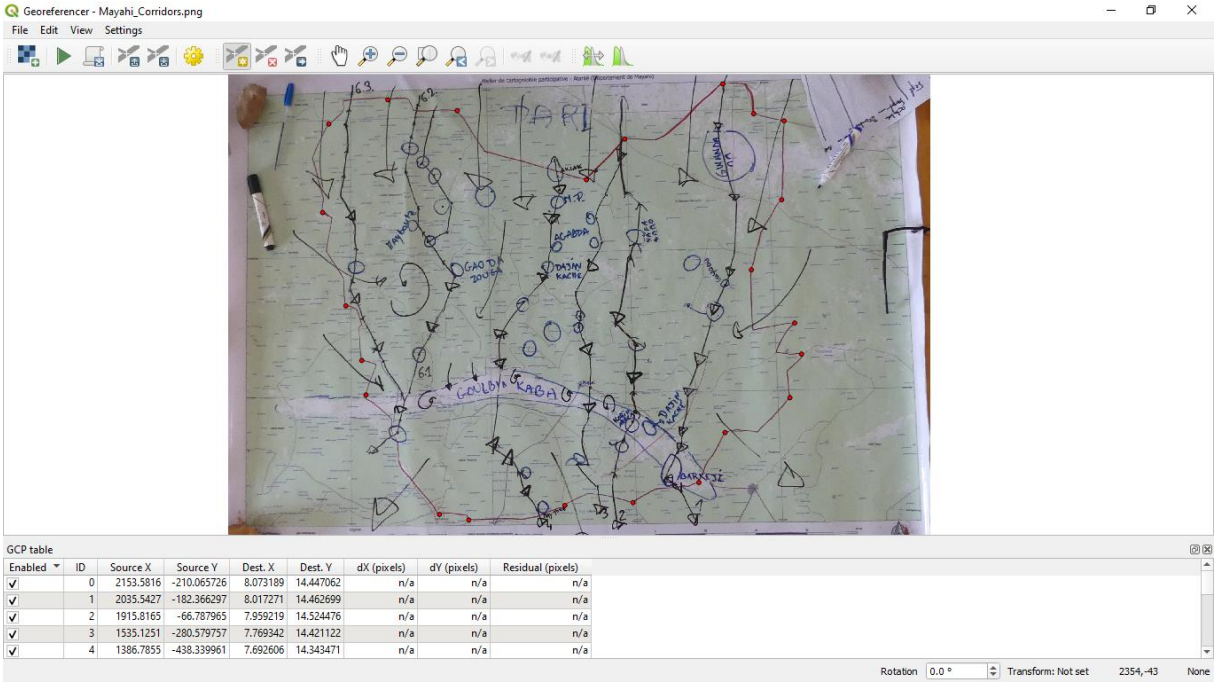


Figure 27 – Georeferencer window during the process of ground control point selection

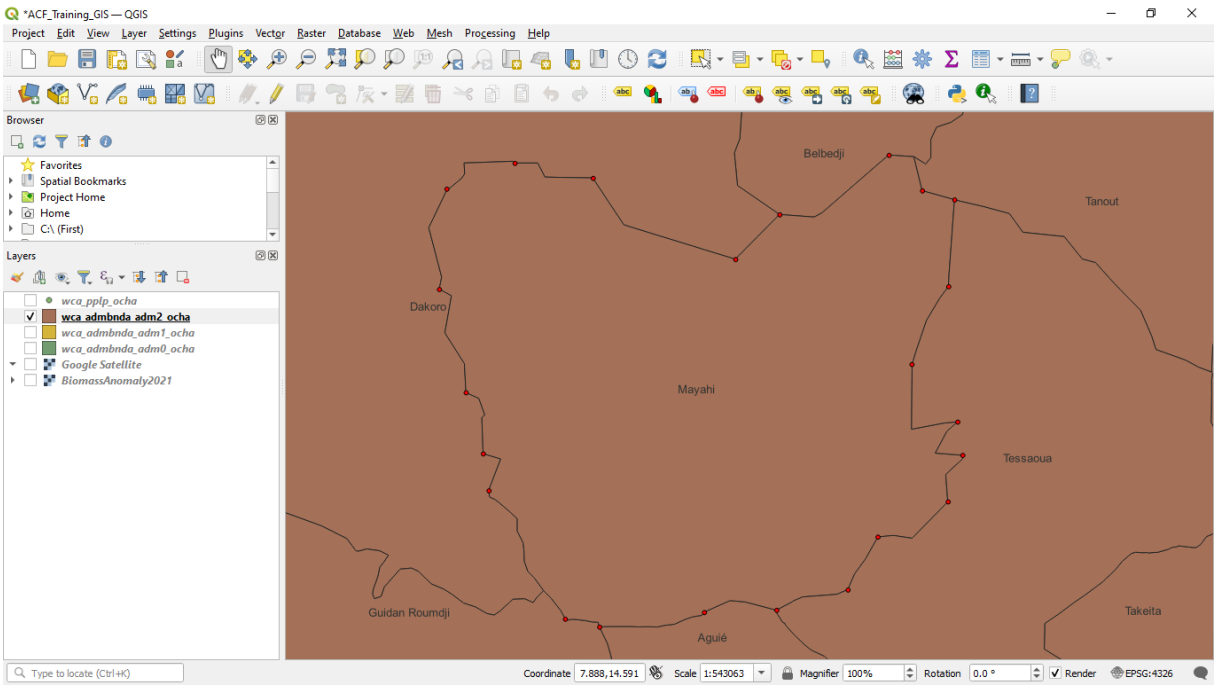


Figure 28 – Main QGIS window during the process of ground control point selection

6 Page layout - print composer

Having seen how to correctly process and display vector and raster data, it is now useful to create a map that can be exported to be used in other software or to be printed out.

6.1 Creating a new Layout

To do this, you need to create a new print composer Project > New Print Layout and give your layout a name and a new window, the layout composer, will open. This will allow you to create the map, set a scale, and add all elements requested to create the final map. If you want to open the saved layout, just go to Project > Layout and choose the corresponding layout.

It is preferable to define the size of the card printout (A0, A2, A3, A4 or other) from the start so that it is directly produced in the correct format. To do this, select Item Properties on the right folder, and select one of the predefined sizes (e.g., A4) or specify manually the width and height in millimetres and the orientation of the layout.

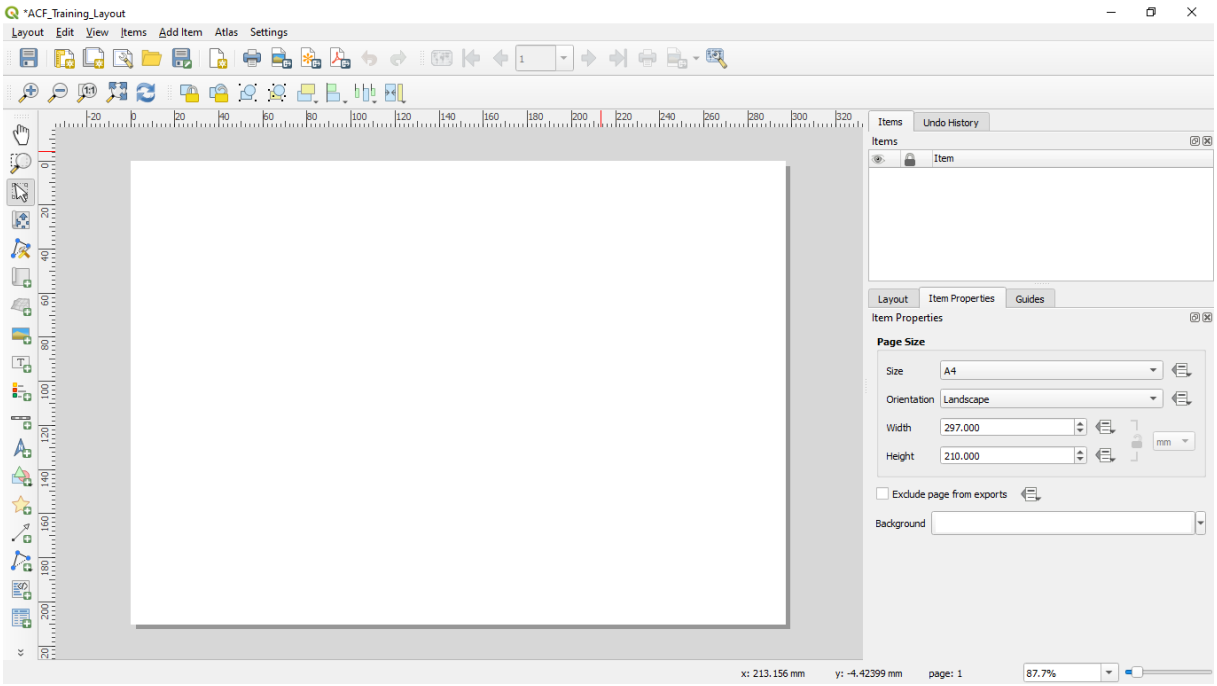


Figure 29 – Layout composer window

Between all, two boutons are very useful:

- permits to set the zoom of canvas at its maximum to fill up the entire window
- forces the refreshing of the viewer while changes have been made in the main QGIS window

6.2 Adding a map and changing the page size

To add a map, the location of the map must be drawn using.

To move around the map, use the icon  and hold the left button while moving the mouse. Map zoom could be adjusted using the mouse wheel and fine-tuned by keeping the shift key pressed.

The map, as every object present on the layout, could be moved on the canvas by switching on  , clicking on the map as a graphical object with maintaining the left mouse button pressed, and moving the mouse. The size of the graphical object could be adjusted by moving one of its corners.

6.3 Adding the scale

A map should always contain a scale. The graphical scale is generally preferred to the numerical scale because the latter is retained even if the final size of the map is changed. To add a scale, click on  and draw the desired location for the scale. A property window of the object opens and refers to the scale bar. In this window, it is possible to manage all the parameters of the scale, i.e., units, segment width, writing size, colours...

6.4 Adding the legend

Any map that includes vector or raster layers representing features must be accompanied by a legend. To add a legend, select  and draw the area where the legend is to be added. In the properties of the legend object, the "Auto Update" checkbox should be unchecked to be able to make changes to the names of the layers and to remove certain elements that are not relevant to the map.

6.5 Addition of a North arrow

It is often advisable to add a North indication. For this, click on  and add an arrow on the map. Other arrows are available in the SVG Group arrows.

6.6 Adding an image or logo

A card made by ACF must contain the ACF logo. To add it, proceed as before by adding an image using  . Once the location has been drawn, the path to the image must be added in the object's property window. For better quality, it is preferable to use svg vectorial file format such as Data/Logo/Acf_Logo.svg

6.7 Adding a title

To add text, click on then  in the object properties, it is possible to write the title, modify the typography and the size of the text. This text tool can also be used to specify the sources of the map data or for any other text addition.

6.8 Adding graphical element

Optional graphical elements, such as rectangle, line, circle, could be easily added to the canvas by clicking on  . Filling colours, and outside borders could easily be adjusted by using the Item Properties menu.

6.9 Exporting the map

Once the map is finished, the final operation is to export it. This could be done in different formats:

- By clicking on  to export as a pdf file easily shareable or printed out.
- By clicking on  to export as a raster image (.png, .jpg, ...) for easy handling to be inserted into to document, but with a slight loose of the quality.
- By clicking on  to export as a vectorial image (.svg) for high-quality document but more complex to handle and with generally an increase of file size.

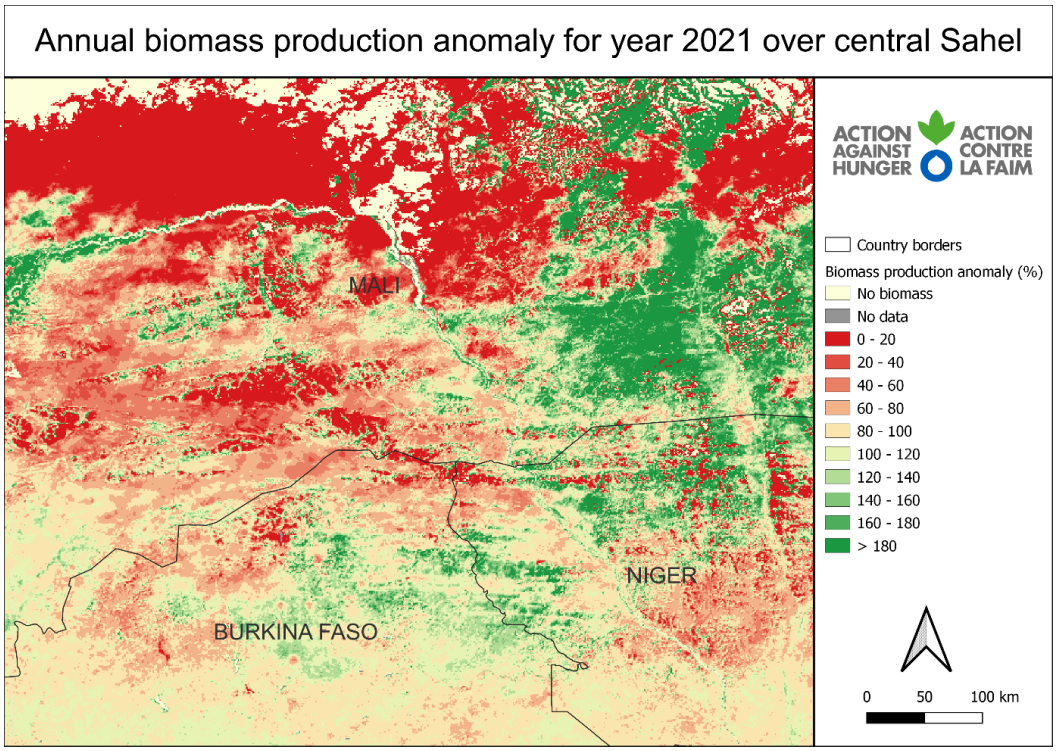


Figure 30 – Example of map production

This publication is developed by the DRR department of ACF's Regional Office for West and Central Africa. The opinions and views of the authors expressed in this publication are not binding on ACF.

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