

[Geographic Information for Vector Surveillance](#)

Day 2 of a 3 day course with Malaria examples

Finding and generating spatial data

Learning objectives

- know how to access free spatial data online
- understand what is meant by GPS
- able to collect GPS points and paths using GPSEssentials
- able to produce a map of collected points and paths using QGIS
- able to create shapefiles using QGIS

Length : 1 day

QGIS version : 3.2

Authors : Andy South, Michelle Stanton, Sophie Dunkley,

Updated : October 2018

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Free spatial data resources

There are lots of freely available spatially-referenced data online. Often the difficulty is in choosing which data are best and of most use to you among a confusing abundance of options that change over time. Data available online are of variable quality and a source that is good one year may become out of date a few years later. Here we will introduce you to some data that can be useful for vector surveillance in your countries. The list that we give is not complete, you may be aware of other resources that are better for your purposes. Also we are concentrating on freely available open data, you may have access to other national data sources through your local contacts.

Here we give you a brief overview of data sources for:

- ★ administrative boundaries (polygons)
- ★ human population distribution (rasters)
- ★ infrastructure, e.g. roads and buildings (points, lines, polygons)
- ★ malaria data (rasters)

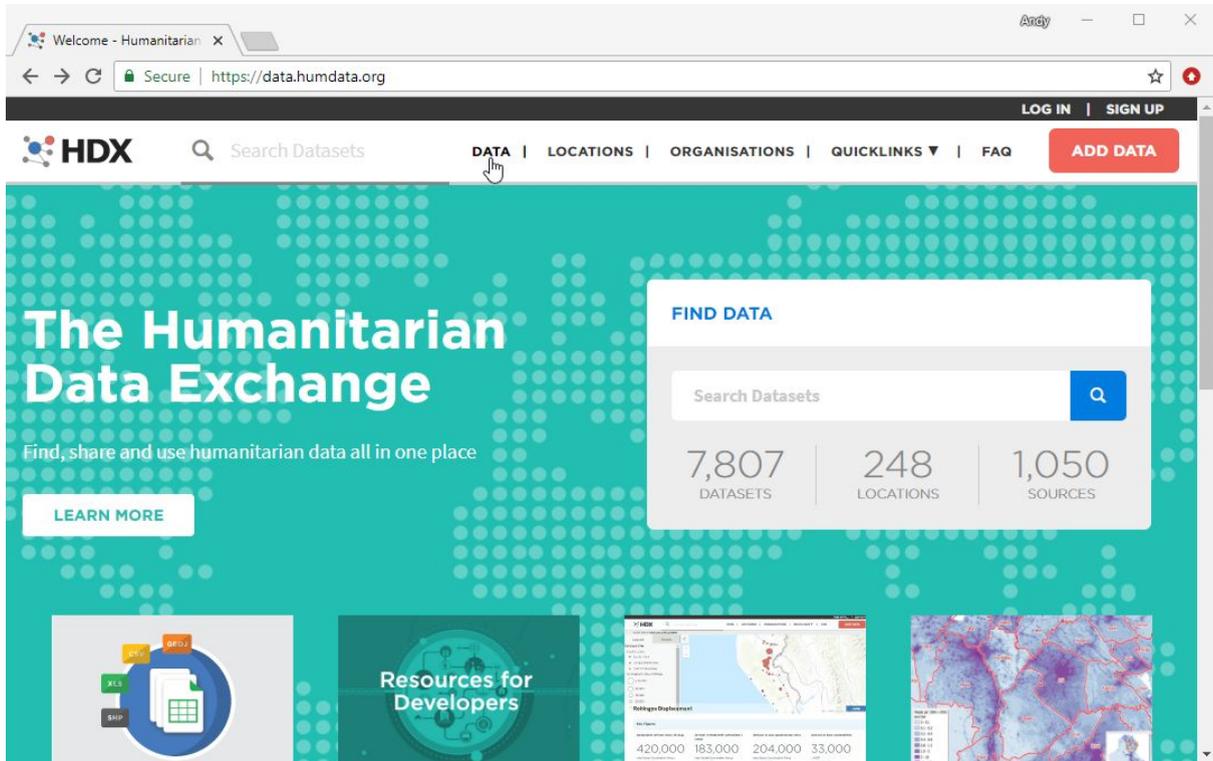
QGIS is able to deal with data in all common spatial data formats, it is unlikely that you will find a spatial data source that QGIS cannot accept.

Because the most difficult thing can be choosing between data sources of variable usefulness we are going to start by pointing you to one website that collates many useful data sources in one place and keeps them updated.

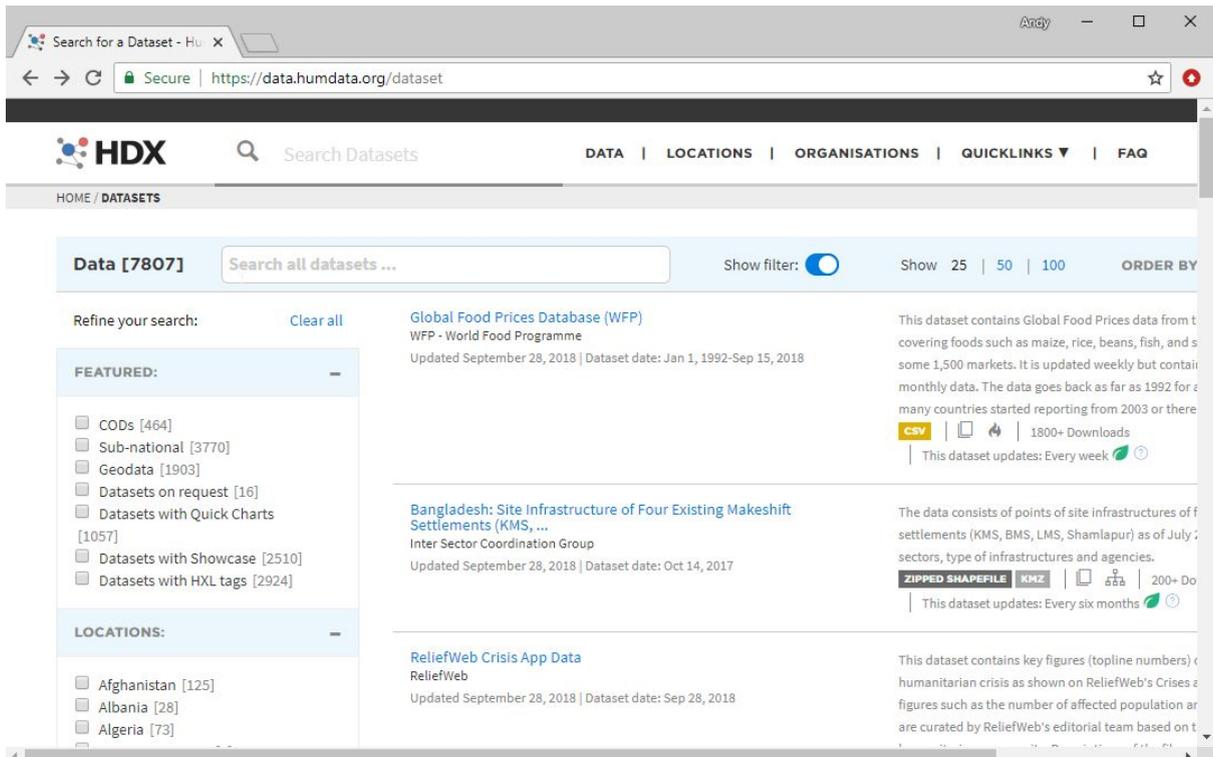
Humanitarian Data Exchange

Humanitarian Data Exchange <https://data.humdata.org/> is a UN run website that collates data for humanitarian action all in one place. These data can also be of use to us. Data can be downloaded

freely and easily and you don't have to register. (If you do register there are also options for submitting your own data.)

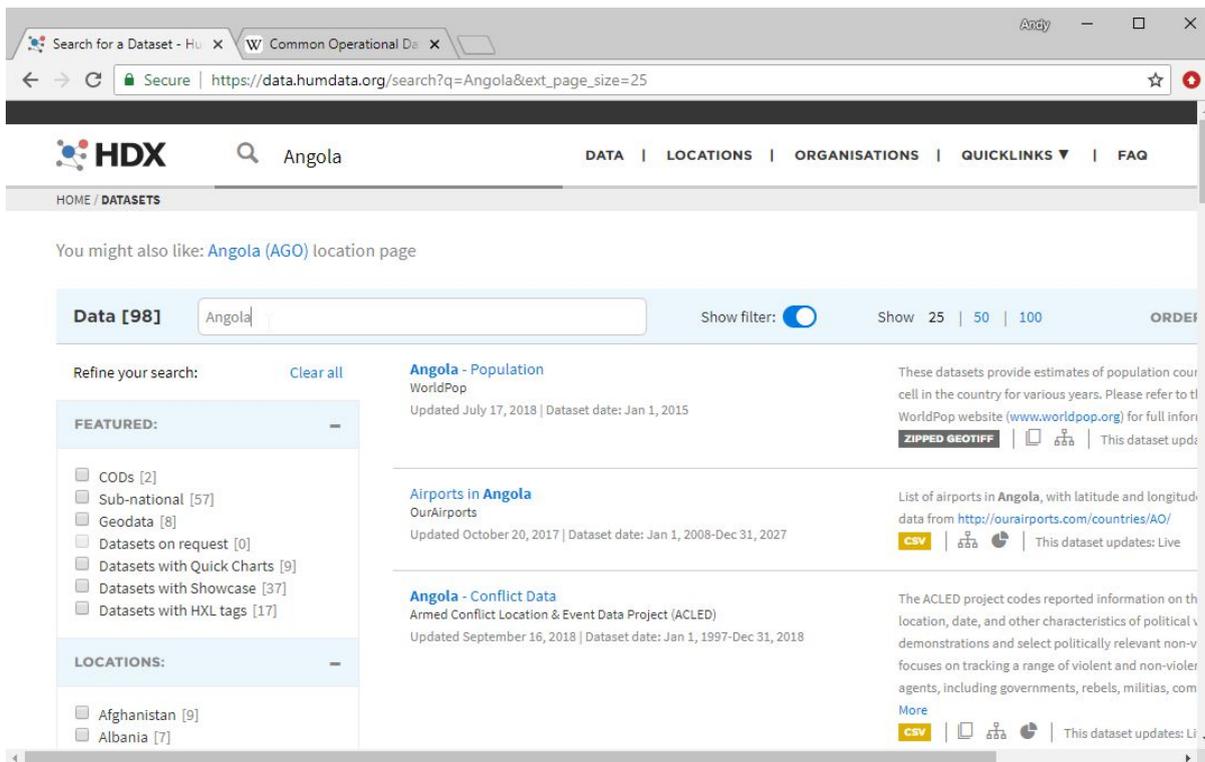


- go to <https://data.humdata.org/>
- click on the DATA tab at the top to go to the data explorer



→ type your country name into the search box and press return

We are using Angola as an example here but we suggest you use your own country.



This will likely return a large number of datasets, not all are spatial and not all will be useful to you.

To get the most useful datasets we can look for the ones called **Common Operational Datasets** or **CODs**. These are defined as authoritative reference datasets needed to support operations and decision-making in a humanitarian response. CODs are 'best available' datasets that ensure consistency and simplify the discovery and exchange of key data.

The main CODs are administrative boundaries (COD-AB) and population statistics (COD-PS).

There are a number of advantages of using HDX as a source of administrative boundaries over other sources such as GADM or Natural Earth. One is that they are regularly updated and may contain edits from more detailed or more up-to-date national data. The second advantage is that they may have been edited to make sure that they can **join** with population or other datasets. We will cover data joining later.

→ Tick the CODs tickbox on the HDX page to show just the Common Operational Datasets

This should display the administrative boundaries and population datasets.

The screenshot shows the HDX search results for 'Angola'. The search bar contains 'Angola' and the results are sorted by 'score+desc'. Two datasets are listed:

- Angola administrative levels 0 - 3** by OCHA ROSEA, updated September 21, 2018. It includes administrative level 0 (country), 1 (province), 2 (council), and 3 (commune) boundaries. Download options include XLSX, ZIPPED SHAPEFILE, KMZ, ZIP, and LIVE SERVICE. It has 200+ downloads and updates every year.
- Angola administrative level 0 - 2 population statistics** by OCHA ROSA, updated September 10, 2018. It includes the 2014 final and preliminary population statistics from the INE. Download options include XLSX, CSV, and SHP. It has 400+ downloads and updates every year.

On the left, there are filters for 'FEATURED' (CODs, Sub-national, Geodata, etc.) and 'LOCATIONS' (Angola).

→ Select the administrative boundaries polygons (be careful not to select the population statistics which may also refer to administrative levels in the text).

This will take you to a preview map :

The screenshot shows the preview map for the dataset 'Angola administrative levels 0 - 3'. The map displays the administrative boundaries of Angola in red, with major cities like Luanda and Brazzaville labeled. The map is interactive, with a 'Shape info' box on the left and social media links on the right. The URL in the browser is 'https://data.humdata.org/dataset/angola-administrative-levels-0-3'.

You will see that this refers to **administrative levels** 0-3. Administrative (**admin**) levels are an international standard for classifying boundaries that copes with fact that the sub-regions of countries are named differently, e.g. provinces, states, counties, districts, municipalities. Admin levels are hierarchical and get smaller as the admin level number increases.

- Admin Level 0 is the country outline
- Admin Level 1 is the next level down, e.g. province in Angola
- Admin Level 2 e.g. municipality in Angola
- Admin Level 3 e.g. commune in Angola

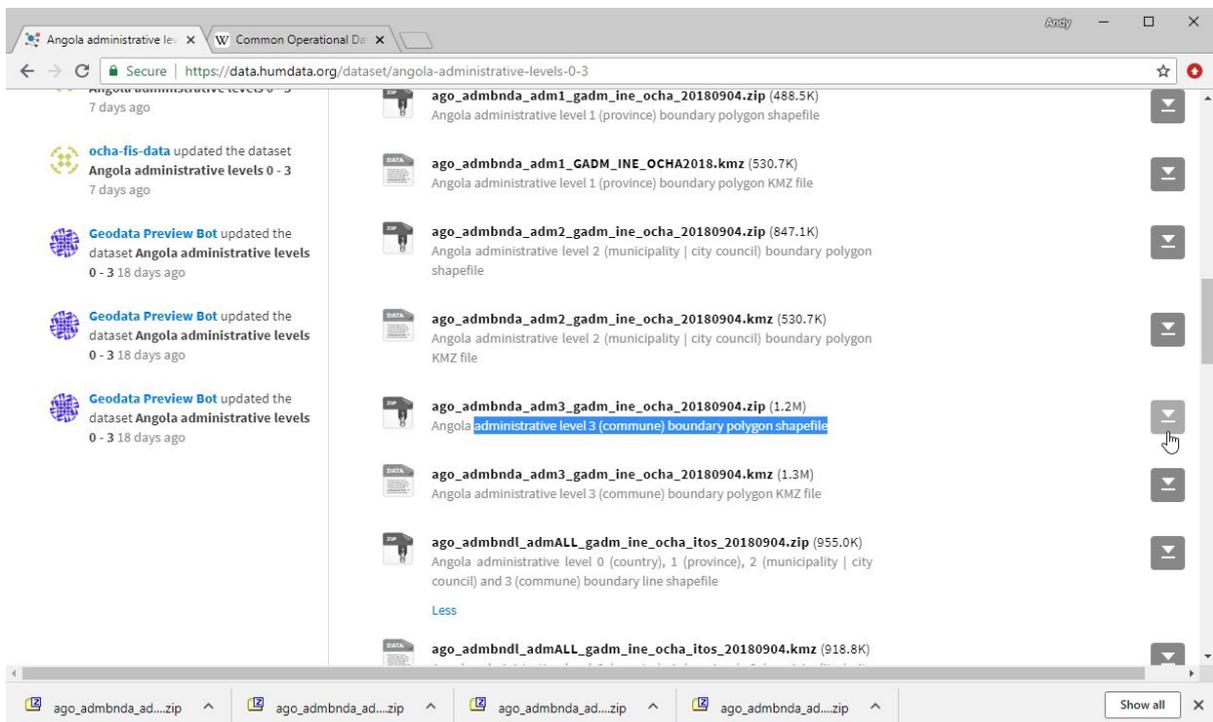
Countries have different numbers of admin levels and not all of the boundaries may be available.

(If admin boundary shapefiles seem not to be available for your country in HDX, another good source to try is the GADM site : https://gadm.org/download_country_v3.html).

- Go back to looking at the HDX map preview page shown in the previous image
- Scroll down to get to the data download options.
- Select in turn each of the boundary polygon **shapefiles**

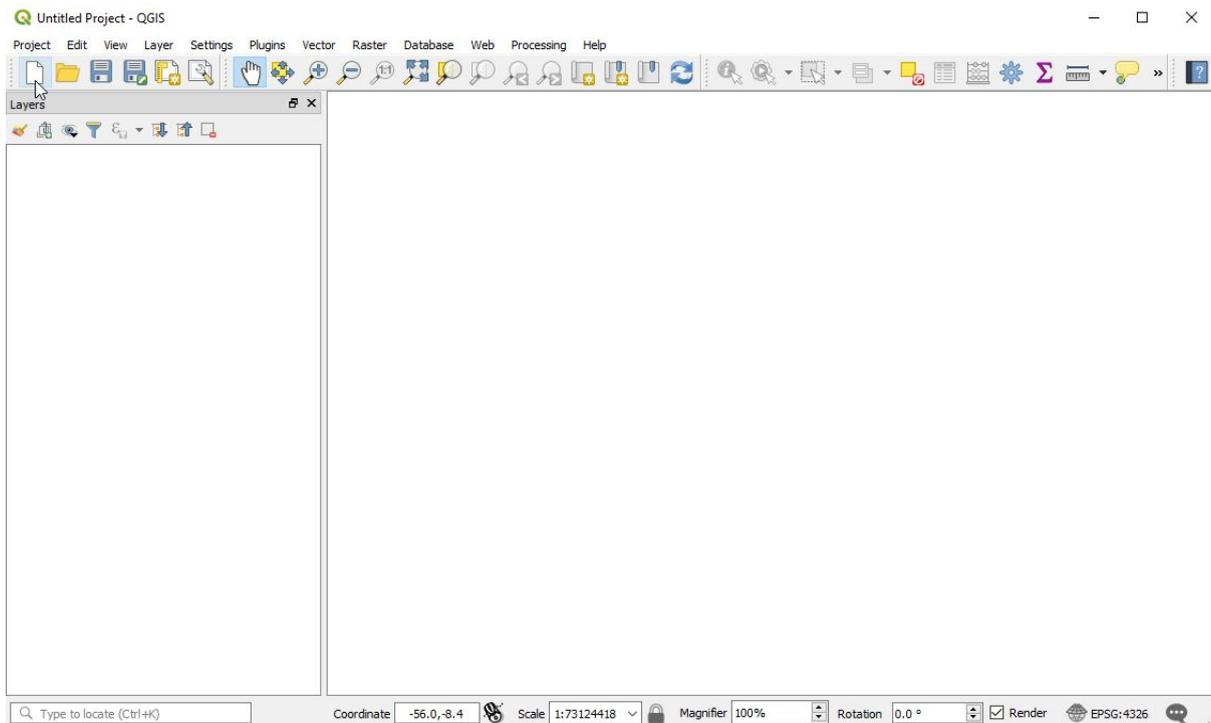
Example for Angola there are levels 0,1,2,3. It can be difficult to see among all the options available. We do not want the KMZ files - which are just a different format - although QGIS can add these too.

- Click on the download symbol on the right for all the level shapefiles you can see



The files may appear at the bottom left depending on your browser.

- Save the downloads to your **my_work/data/spatial** folder
- Start QGIS Desktop from the Start Menu or from a shortcut if you have created one
- Start a new project, by selecting Project, New or click the blank paper icon



- Save the new project as **my_work/qgis_projects/day2open-data.qgz**

Adding data to a project

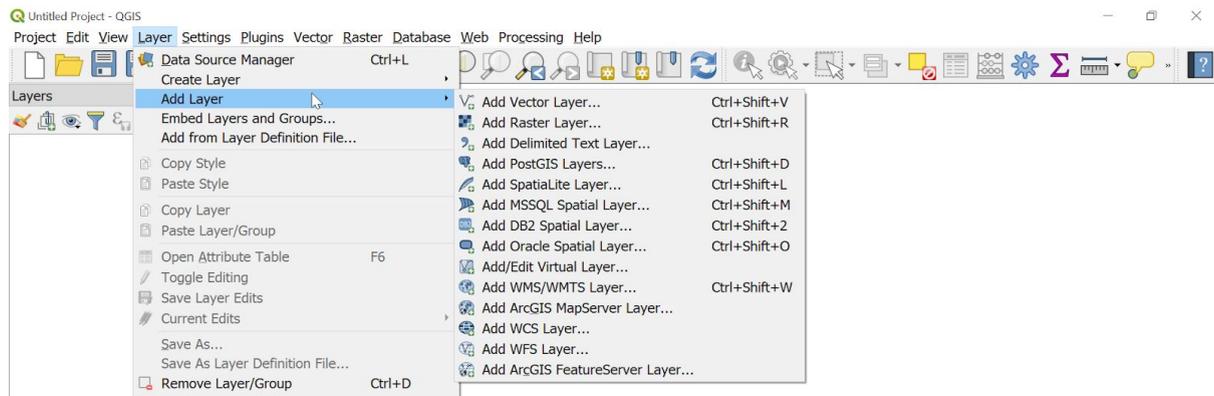
Once you have some data, you need to know how to add it to your QGIS project to create your map. Remember that projects organise the data in a series of layers.

To add data to a project we therefore:

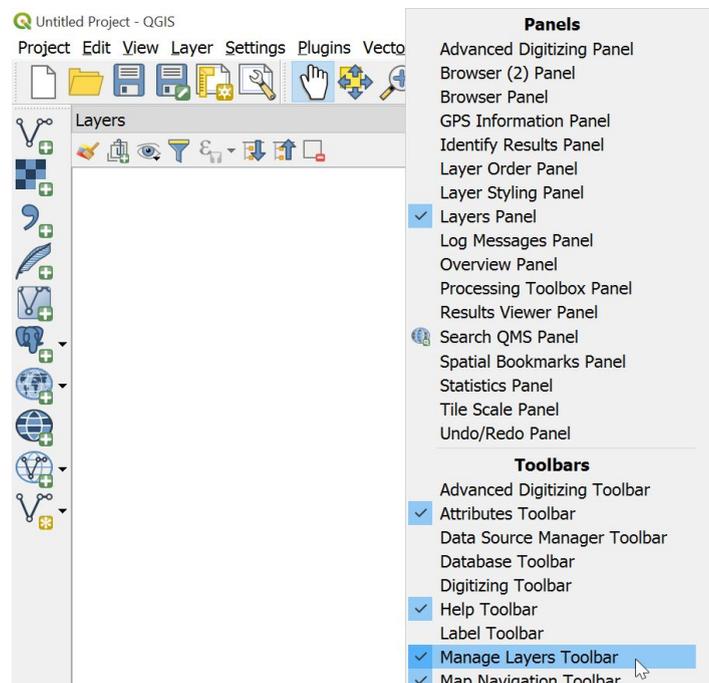
- Go to 'Layer' in the menu
- 'Add Layer'
- Then select the option appropriate for the type of data we are adding.

You will most likely use the top three options at this stage.

- ◆ Remember that points, lines and polygons are all 'Vector' data
- ◆ Raster data are things like satellite images, information associated with each pixel.
- ◆ Delimited text refers to data like CSV files, which can be added into a project and then either saved as spatial data (if for example it contains coordinates), or joined to spatial data (a vector layer the data correspond to). More on this in the joining data section.

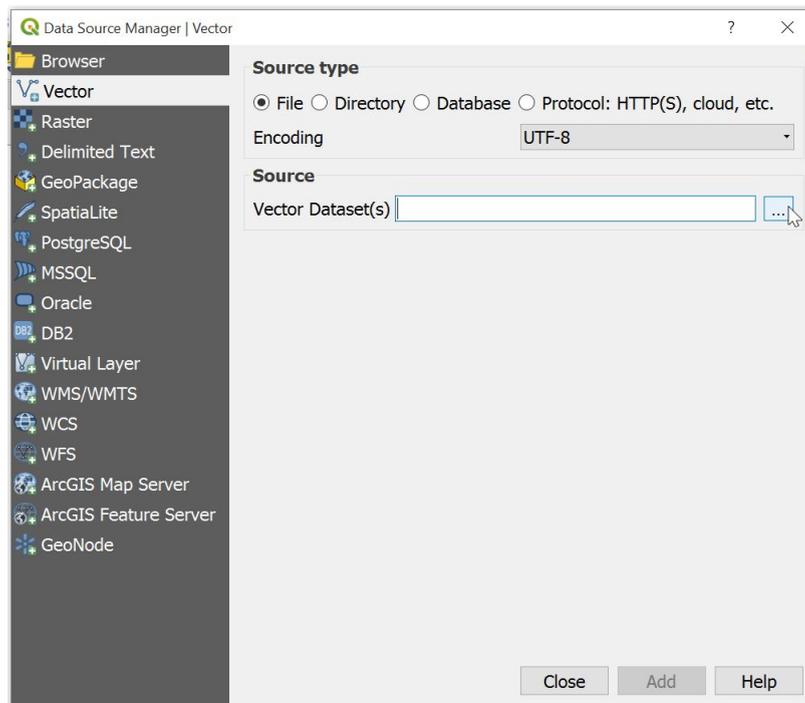


- There are shortcut keys available as indicated in the menu (Ctrl+Shift+ V or R)
- There is a toolbar available once you are familiar with the symbols for these options, the 'Manage Layers Toolbar'. If you activate this from the list (right-click in panel/toolbar to see list, left-click to select option), it will appear on the left-hand side.

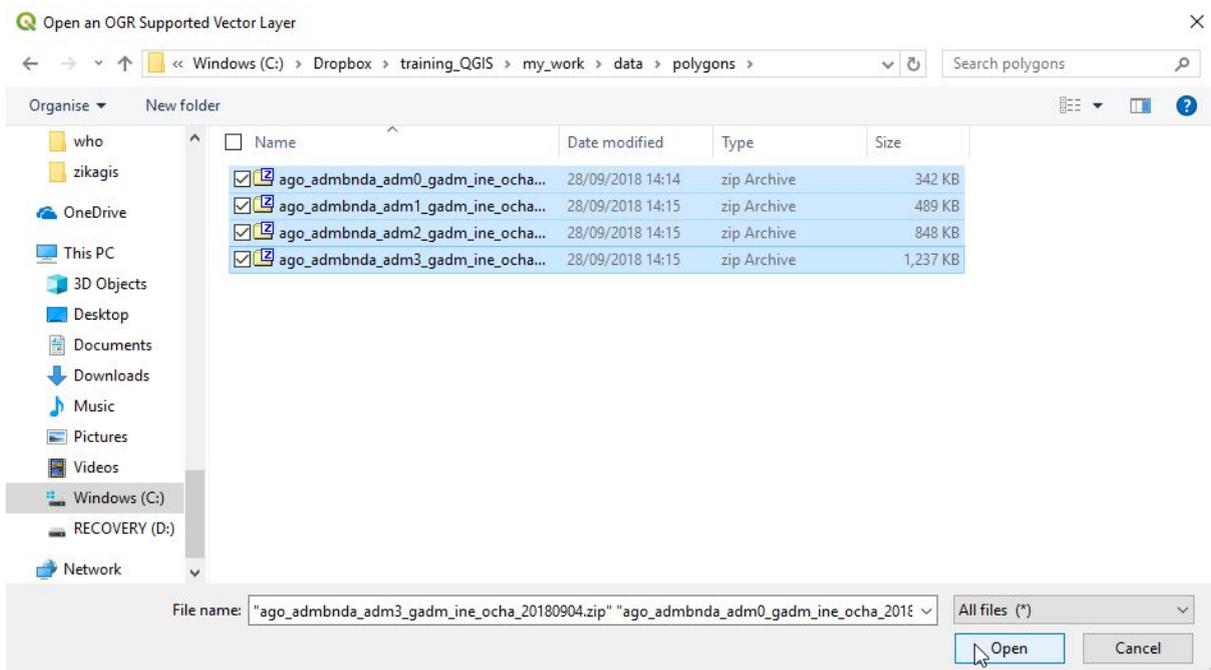


Let's now add the downloaded data to your project:

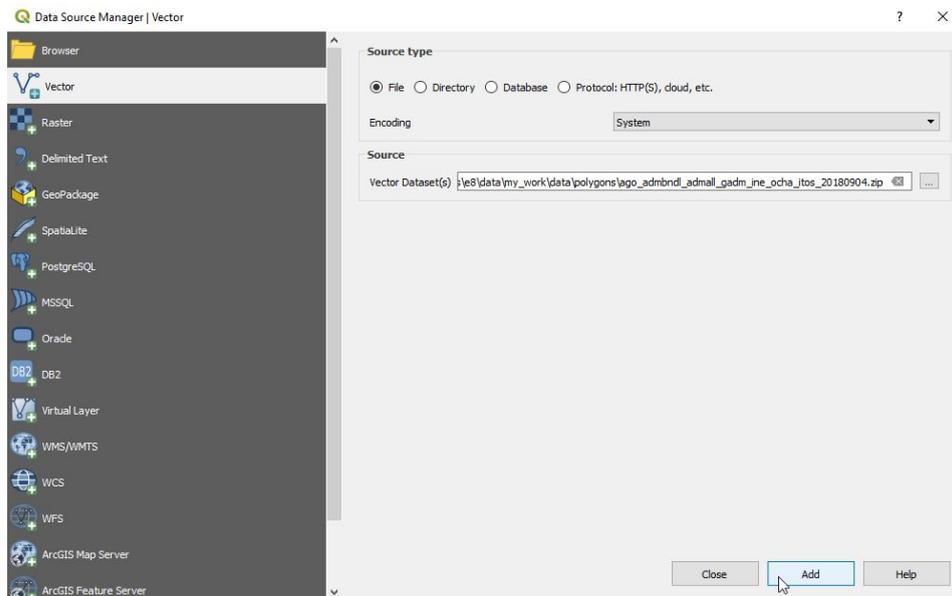
- Select Layer, Add Layer, Add vector layer
- To find the files you saved, press the 3 small dots to the right of 'Vector datasets' under 'Source'



- Navigate to find the files you saved in **my_work/data/spatial**
 - ◆ Remember that shapefiles are made up of more than one file (e.g. .shp, .shx, .dbf). The files that we downloaded contain all of these files within a zipfile.
 - ◆ For shapefiles, you do not have to unzip the file first, you can select the zipfile from QGIS to add the layers directly.
- You can use Shift or Control to select and add multiple files at a time.



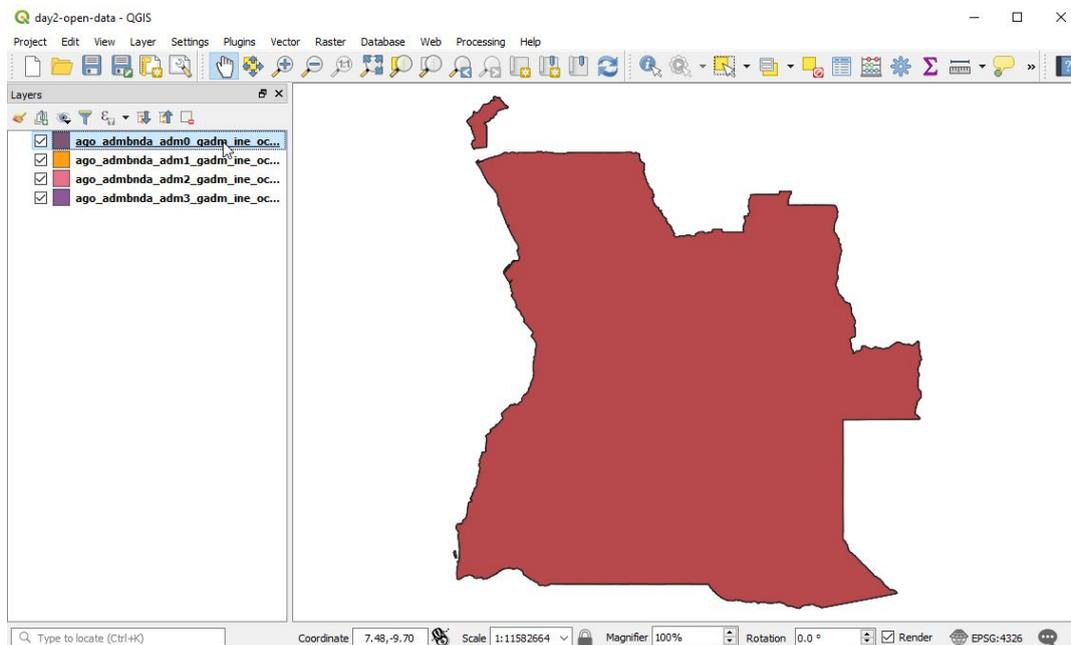
- Click 'Open' from the lower right of the window
- Click 'Add' from the lower right of the remaining Data Source Manager window



The layers will be added to your QGIS project, but if it is hidden behind the Data Source Manager window you may not see it. (This is slightly different from earlier versions of QGIS and potentially a bit confusing because you may think that nothing has happened).

→ Click the 'x' at the top right corner to close the Data Source Manager

Now you should see the layers added to your map.

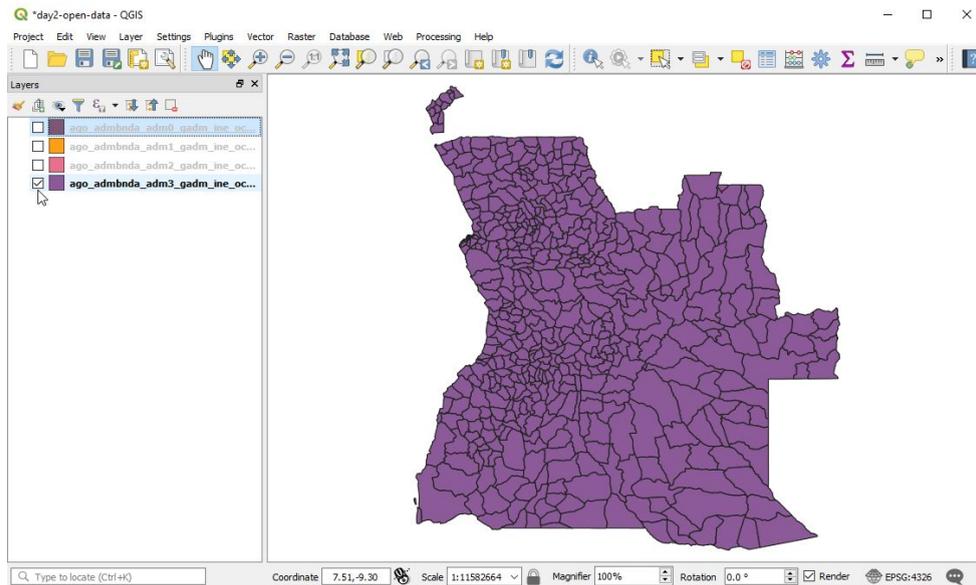


Initially looking at the map you may wonder where all the regions are. Maybe you will just be able to see the country outline as in this example.

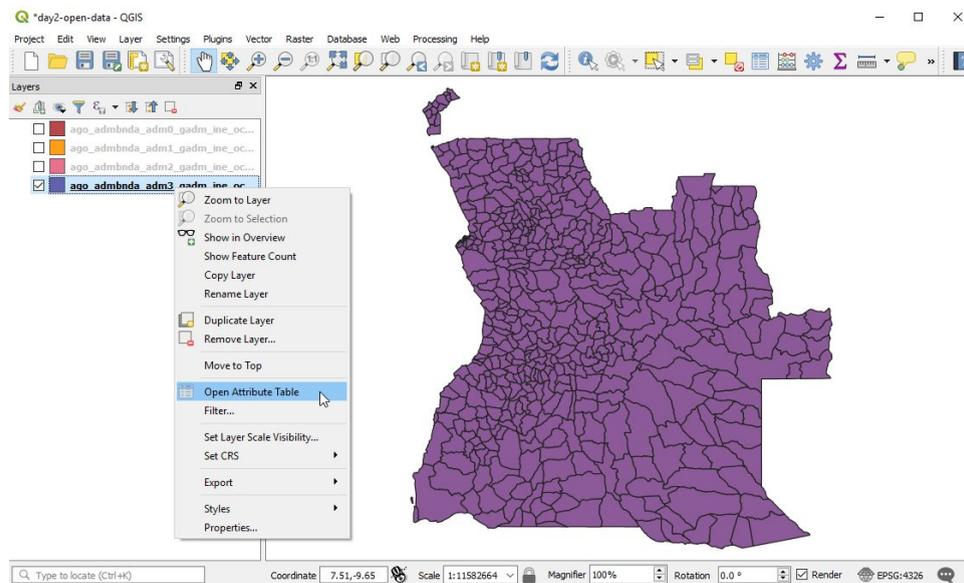
Q. Why is it that we can only see the country outline here ?

A. You may remember that the visibility of layers in the map is determined by their order in the layers panel on the left. The layers higher up are painted on top of the lower ones. Thus in this case the adm0 country polygon is painted on top of the smaller subregions.

→ Untick the higher layers in the layers panel to reveal the smaller subregions



→ Right click on the layer name in the Layers Panel on the left
→ Select 'view attribute table' to view the data behind the layer.



→ Each row in the attribute table corresponds to one polygon in the layer.

ago_admbnda_adm3_gadm_ine_ocha 20180904 :: Features Total: 539, Filtered: 539, Selected: 1

	Shape_Leng	Shape_Area	ADM3_EN	ADM3_PCODE	ADM3_REF	ADM3ALT1EN	ADM3ALT2EN	ADM2_EN	ADM2_PCODE	ADM1_EN	ADM1_PCODE	ADM0_EN	ADM0_PCODE
1	1.79420557...	0.11681504...	Kanjala	AO02014055				Lobito	AO02014	Benguela	AO02	Angola	AO
2	2.46563103...	0.30006905...	Kanzar	AO12101327				Cambulo	AO12101	Lunda Norte	AO12	Angola	AO
3	1.03228604...	0.05054501...	Kanhamela	AO02010039				Caimbambo	AO02010	Benguela	AO02	Angola	AO
4	1.32923173...	0.08531095...	Kanhoca	AO06042151				Cazengo	AO06042	Cuanza Norte	AO06	Angola	AO
5	1.50635163...	0.09753094...	Kangote	AO03018072				Chinguar	AO03018	Bié	AO03	Angola	AO
6	5.10749981...	0.73536172...	Kangumbe	AO15136442				Luenta	AO15136	Moxico	AO15	Angola	AO
7	0.95644316...	0.04609072...	Kangando	AO14122396				Malanje	AO14122	Malanje	AO14	Angola	AO
8	1.62073805...	0.10445487...	Kangola	AO17142462				Cangola (Alt...	AO17142	Uíge	AO17	Angola	AO
9	0.98388067...	0.05148619...	Kanacassala	AO01005019				Nambuango...	AO01005	Bengo	AO01	Angola	AO
10	0.65359006...	0.01978175...	Kanbomdo	AO06044159				Golungo Alto	AO06044	Cuanza Norte	AO06	Angola	AO
11	2.93058046...	0.28281284...	Kambundi-K...	AO14116375				Cambundi-C...	AO14116	Malanje	AO14	Angola	AO
12	3.73927437...	0.64078827...	Kameia	AO15130424				Cameia (Lu...	AO15130	Moxico	AO15	Angola	AO
13	1.52046518...	0.11931226...	Kambuengo	AO10088287				Mungo	AO10088	Huambo	AO10	Angola	AO
14	2.21061356...	0.17819210...	Kambulo	AO12101326				Cambulo	AO12101	Lunda Norte	AO12	Angola	AO
15	0.99172306...	0.04664536...	Kamakupa	AO03016062				Camacupa	AO03016	Bié	AO03	Angola	AO
16	1.24405966...	0.07030510...	Kambo	AO14118383				Cahombo	AO14118	Malanje	AO14	Angola	AO
17	2.31528416...	0.14459258...	Kalulo	AO07054182				Libolo (Calulo)	AO07054	Cuanza Sul	AO07	Angola	AO
18	1.11255518...	0.04734628...	Kamabatela	AO06037134				Ambaca	AO06037	Cuanza Norte	AO06	Angola	AO
19	2.96747679...	0.37235342...	Kalucinga	AO03015060				Andulo	AO03015	Bié	AO03	Angola	AO

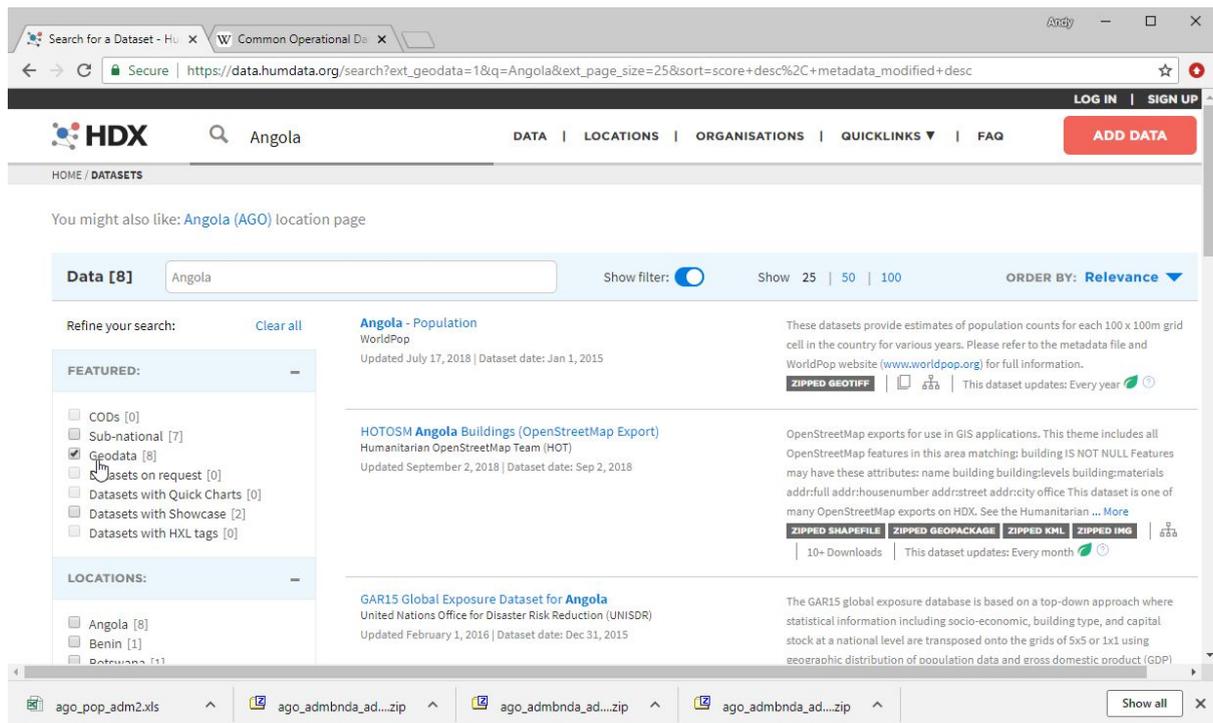
Show All Features

Humanitarian Data Exchange (continued)

Going back to look at the HDX data page you should see that the other Common Operational Dataset available is a population statistics table. These are usually either an .xls or .csv file. They are not spatial data formats but they have column names that allow the data to be **joined** to spatial data. We will cover how to do that tomorrow. For now let us look for some other data.

- ➔ In the HDX data explorer untick the COD filter option
- ➔ Select the 'Geodata' tickbox.

Note that selecting Geodata can exclude some datasets that are spatial, but it is one way of finding some of the most useful spatial data.



The first layer that comes up for Angola is Population by WorldPop. These data are different from the population statistics mentioned previously. As it says in the information :

These datasets provide estimates of population counts for each 100 x 100m grid cell in the country for various years. Please refer to the metadata file and WorldPop website (www.worldpop.org) for full information. These are modelled data that combine census data with satellite data to estimate high resolution population density.

Q. Can you remember what was the name for the data type that has information by grid cells ?

A. Grid cell data are usually called **raster** data.

→ Try to find the WorldPop data for your country on HDX



→ Click on the download symbol on the right

→ Save the zip file to **my_work/data/spatial**

Again this file is a zip file, but **differently for raster data we need to unzip the file before QGIS can add it.**

→ Double click on the zip file to unzip

→ Extract all the files to the same folder

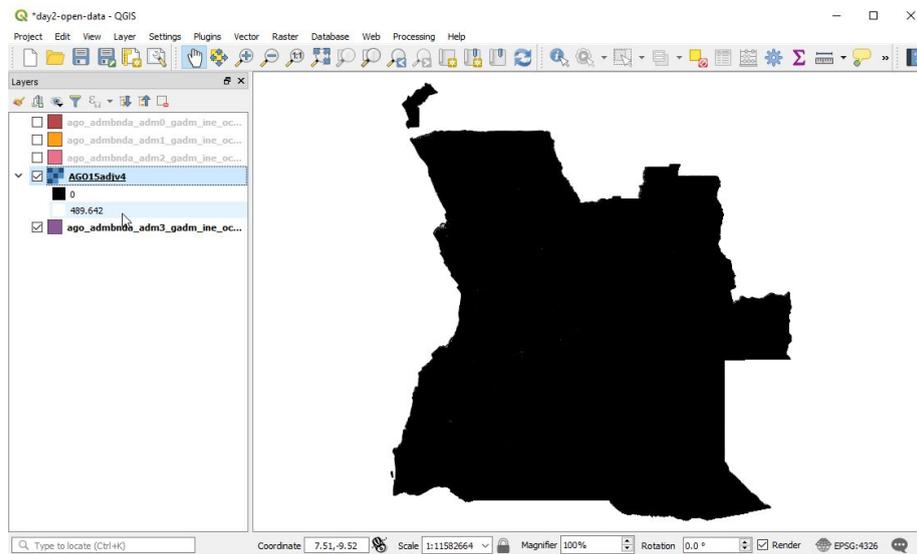
This is a geotif raster file which, similar to a shapefile, is made up of several component files with different file endings that need to be kept in the same folder.

To add the file and view it in QGIS:

→ In the menu, select Layer, Add Layer, Add raster layer

- To find the files you saved press the 3 small dots to the right of 'Raster datasets' under 'Source'
- Navigate to find the files you unzipped in **my_work/data/spatial** select the file with the ending **.tif**
- Click 'Add'
- Close the window.

Initially the layer will appear like this, appearing as a single colour polygon :



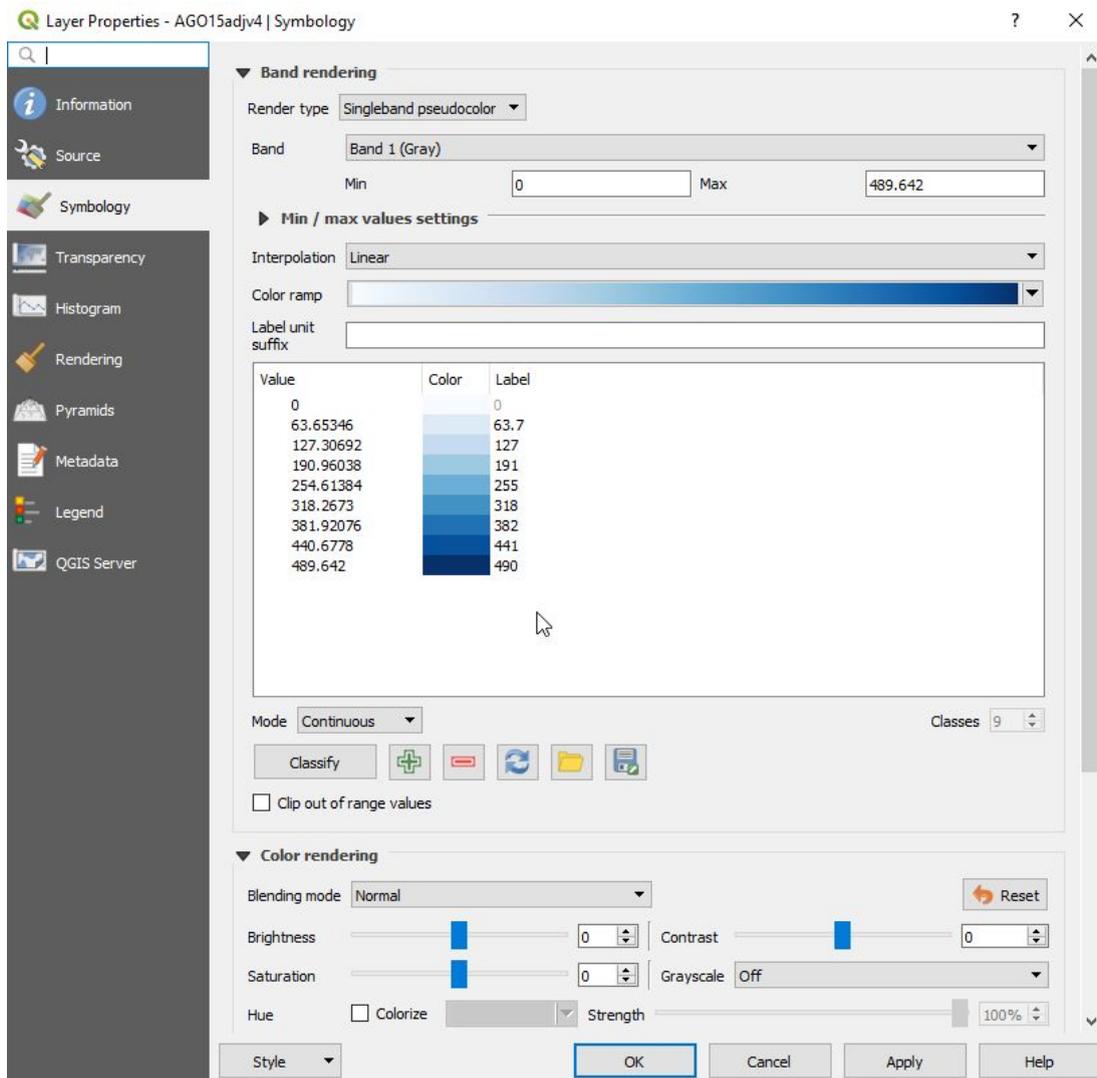
We can change the appearance of raster layers in a similar way to vector layers, via the Layer Properties window, in symbology.

- Right click on the layer name and select 'Properties'
- Choose Symbology on the left

The raster symbology options are different to those of vector layers. In rasters we talk about 'band rendering'. The Singleband or Multiband refers to the data associated with the pixels. Our file is Singleband because it only has one (single) information associated with it - estimated population figures.

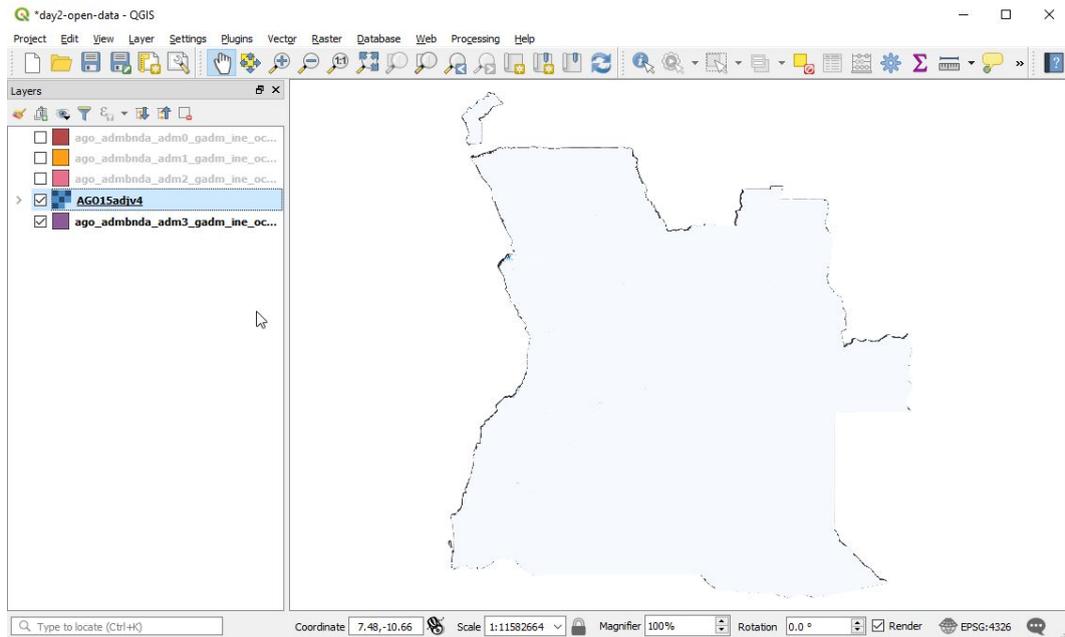
To change the colour of our raster layer from black and white to coloured:

- Change 'Render Type' to 'Singleband pseudocolor'
- Change the 'Color ramp' to Blues
- Change the number of Classes on the right to something smaller, I used 9 here



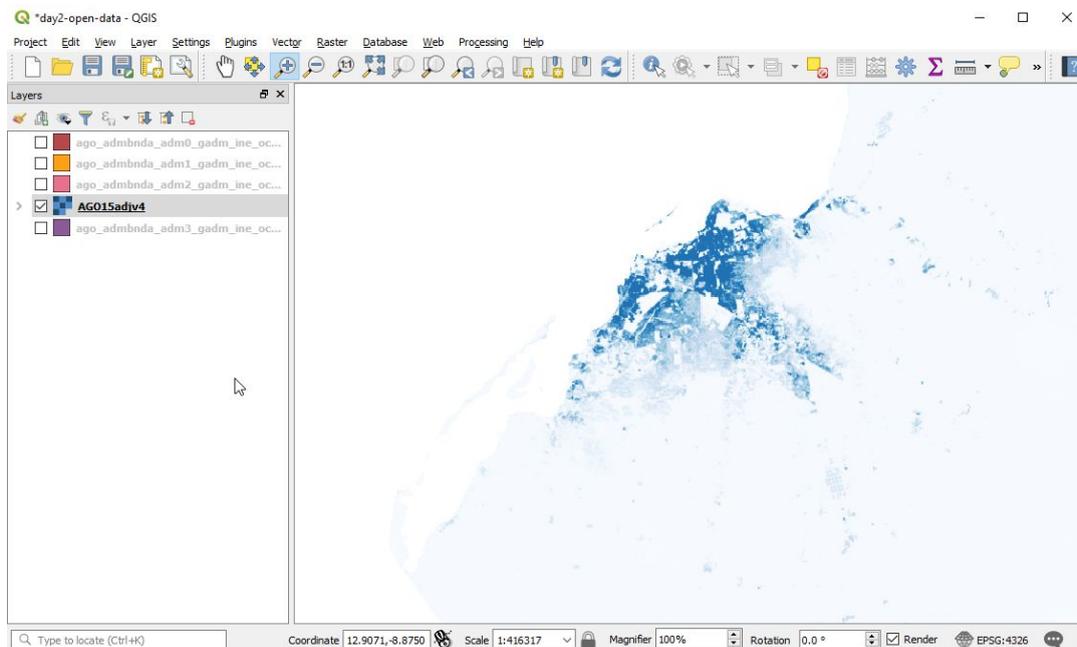
→ Click OK

Q. When I did this initially I got a map looking like that below and I thought something was wrong. Can you work out what is happening ? Why do there appear to be no data except around the edges ?



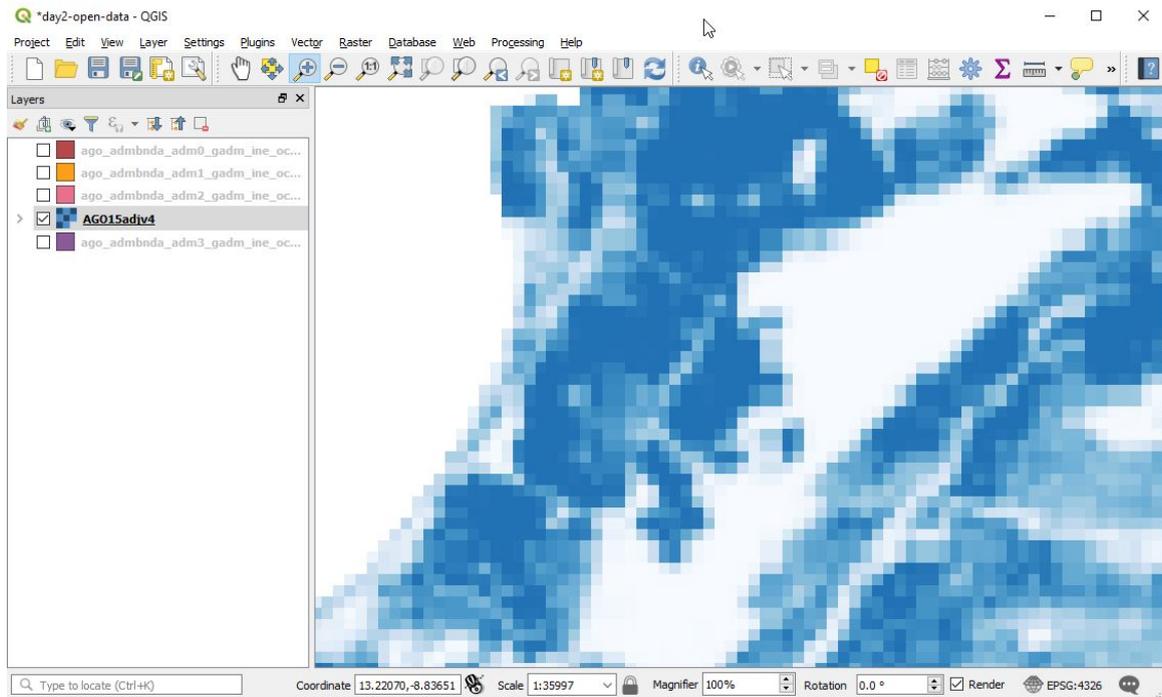
A. The dark colours around the edge are caused by the polygon layer underneath. If you untick the polygon layer the boundary disappears. Then looking carefully you may be able to see there are some areas of blue colour on the map. Zooming in to one of these areas you should see that there are different coloured grid cells.

Here zooming into an area in the NW that I now know is the city of Luanda :



This issue is created by the fact that the data are at 100m resolution and when we were looking at the whole country most cells have very low population, whereas a relatively small number of cells in cities have very high population.

If you zoom in further you can see the individual 100m grid cells :



→ Now return to the HDX webpage to see what other data we can find.

OpenStreetMap

Currently the second item in the Geodata list for Angola is :

[HOTOSM Angola Buildings \(OpenStreetMap Export\)](#)

We came across OpenStreetMap yesterday, when we used it in a plugin as a base map.

OpenStreetMap is an open collaborative project to provide freely available map data. It is maintained by volunteers around the world - you too could contribute! In addition to being useful as a base map, OpenStreetMap can also be used as a source of data. Data can be downloaded from OpenStreetMap directly or via QGIS using another Plugin. It is also made available from sites such as humanitarian data exchange.

HDX provides regularly updated extracted files of OpenStreetMap data that have been designed to be easily used in GIS.

- Try to find the OpenStreetMaps Buildings data for your country in HDX
- Select and scroll down below the preview map to see available downloads

DATA AND RESOURCES

	hotosm_ago_buildings_polygons_shp.zip ESRI Shapefile	
	hotosm_ago_buildings_gpkg.zip Geopackage, SQLite compatible	
	hotosm_ago_buildings_polygons_kml.zip Google Earth .KML	
	hotosm_ago_gmapsupp_img.zip .IMG for Garmin GPS Devices (All OSM layers for area)	

Above are the available download formats for Angola. You will see ESRI Shapefile that we are now familiar with and options for Google Earth and GPS devices. We are going to choose the **Geopackage** option.

Geopackage

Geopackage is a spatial data format that is more modern than shapefiles and solves some issues. It is more convenient being just a single file rather than a collection and it doesn't have a limit on the number of characters in column names as shapefiles do. Despite limitations shapefiles are still very common and are likely to be around for a long time.

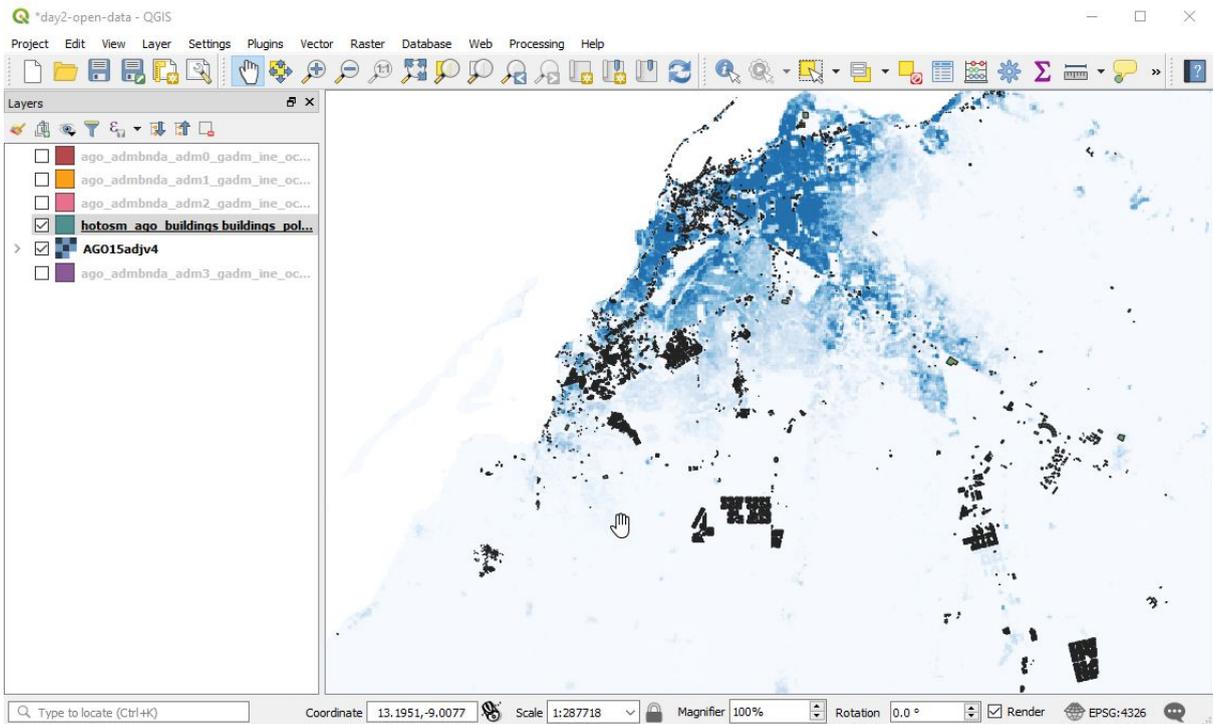
- Select the download icon for the geopackage option for your country
- Save to **my_work/data/spatial**
- Double click on the zip file and extract all files to the spatial data folder

You should see that the main geopackage file has an extension **.gpkg**

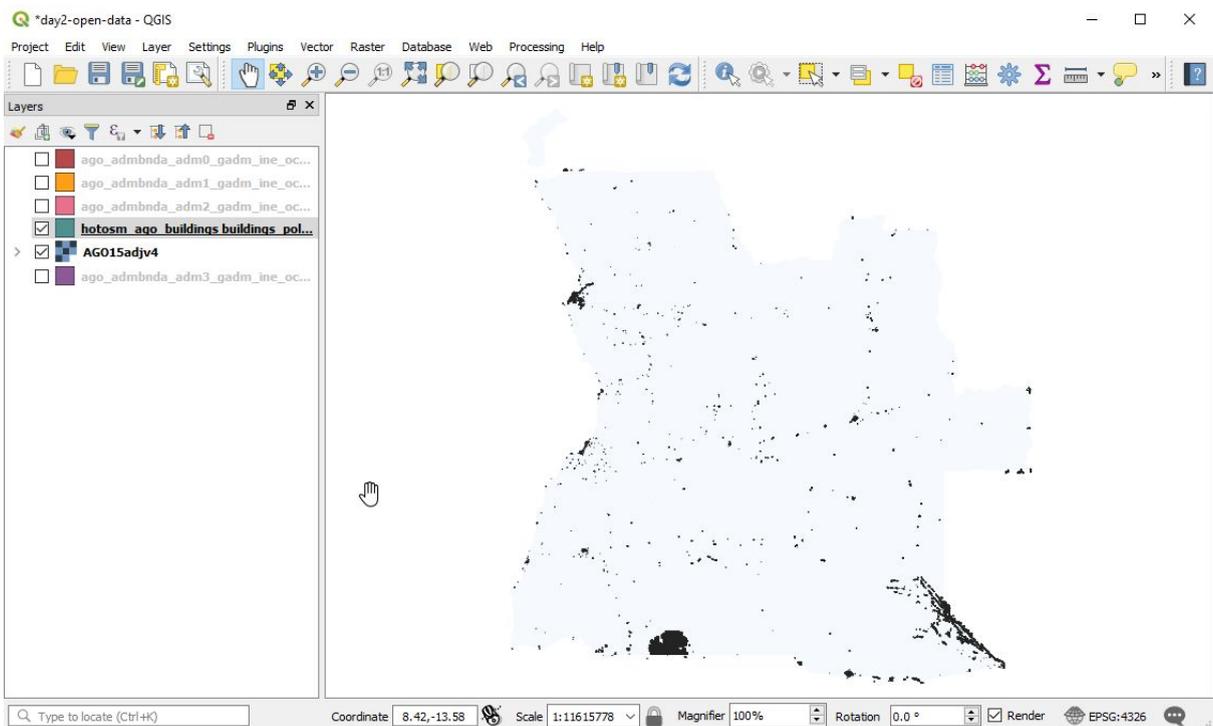
These data are polygons, so they are vector data. To add them to your project:

- In QGIS, select Layer, Add Layer, Add vector layer
- Navigate to find the **.gpkg** file
- Once you have added the layer zoom in and out to see the buildings data.

You should see that it is not complete, areas where the worldpop data estimates high population have no buildings. But in some areas there is very detailed building coverage and this can be a very useful dataset that is improving all the time.



If you zoom out completely it can take the map a long time to display because there are a very large number of polygons.



→ Right click on the layer and open the attribute table to see how many features there are (the attribute table may take a while to open). 'Features Total' is listed at the top of the window along with the title.

◆ For Angola there are currently around 300,000 digitised buildings.

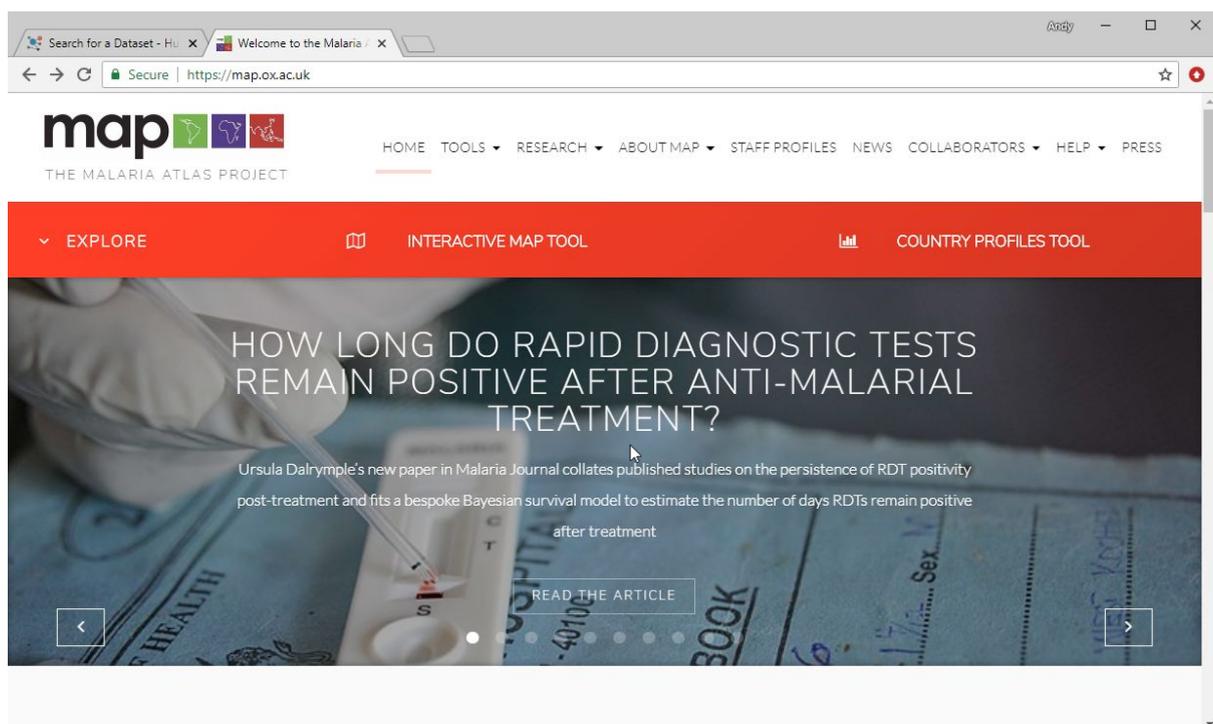
From the HDX Data Explorer web page you can also download OpenStreetMap roads and waterways files.

- Download and add the OpenStreetMaps roads and waterways layers to QGIS for your country

Malaria Atlas Project

The mission of the [Malaria Atlas Project](#) is “to generate new and innovative methods to map malaria, to produce a comprehensive range of maps and estimates that will support effective planning of malaria control at national and international scales”.

They have a wide range of freely downloadable spatial data.



- Select the Country Profiles Tool
- Search for and select your country

Select or search for a malaria-endemic country to browse and download associated data held by MAP

Search for a country:

Afghanistan AFG	Algeria DZA	Angola AGO
Argentina ARG	Armenia ARM	Azerbaijan AZE

→ Select Download Data

Number of sources 18

INTERACTIVE GRAPHS **DOWNLOAD DATA** MAPS AND IMAGES

The Malaria Atlas Project is a strong advocate of open and free access. [Read more](#) about our Open Access Policy for using the data we provide.

Plasmodium falciparum Parasite Rate

● Lower CI (95%) ● Mean estimate ● Upper CI (95%)

Proportion of at risk individuals infected

Year

2000 2010 2016

0.0511 0.1000 0.2000 0.3000 0.3291

DETAILS CSV

Plasmodium falciparum Incidence Rate

● Lower CI (95%) ● Mean estimate ● Upper CI (95%)

Clinical cases / 1,000 person-years observed

Year

2000 2010 2016

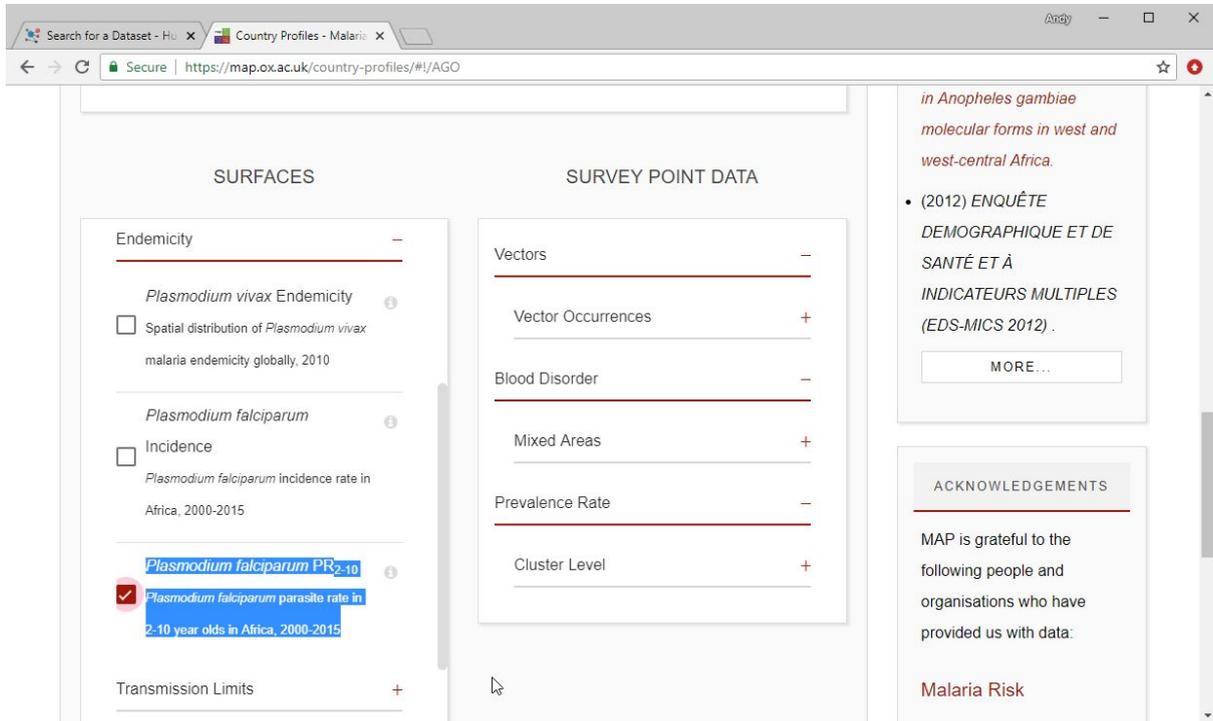
58.30 100.0 200.0 300.0 372.0

DETAILS CSV

V. Petrarca, M. Calzetta, M.A. Di Deco, F. Fortes, P.J. Cani, F. Santolamazza (2008) *Distribution and chromosomal characterization of the Anopheles gambiae complex in Angola.*

- A. Della Torre, V. Petrarca, M.J. Donnelly, I. Dia, J. Pinto, E. Barrese, J. Etang, F. Santolamazza, F. Simard, M. Calzetta, A. Caccone (2008) *Distribution of knock-down resistance mutations in Anopheles gambiae molecular forms in west and west-central Africa.*
- (2012) *ENQUÊTE DEMOGRAPHIQUE ET DE*

- Scroll down and under Surfaces select: Plasmodium falciparum PR2-10
Plasmodium falciparum parasite rate in 2-10 year olds in Africa, 2000-2015

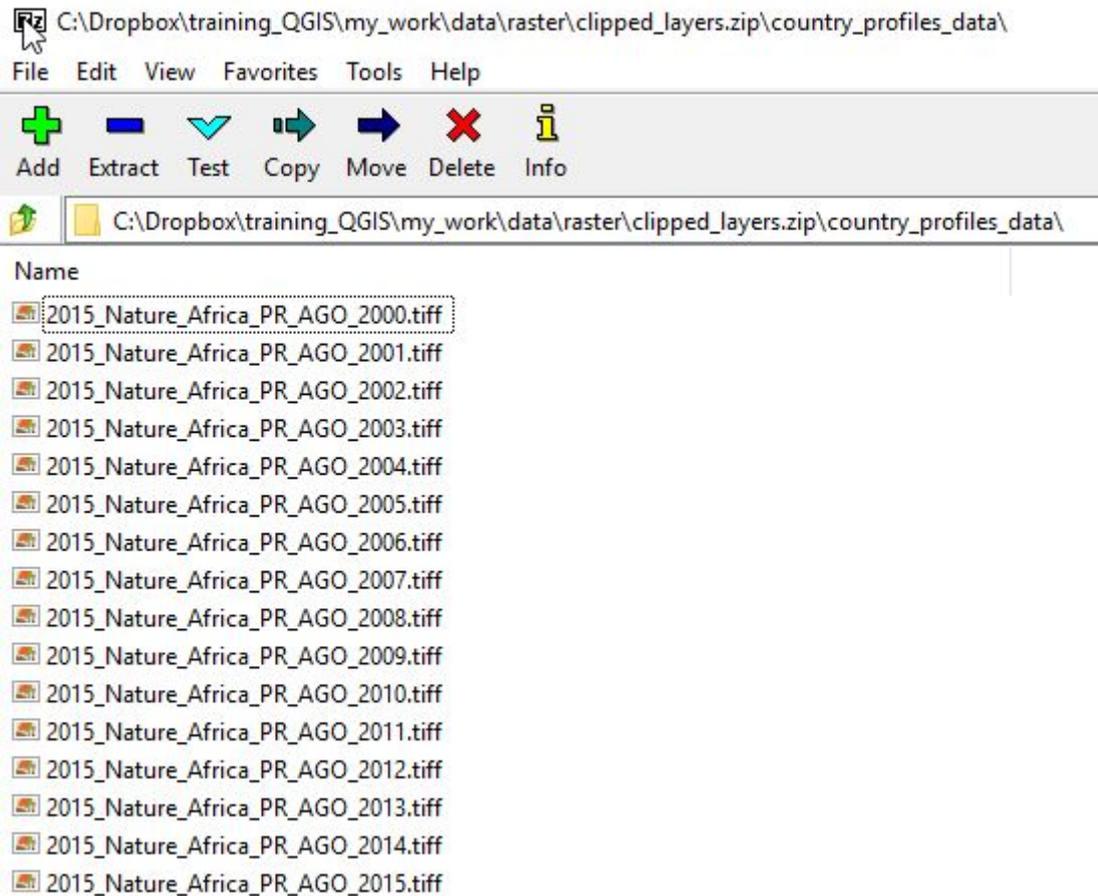


- Scroll further down to click download

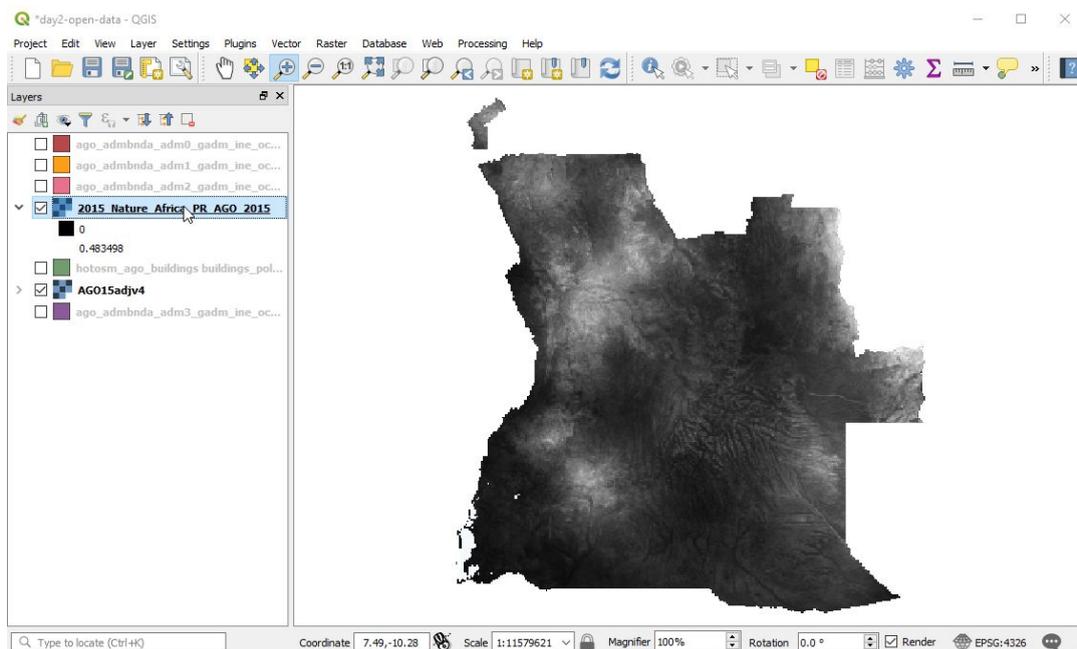
(Note that you can download more than one layer at a time)



- Save the download file (clipped_layers.zip) to **my_work/data/raster**
- Double click on the zip file and you should be able to find 15 yearly tiff files
- Extract these

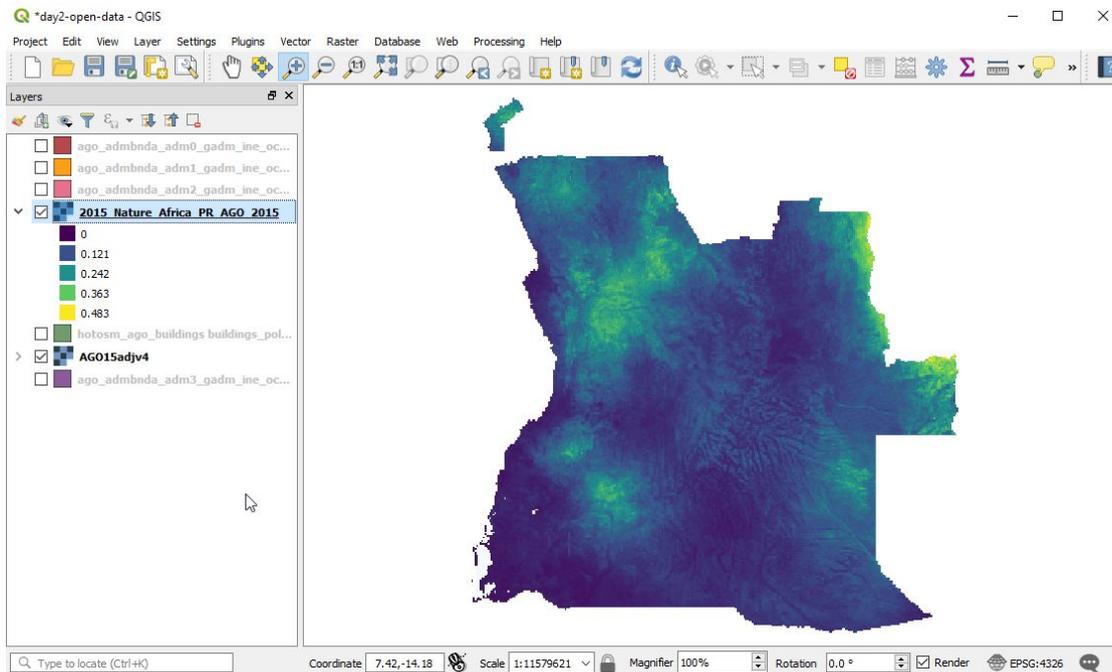
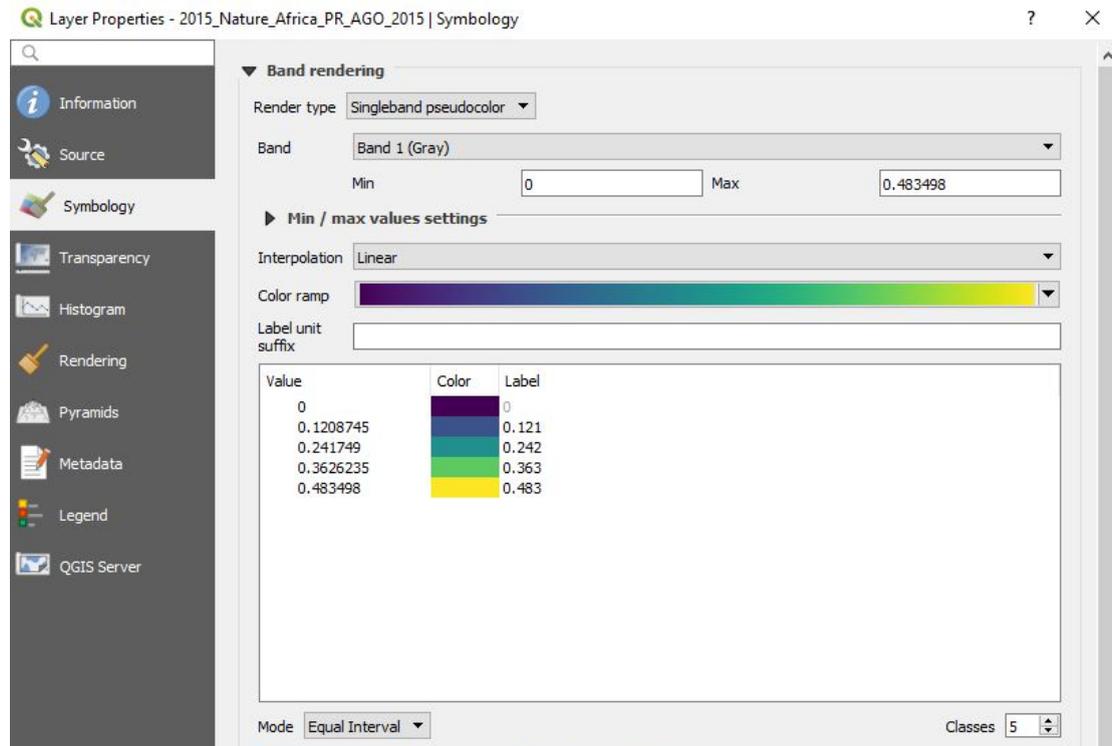


- In QGIS select Layer, Add Layer, Add raster layer
- Browse using the ... to select the .tiff file for 2015

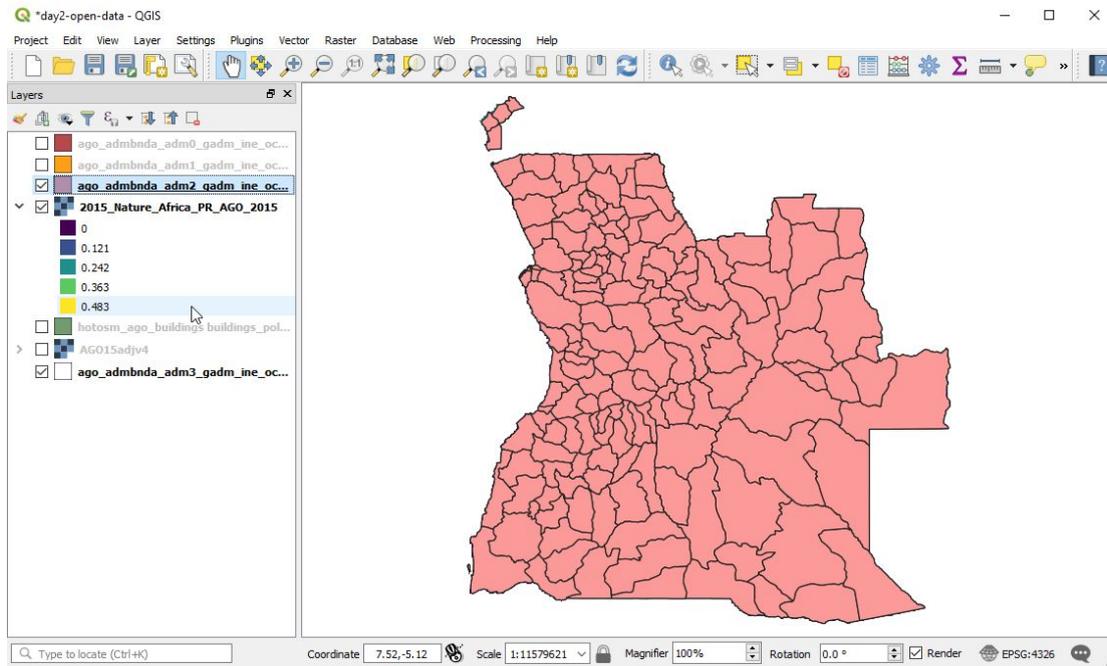


- Right click on the raster layer name, select Properties, Symbology

- Change 'Render Type' to 'Singleband pseudocolor'
- Change the 'Color ramp' to Viridis
- Change Mode to 'Equal Interval' and classes to 5
- Click OK

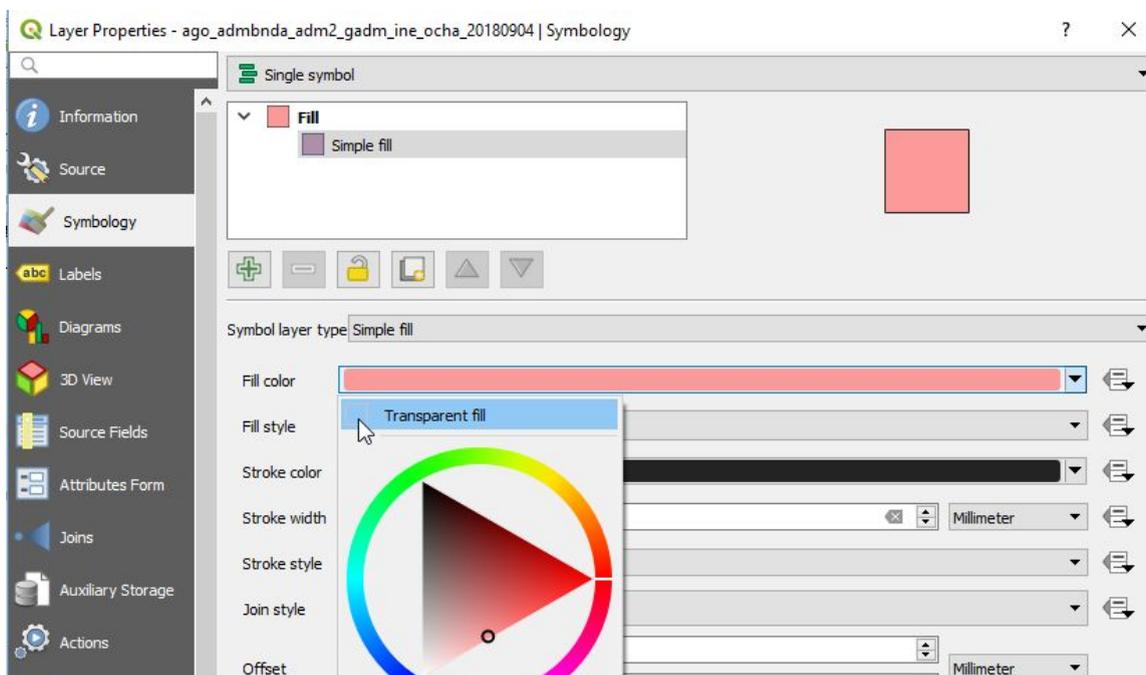


Now if we want to view the admin layer boundaries on top of the malaria surface we can tick it in the layers panel, but this results in the polygon colours hiding the raster layer.

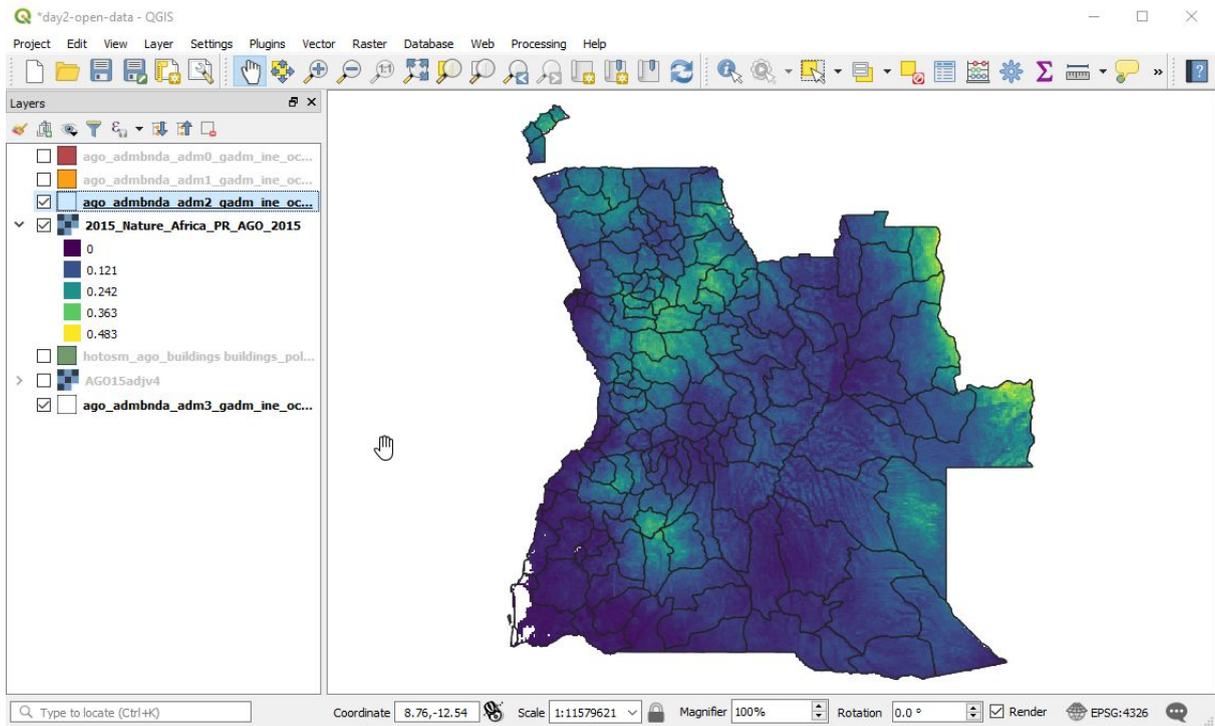


To make the polygons transparent :

- Right click on the layer name, properties, symbology
- Click on simple fill near the top
- Select Fill colour lower down
- Tick the option for 'transparent fill' (if you can't see an option for transparent it may be because you haven't selected 'simple fill' above)



You should end up with a map somewhat like this.



→ Click Project, Save to save changes to your project.

There are other malaria and mosquito vector surfaces available on the Malaria Atlas Project download pages.

If you have time, try downloading some other data for your country and displaying them in QGIS.

Collecting spatial data using GPS

GPS (global positioning systems) are satellite-based navigation systems that enable us to detect where we are. Satellites carry an atomic clock and are continuously transmitting their current time and position. A GPS receiver on the earth's surface needs to receive a transmission from at least three satellites to enable it to calculate its longitude and latitude. If four or more transmissions are received, it is also possible for the receiver to calculate its altitude. Note that as GPS is dependent on receiving signals from satellites obstructions of the view of the sky, particularly buildings, can limit performance.



Figure 3.1: (left) A diagram of the satellite-based GPS system, (right) examples of devices that can receive transmissions for the GPS satellites.

The GPS that we use today was initially launched by the United States in 1973 and has been fully operational since 1995. It was initially restricted to military use but became available to civilians in 1996, meaning that anyone with a GPS receiver can record locations with an accuracy of approximately 3-4 metres. The accuracy of the receiver can however be affected by a number of external features. Firstly, as mentioned the receiver needs to be placed outdoors with a clear view of the sky. Any surrounding obstructions including tall buildings and trees will affect the accuracy of the coordinates. Further, placing the receiver in a bag, pocket or case may affect its ability to receive a signal.

GPS receivers can be found in many devices. Until relatively recently, researchers were restricted to using dedicated GPS devices (see the yellow device in Figure 3.1) to collect coordinates. These devices can be very expensive, and further cannot be easily used to collect other information associated with the location. However, the vast majority of modern smartphones also now contain a GPS receiver and as such are being increasingly used to collect coordinate data (Figure 3.1). The benefit of using smartphones is that they can be much cheaper than a dedicated GPS device and they allow the user to record much more information associated with the location including questionnaire responses, survey data, photographs, bar codes and even sounds and videos. As a result, there are now many apps on the market that allow people with little technical experience to use their smartphones as GPS and data collection devices.

Introduction to the GPSEssentials app

During this course we will be using the GPS Essentials app to record location information. GPS Essentials is an app for Android phones that is freely available. Currently the app is only in English,

but there is a Spanish user manual available. Whilst there are many more sophisticated apps available that enable you to record a lot more information in addition to GPS coordinates (e.g. Open Data Kit for Android phones), the GPS Essentials app allows the user to start collecting point and track data (plus additional labels and descriptions) straight away without requiring any account set up. Users are able to transfer the data they collect to their computer very easily via email. We will now use this app to collect coordinates in the surrounding area.

Installation of GPS Essentials on an Android phone or tablet

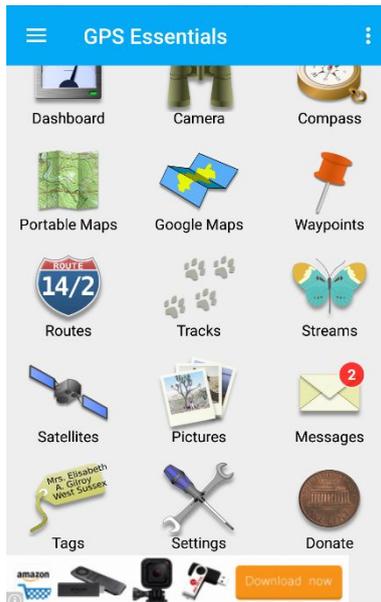
- 1. Tap 'Play Store' icon 
- 2. Tap where it says 'Google Play' and type 'GPS Essentials'
- 3. Tap the first result with an icon like this: 
- 4. Tap 'Install'

The above method from Google play is the most likely method you will use. If, however, you don't have access to Google Play you can download an 'apk' file to install from the Downloads tab at <http://www.gpsessentials.com/>. Download the file to your phone. To allow installation go to Menu > Settings > Security > and check Unknown Sources. To install find the APK file, tap it, then hit Install. We will assist you individually if this alternative installation method is required.

Starting GPS Essentials

- Tap the GPS Essentials icon: 
- Go to 'All Apps' if you can't find it.

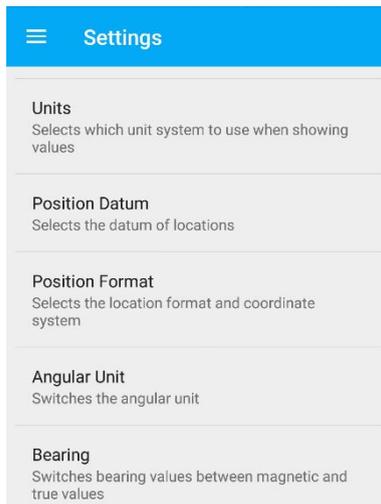
The 'home' screen of the App should look like this (you can ignore the advert at the bottom of the screen):



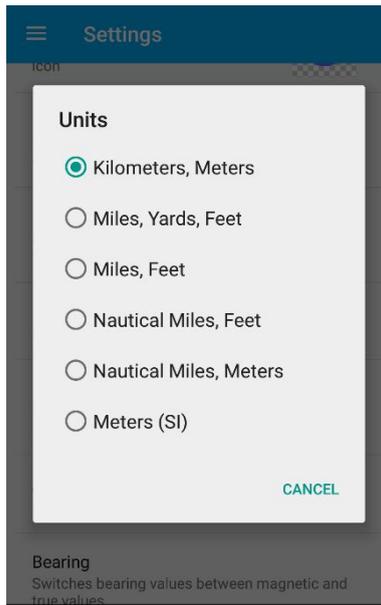
→ Tap settings:



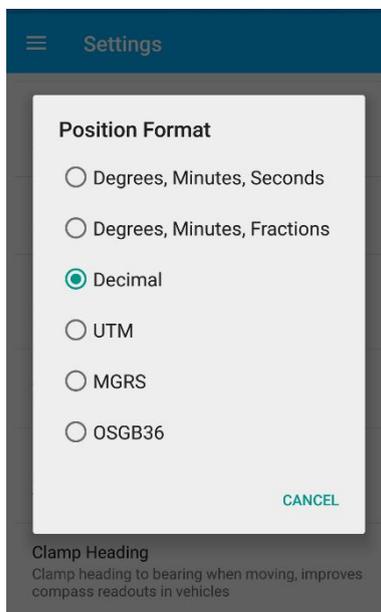
→ Scroll down to 'Units' and 'Position Format'.



→ Set 'Units' to km:



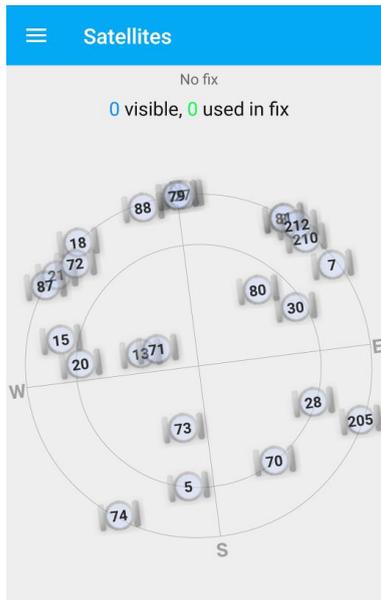
→ set 'Position Format' to Decimal:



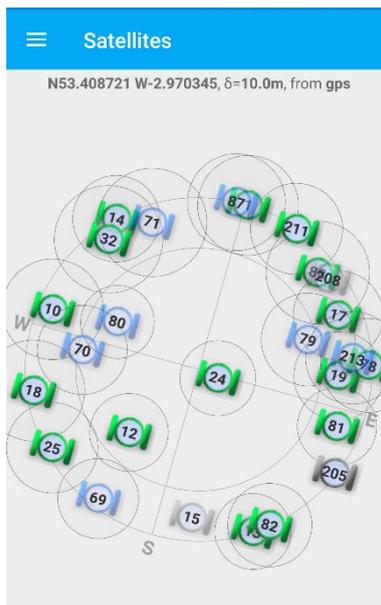
As we know GPS relies on satellites.



If you are doing this indoors (as I am), you will probably find that the App isn't able to 'see' any satellites.



When you go outside the App should be able to see more satellites and then it will give you an estimate of your position:



→ To return to the App home screen, tap 'back' on your phone.

This button looks slightly different on different phones. For example, you may have a small triangle pointing left at the bottom of your screen.

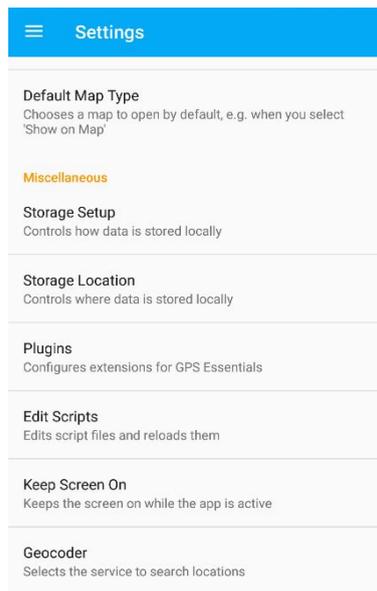


Storing maps offline

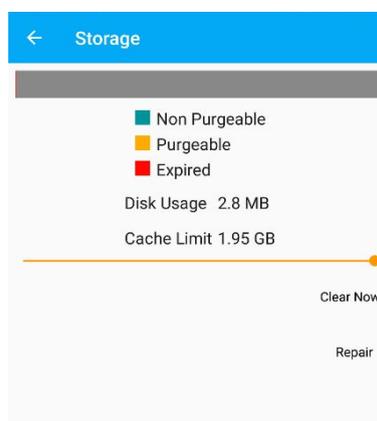
The GPSEssentials App allows you to download background maps while you have an internet connection to allow for use in areas where you don't have access to the internet. This can be accessed through the 'Portable Maps' icon from the home screen. It is called a portable map because you can then carry it anywhere, even away from an internet connection.

Before we go to the portable map icon, we want to increase the default amount of space the GPS Essentials app allocates to storing maps 'offline'. This will allow you to store larger geographical areas on your phone without needing an internet connection.

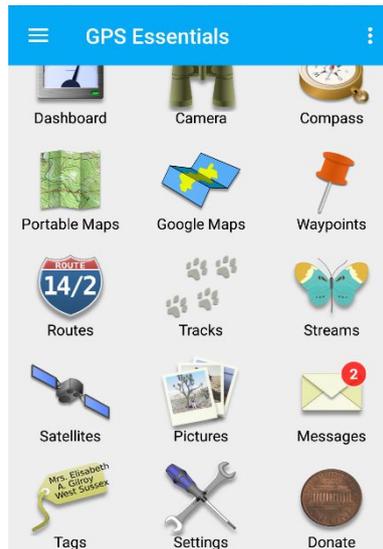
- Go to the settings screen, and scroll down to 'Storage Setup' which is under the 'Miscellaneous' heading.



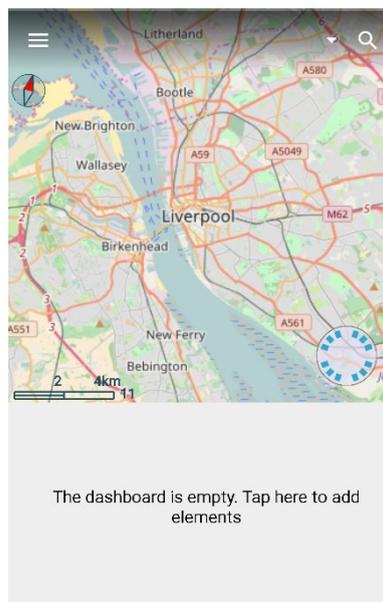
- In the Storage screen, slide the orange slider to increase the *Cache Limit* to its maximum. Once this is done, return to the Settings screen, then go back to the home screen.



- tap on the 'Portable Maps' icon to download maps to view offline.



This should bring up a map of your local area. The map you see is automatically downloaded so that you will continue to be able to access it if you lose your internet connection. To download more 'zoomed in' maps, you need pinch in and out with two fingers to zoom in and out. Pan around the screen to cover as much of the area outside of the building as possible as you can only be certain that the map has been downloaded to your phone once you have seen it on your screen. Do not worry about the message saying that the Dashboard is empty for now.



→ To prepare for the practical exercise, tap on 'Portable Maps' and zoom in to see the area that we will be walking in. We will demonstrate this to show you the region to zoom into.

Practical Exercise: Collecting data

For the practical exercise we will go outside and record both a line and some points.

A. Line

To record a line we will use the option “Tracks” in the app. A 'track' is where the app automatically records a line for your route, and a series of points along the way every few seconds.

B. Points

To record points there are two options in this app. 'Waypoints' will register points but only points. The 'Tracks' option we are using for part A also allows for specific points along the way to be captured, so we can simultaneously record a line and points. We will therefore use the Tracks option to collect both at the same time.

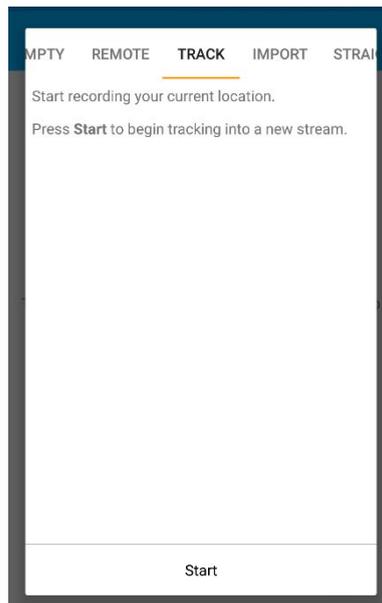
A. Line

You are able to record tracks either when walking on foot, or travelling in a vehicle. Today we will record your walking route.

→ To start recording a track first tap the Tracks icon.



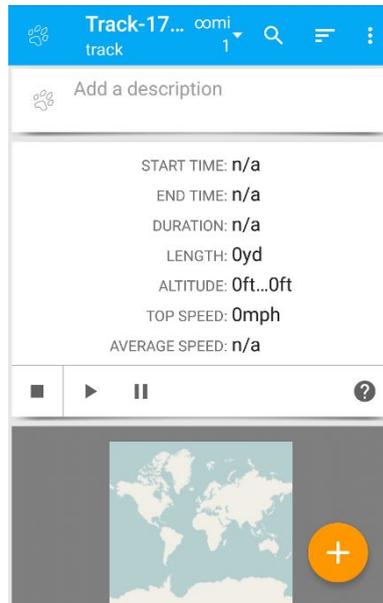
This should bring up the following screen:



→ Tap Track at the top

→ Tap Start at the bottom

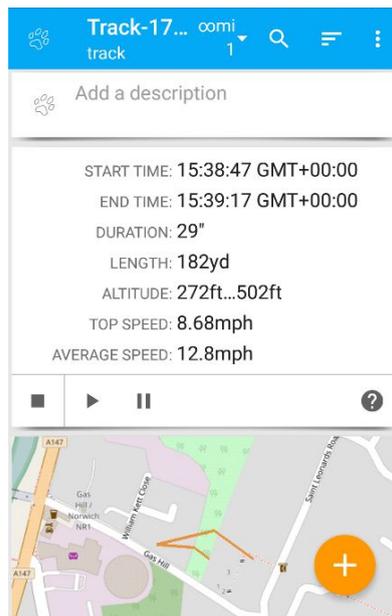
The app will automatically start recording your track until you press stop.



The small paw icon shows that a track is being recorded.

→ Tap and type in the 'Add a description' box

Once you go outside and start moving information about the track will appear. e.g. the length and altitude, check that these measurements are in metres (m). This will show that you successfully changed the units above. In the screenshot below the units are in yards and feet, this shows that the units haven't been changed and is not what we want for this exercise where we want to record in metres.

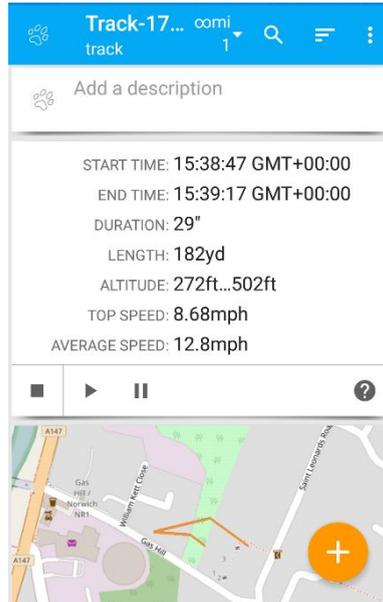


B. Points

It is possible to record specific points (Waypoints) at the same time that the track is being recorded. Waypoints are simply locations of interest. You may want to record the location of a house included

in a survey, or a location of a trap you have set up for example. In this exercise we will simply record interesting landmarks that you find on your walk.

→ Whilst still recording your track, tap the orange circle with a '+' in at the lower right:



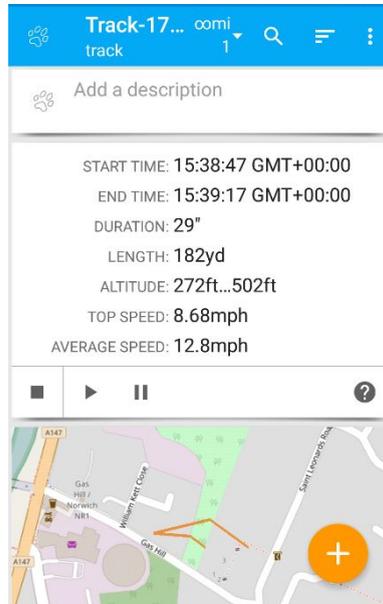
→ Swipe right until you get to the 'WAYPOINT' screen. Here you can choose an icon, add a name and description

→ Tap 'Create' at the bottom

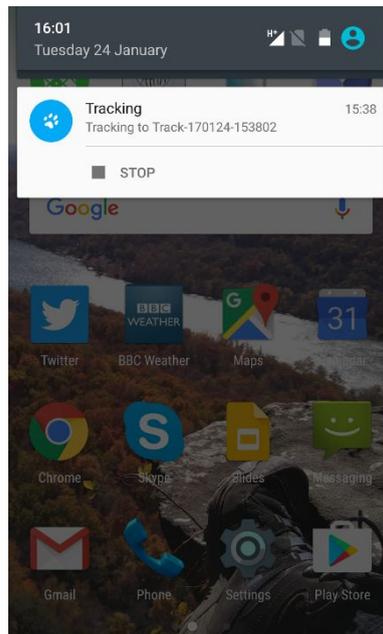


You can choose any landmarks for your waypoints, maybe a building entrance, tree or sign. After you have recorded three waypoints and walked a few hundred metres, we will stop the recording of the track.

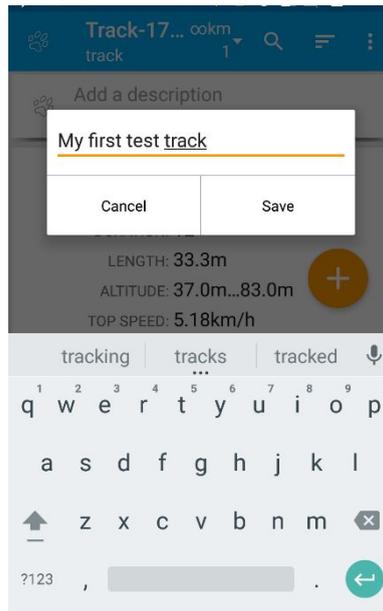
→ To stop recording of the track you can press the square stop button if the app screen is visible.



If the app is in the background (it can continue to record without being visible) swipe down from the top of the screen and you should see the screen as below where you can press 'stop':



→ Tap 'Add a description' to bring up a screen where you can name and save the track:



Practical Exercise: Download data from phone to PC and into QGIS

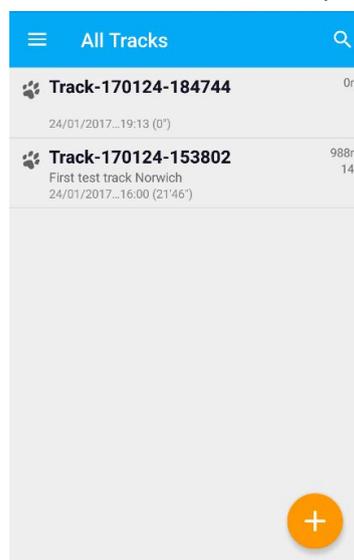
There are a number of ways of getting the data we have collected from the phone to a PC and into QGIS. We will use a GPX file.

GPX

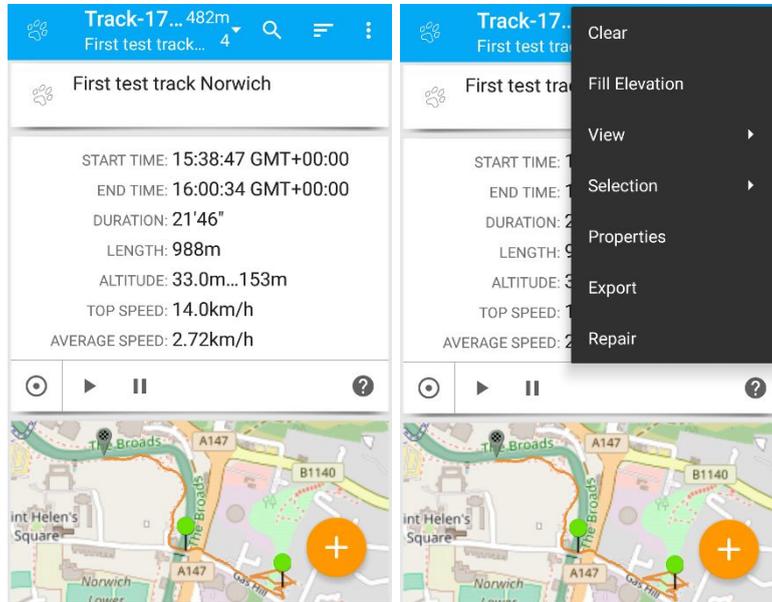
GPX stands for GPS Exchange format and is the most common format for transferring GPS track and waypoint data.

We will use GPX 1.1 - the more recent version. You could also use a KML file which is a format designed for Google Earth and can also be imported into QGIS, but it tends not to work so well.

→ First go to Tracks, you will see a list of saved tracks, tap to select one:

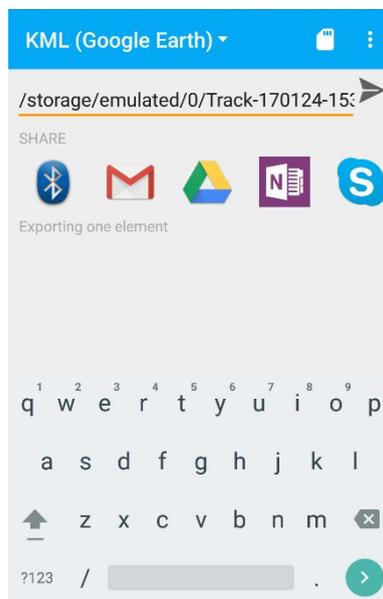


→ Once you have selected a track, tap the 3 vertical dots at the top right to access options including Export :



→ Tap 'Export' to bring up a screen as shown below.

→ Tap to change the 'KML (Google Earth)' option to 'GPX 1.1'.

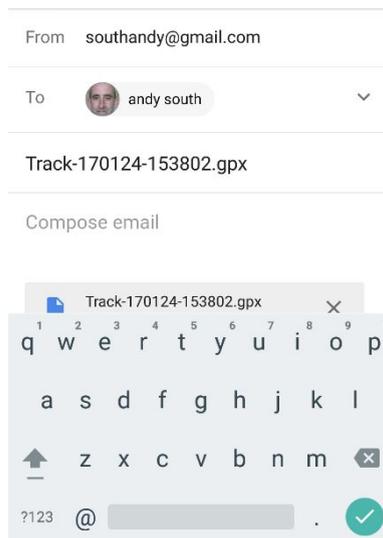
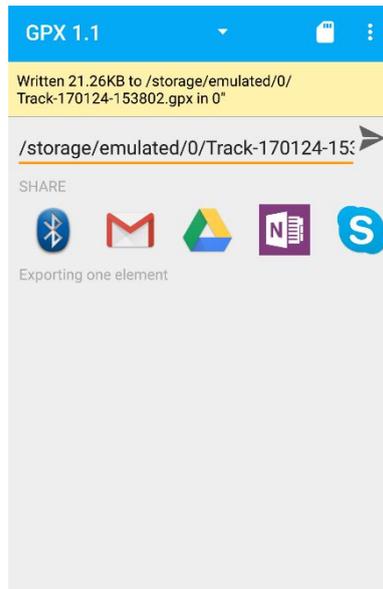


There are two main options to get the GPX file from the phone to your computer. Either you can use email to send the file over the internet or you can use a cable to plug the phone into your computer and download the file directly. Email works much better, using a cable can be tricky.

If you have email on the phone and access to wifi then this method is the most straightforward. We will cover that first and cover the backup option of using a cable afterwards.

To use the email option to send yourself a copy of the GPX file :

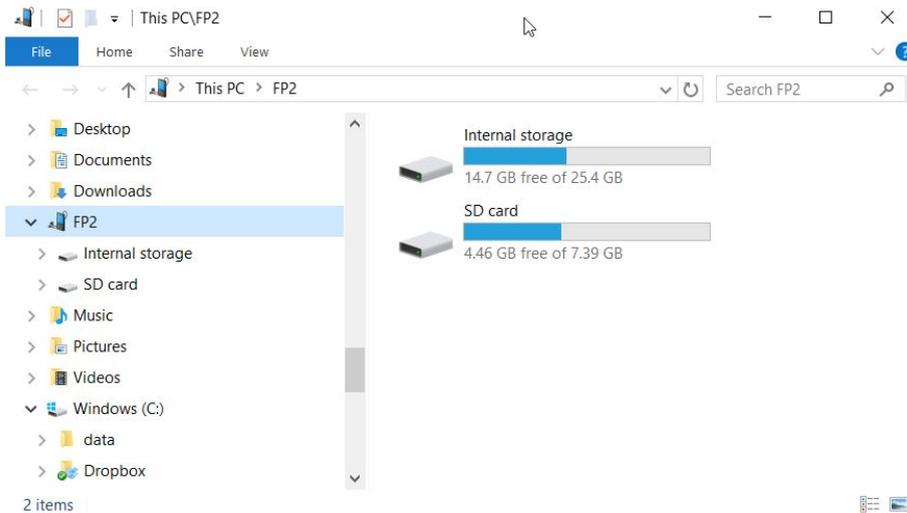
- select your email program from underneath SHARE. Because I use gmail I have a red M representing gmail. If you use different email software on your phone choose the icon that you usually use.



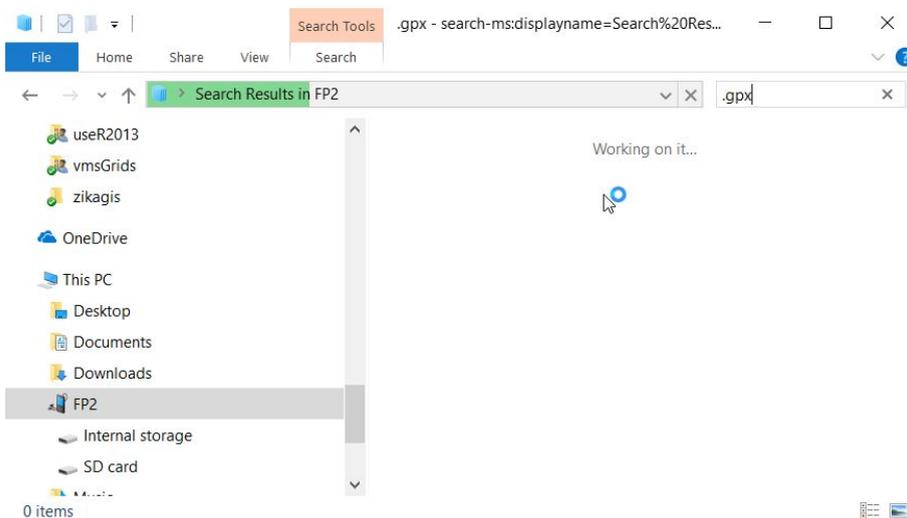
If you do not have access to the internet and email from your phone you can use a USB cable to transfer the GPX file from phone to computer.

Connect phone to computer with a USB cable. You may be asked if you want to charge your phone or connect it as a 'media device'. If so choose Media device. Exactly what happens will depend on both your phone and computer so may look different to what we show here. What we want to do is to use the computer to browse the memory of the phone and find the GPX file.

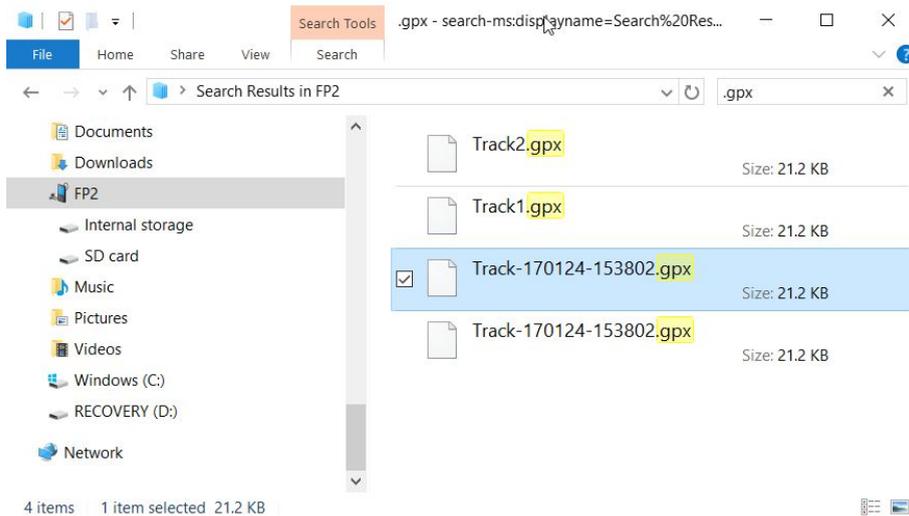
When you initially connect your phone it may bring up Windows file explorer and say 'This folder is empty'. If it does this try refreshing the phone screen and that should bring up the phone file system as shown below. If it doesn't try using Windows file explorer to find the phone in your computer's file system.



Because we are not sure where the App has saved the file we will search for GPX files. Type .gpx into the search box and press return, the search may take a few minutes.



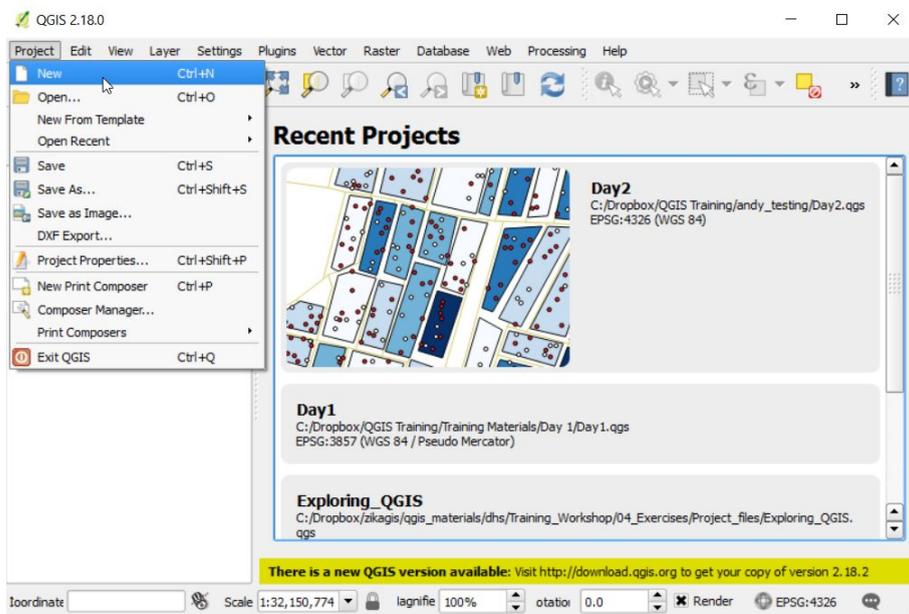
The GPX file(s) should be found as shown below. You can select and use Ctrl C to copy, ready to paste to the folder indicated in the next section, or you can drag and drop. If a GPX file is not found this may be because the phones file system has not refreshed on the computer. Try unplugging and replugging in the cable. If that does not work try re-saving the file again and repeating the search.



Either way that you transferred the GPX file now we will save it to a folder on your computer where we can access from QGIS.

→ Save the GPX file to the folder '/my_work/data/gps/' on your computer.

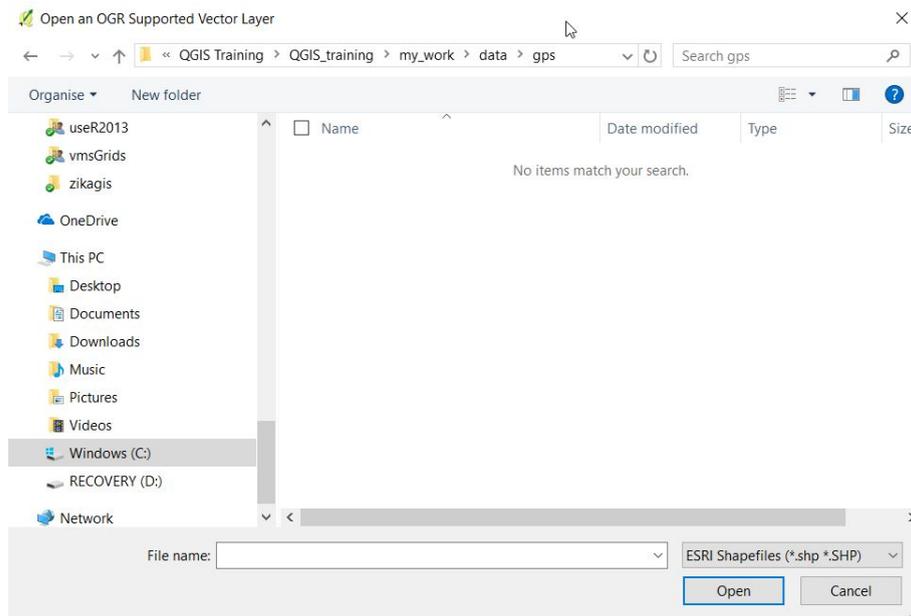
→ Open QGIS and click 'Project, New'



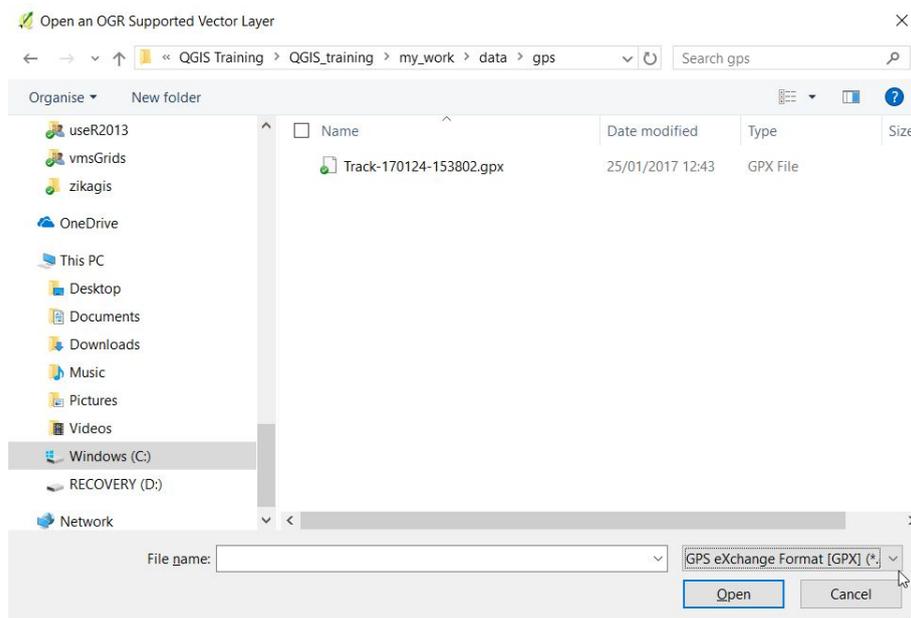
→ Select Layer, Add Layer, Add Vector Layer as we have done before

→ Press Browse and navigate to where you saved the GPX file (/my_work/data/gps/)

When you do this you may be surprised to see that it says 'No items match your search'. Can you think why this might be? (Hint: there is an option you may have changed when adding vector data previously).



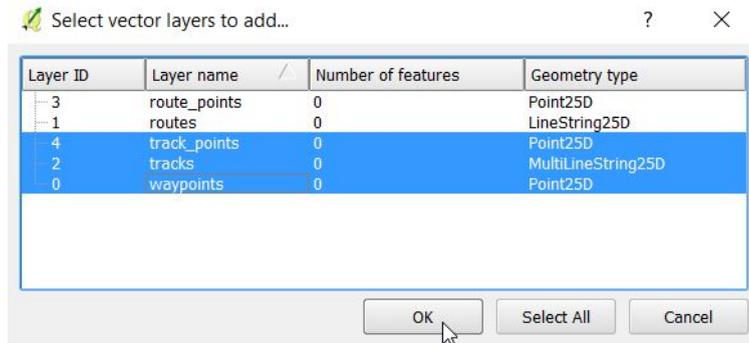
Your filter may be set just to show Shapefiles, if we change the filter on the lower right to either 'All files' or 'GPS eXchange Format' you should see your GPX file if you couldn't before.



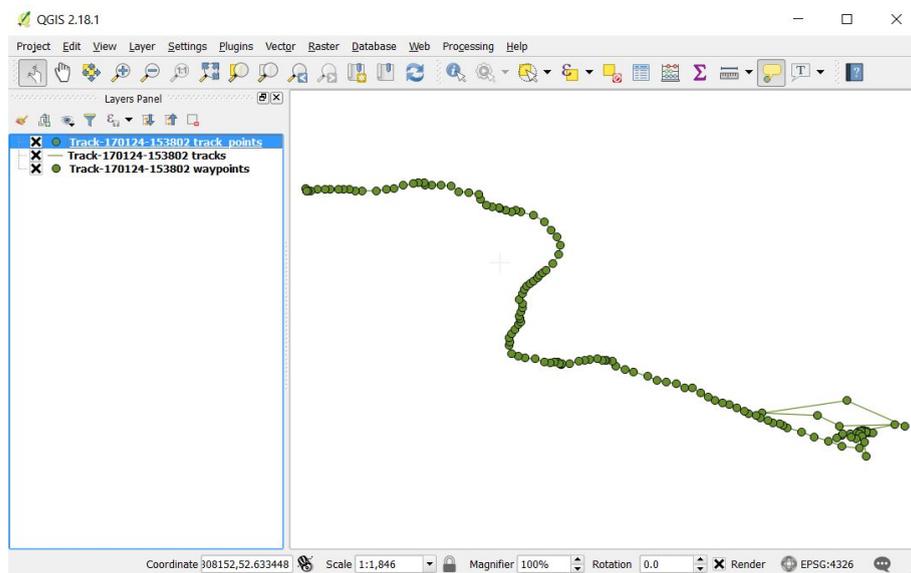
- Double click on the gpx file
- click the Open button in the following window as we have done before.

This should bring up a window called 'Select vector layers to add ...' with options to add route_points, routes, track_points, tracks and waypoints. Routes are a little different than tracks and we have not looked at them here so we will select the others.

- Select track_points, tracks and waypoints (using Ctrl to select multiple options) then click OK.



This should bring up 3 separate layers of your track (line), track_points and waypoints (points) in QGIS! Try turning on and off the different layers and zooming in and out. Are the positions similar to how you remember them ?



Exercise

Produce a map of your data using Print Layout. Include labels for the waypoints you have collected and a basemap for context. Save the file as a png. We will gather these together and share them with the group.

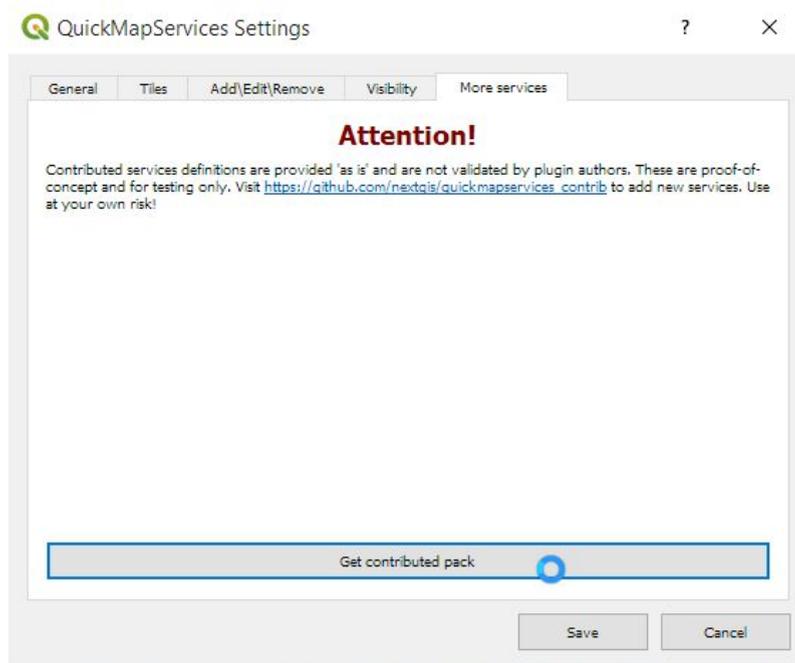
Creating shapefiles

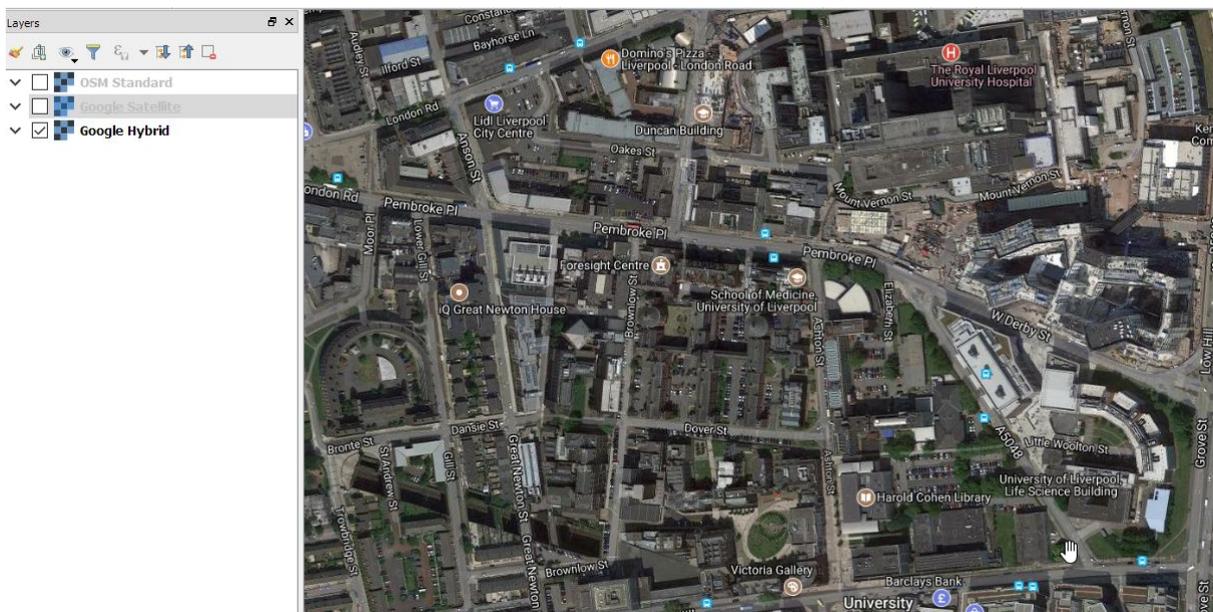
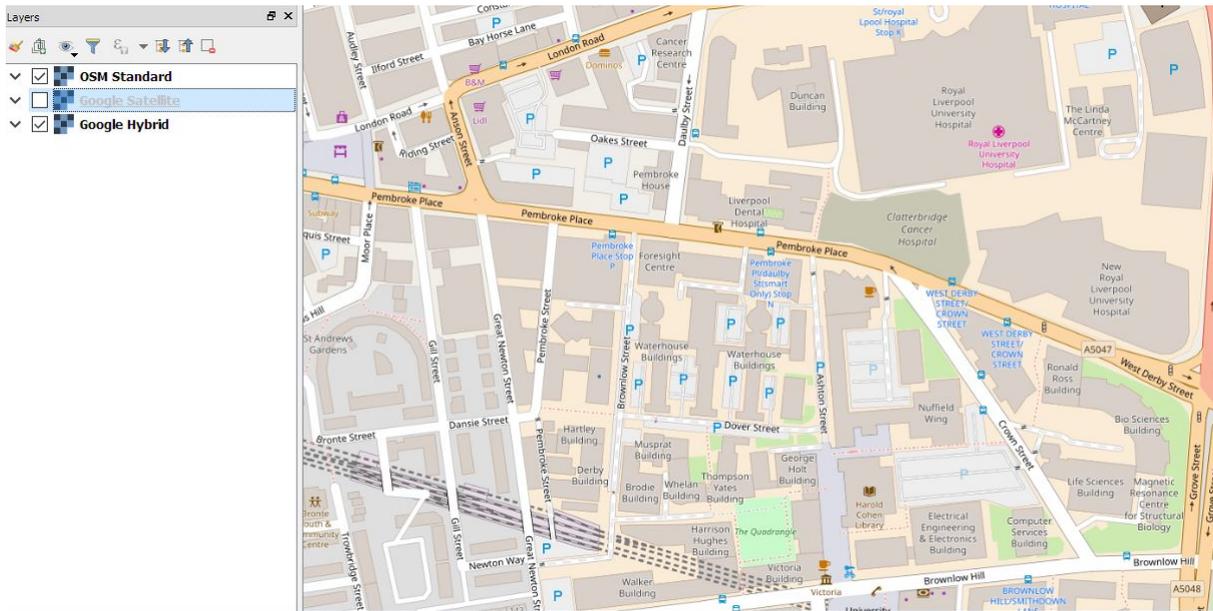
There may be occasions where the shapefile you need doesn't exist, and instead you will need to create it yourself using data from basemaps. For example, you may know the names of the villages where you conducted surveys and you can visualise them on a map but you do not know their coordinates or you may be using non-standard administrative areas.

Using the basemaps in the QuickMapServices, it is possible to draw points and polygons on a map and save them as a shapefile. We will show you a quick example of how to create polygons. The process of making points on the map is similar to this, and simpler!

- Create a new project within QGIS
- Using the QuickMapServices plugin, add the OpenStreetMaps basemap to your project
- See if you can find Liverpool, then LSTM on the map

You may want to add the Contributed packages to QuickMapServices to use Google Maps to help you. You can add these by going to the Settings window, accessed using the QuickMapServices dropdown menu, and clicking More services, Get contributed pack



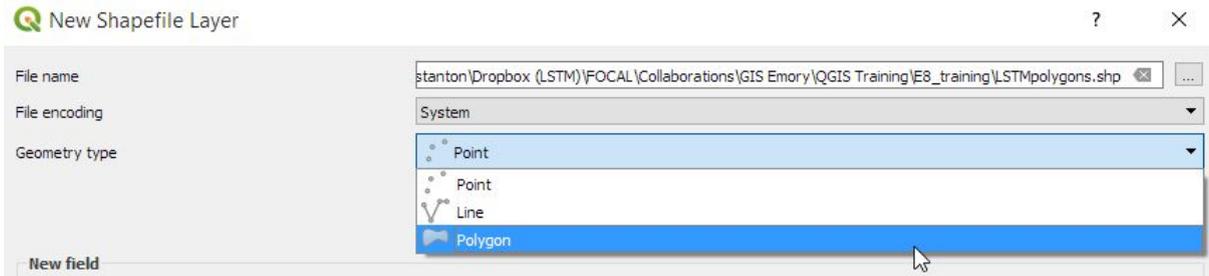


In this example we will create polygons in the area around LSTM to represent 'blocks' of buildings.

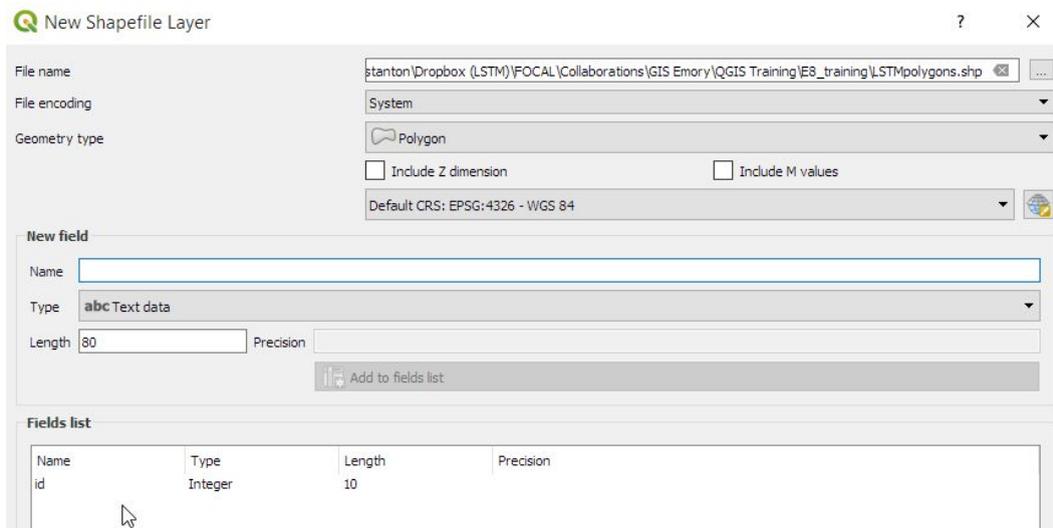
→ Select Layer, Create Layer, New Shapefile Layer



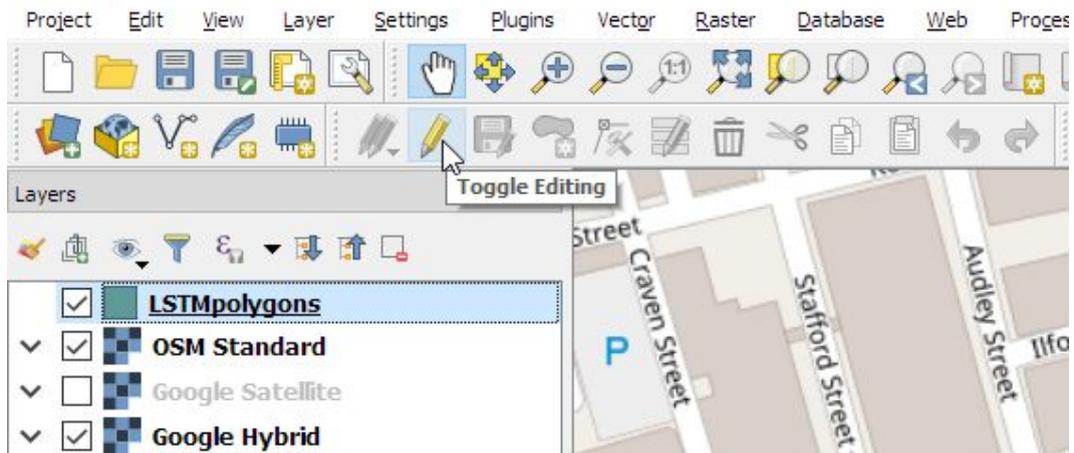
- In the New Shapefile Layer window, choose a file name for your new layer, and select the geometry type *Polygon*
- Select an appropriate coordinate reference system, e.g. WGS84



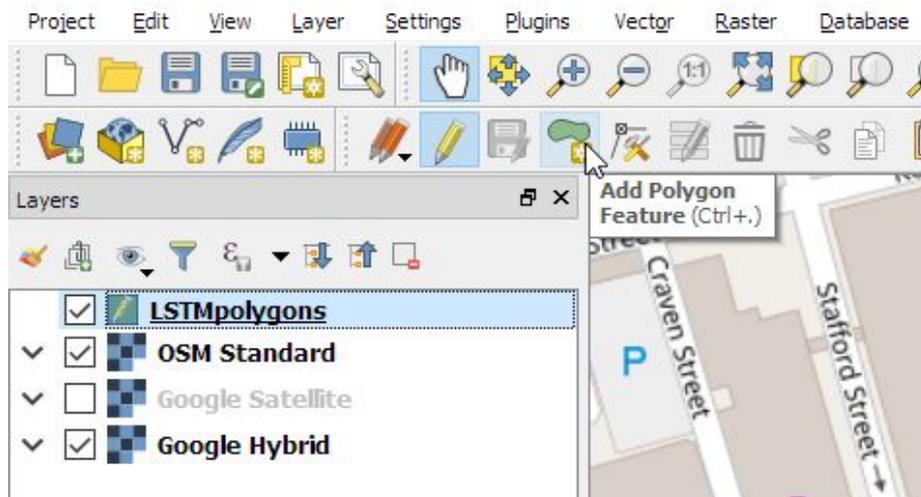
By default, the shapefile will contain one field called ID. You have the option of adding further fields to your shapefile if you wish by using the New field option. In this example however we will just create polygons with no additional attributes associated with them.



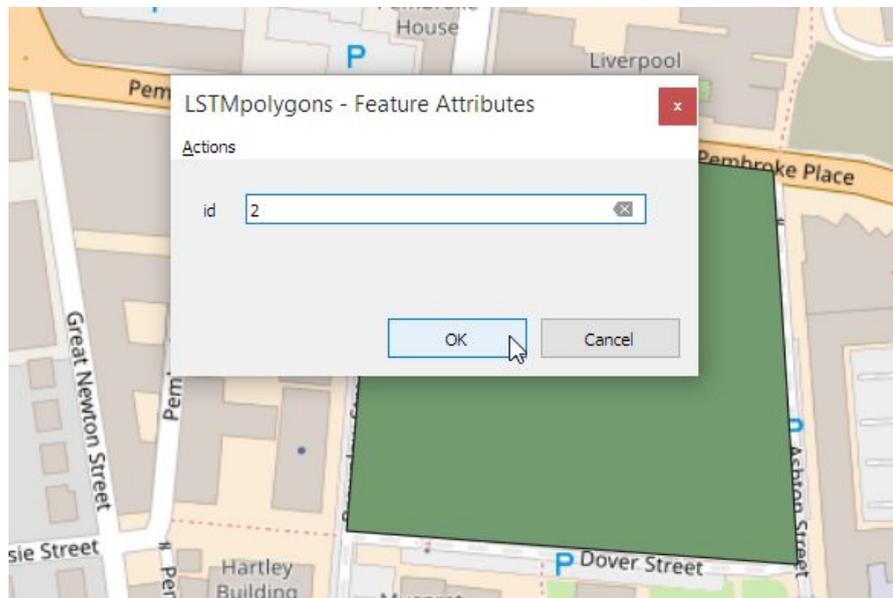
- Click OK. Your new (empty) shapefile will appear in the Layers panel
- Use the shapefile editing tools in the toolbar to enable you to edit the shapefile (Toggle editing)



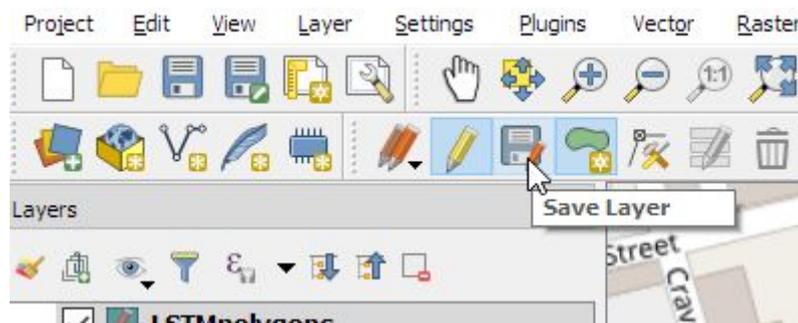
- Once you have clicked the pencil to toggle the editing tools, the surrounding buttons will become active i.e. turn from gray to coloured. You can hover over the buttons to see what each one does
- Select the Add Polygon Feature button



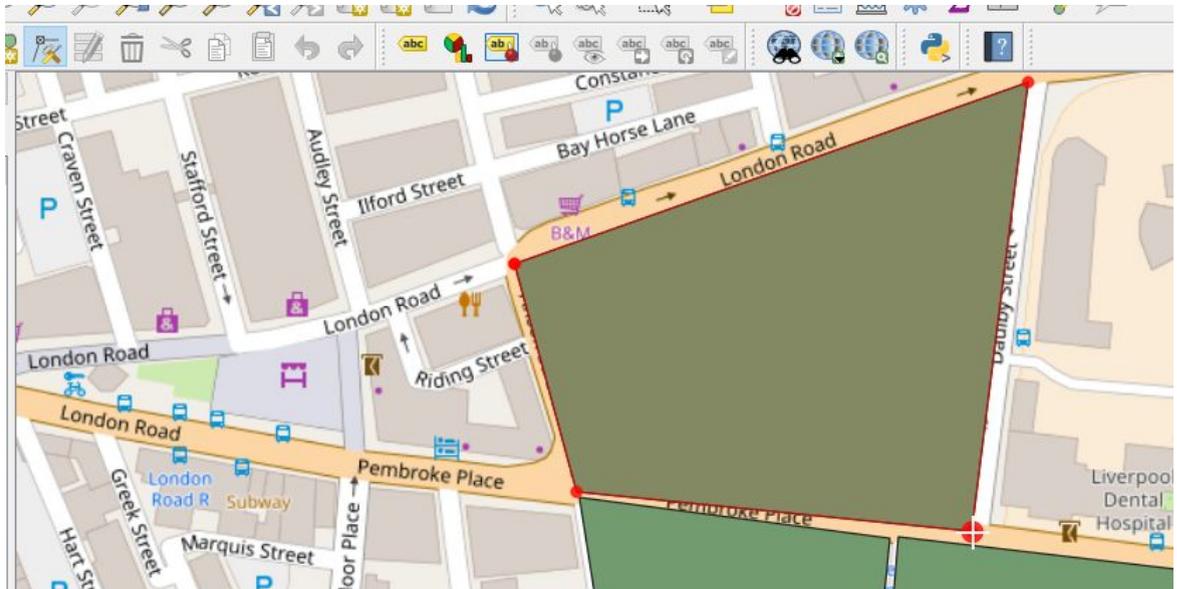
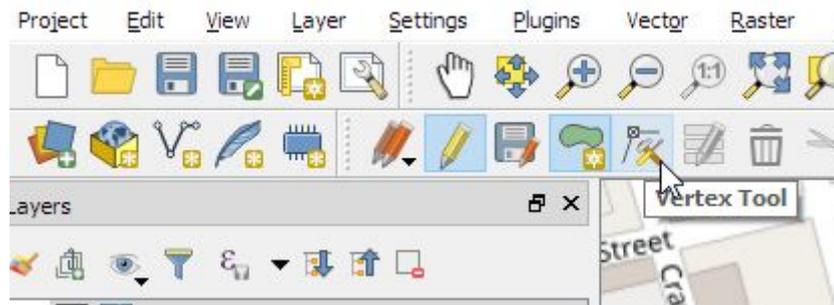
- Using the mouse, you can then click on the map to mark out the vertices of your polygon. The polygon you are drawing will be shown in red. Once you have finished, right-click the mouse and you will be asked to give the polygon an ID.
- Once an ID has been assigned, the polygon will become a solid colour, and you can move on to the next one



→ Once you have finished, click on the Save Layer icon in the toolbar, and *Toggle off* the editing tool



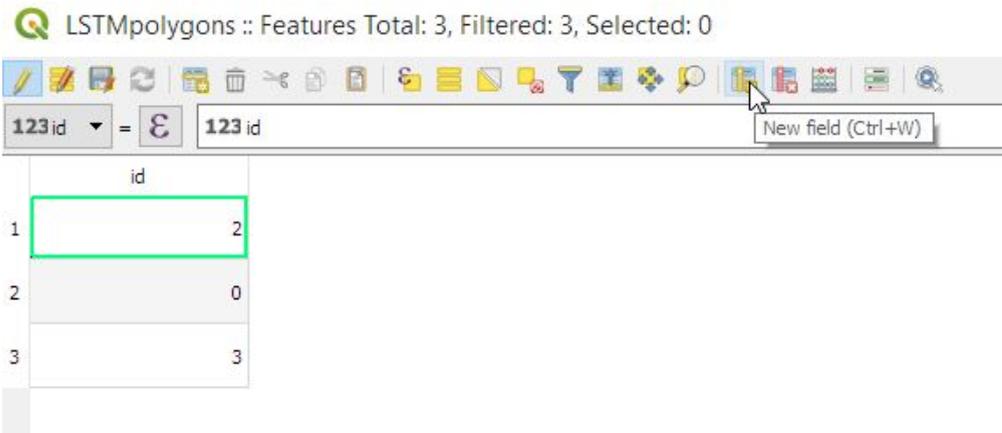
If you make a mistake with one of your polygons you can edit it using the Vertex tool before you turn off the editing feature. To use this tool, just hover over the vertices of the polygon that you want to edit.



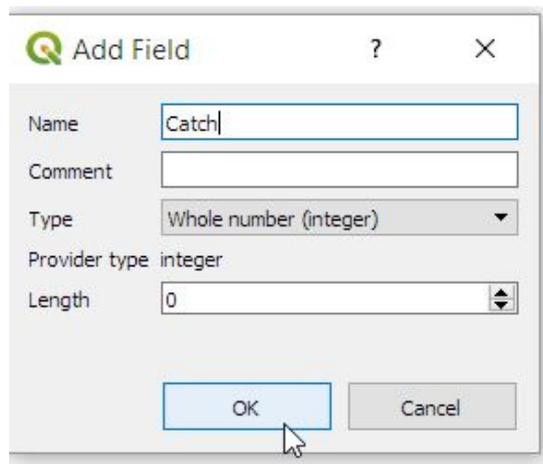
A similar process is followed to create line and point data.

If you want to retrospectively add extra data to each polygon e.g. number of mosquitoes caught in traps, you can do this within the Attributes table

- Right-click the layer in the Layers panel and select Attribute table
- Toggle on the editing tools by clicking on the pencil icon
- Click the New field button



→ Give the field a name e.g. Catch, and specify its type. In this case we want it to be a whole number



→ You can then type in the data. Once you have finished, don't forget to save the edits and turn off editing mode

	id	Catch
1	0	20
2	2	11
3	3	NULL

Alternatively, you can join data from an Excel spreadsheet, matching the data to each polygon using the unique ID value (see Day 3).