

# Using geospatial mapping to leave no one behind

**A guide for practitioners**

*version 1.0 (July 2022)*

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# Introduction

This guidance is applicable to any programmes (beyond the health sector) that aim to further equity and ‘leave no one behind’. Using publicly available geodata, we are able to map different secondary data sources together from a programme context to understand the geographic distribution of different marginalising experiences (most notably, people living in poverty and affected by conflict), and programme accordingly to ensure the programme is driving equity.

Mappable data can inform and influence programming decisions, but will only form part of the factors affecting where the programme operates (it is essential to consider relationship with communities, the relevant government agency, coverage with other partners, etc). Leaving no one behind also means more than going to the right places: inclusive and accessible marketing, service delivery and providing high quality consistently is critical to maintain an equitable programme. MSI’s approach to leaving no one behind is outlined in [Reproductive Choice for All: Leaving No One Behind in Reproductive Healthcare](#) (MSI Reproductive Choices, 2021).

## Uses & limitations

- ✔ This method of poverty mapping is intended as a simple way to get a sense of the distribution of poverty in a country.
- ✔ It is appropriate to use such a map in: high-level programming decisions to highlight geographical areas with the greatest need
- ✘ Using the map at a sub-regional level to select specific sites that may be poorer than other sites within the same district however would not be advised.

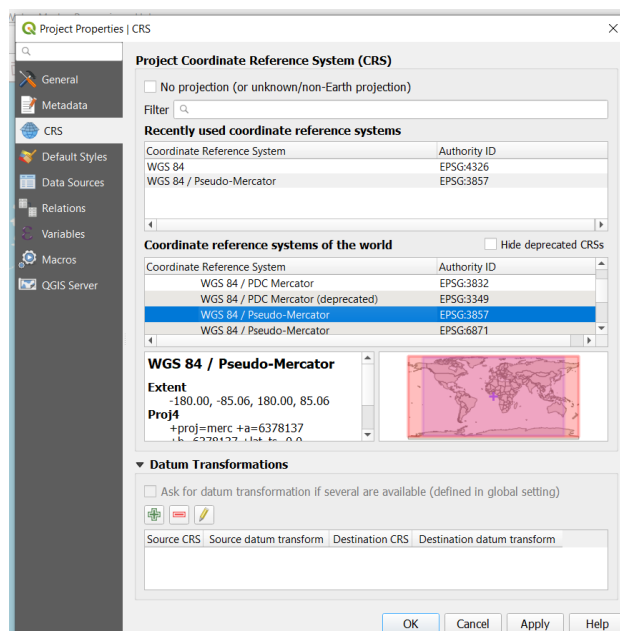
## Software requirements

- QGIS (free to download): <https://qgis.org/en/site/>. If new to mapping, you may want to familiarise yourself with the basic functions of QGIS (there are plenty of demos available online)
- Stata or other analysis software.

## Setting up your QGIS project

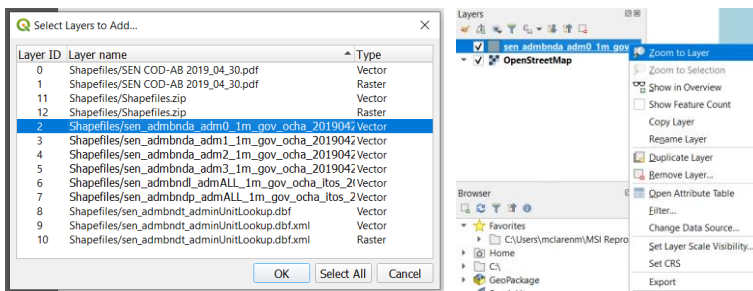
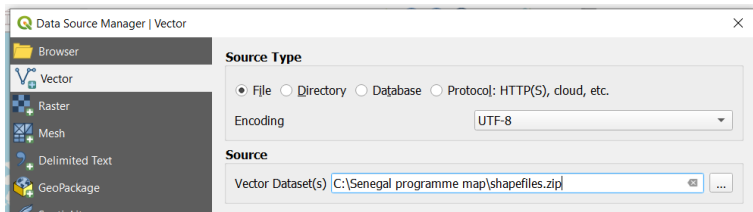
1. Create a **project folder** – this will be where you save your QGIS project and map files
2. Open QGIS and open a new project (ctrl+n). Within the “Browser” window, scroll down to “XYZ Tiles” and double click. Select “OpenStreetMap” and drag it down to the “Layers” window. You should now see a map of the world, which will be the base layer for your map
3. Go to Project > Properties... and make sure the Coordinate Reference System (CRS) selected is WGS 84 / Pseudo-Mercator (EPSG:3857). Click OK. Save the project in the folder you created.

**Senegal is used as the example country throughout this guidance, though the same steps should apply to any country.**



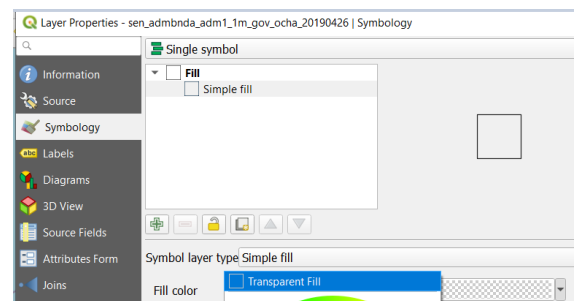
# Adding national and regional borders

1. Visit <https://data.humdata.org/> and type in the search box the name of the country, followed by 'boundaries' (e.g. Senegal boundaries). Select the first result which should be the subnational administrative boundaries
2. Note the source of the dataset (e.g. OCHA ROWCA) as this should be cited with the map. Find the .zip file which contains **shapefiles** and download it. Move it into the project folder. You do not need to unzip/extract all
3. Back in your QGIS project, select Layer > Add Layer > Add Vector Layer... The Data Source Manager will pop up on the Vector tab (as below). Select the '...' button and navigate to your project folder. Double click the zip file you just saved there. Click Add.



4. You will be presented with a pop-up asking you to select a layer. Select the Vector layer that has 'adm0' in the layer name (this is administrative layer 0 – the country border). Close the add layer window
5. You will see the outline layer has been added to the map. In the 'Layers' pane, right click the outline layer and select 'Zoom to Layer'. Right click the layer again and rename it to something that makes sense to you (e.g. adm0 or 'admin level 1' or 'outline').

6. Right click again and select Properties. Select Symbology from the menu options on the left of the properties window. Click Simple Fill in the white box and change the Fill Colour to Transparent Fill. Click OK
7. Repeat steps 4 & 5 to add subnational boundaries. Depending on the administrative structure of the country, adm1 or adm2 may be useful to display as well. To apply the same transparent fill, you can just right click the adm0 layer, and select Styles > Copy Style > All Style Categories, then right click adm1 or adm2 layer and select Style > Paste Style > All Style Categories



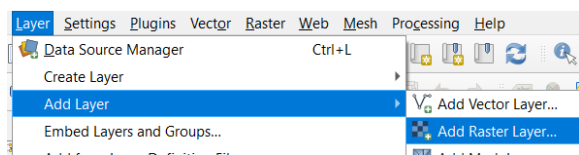
8. It is often useful to display region / district names as labels: right click the layer in the Layers pane and select Properties. Select the Labels option in the Properties window menu on the left-hand side. Change the drop down to Single Labels, and next to 'Label with' select the variable that holds the region/district name - for Senegal regions for example, this is 'ADM1\_FR'. Select OK. It is also useful to keep these boundary layers on top of other layers: you can click and drag them in the Layers pane to keep them at the top of the list (meaning they will appear at the front) or right click and select Move To Top.



## Adding standard demographic layers

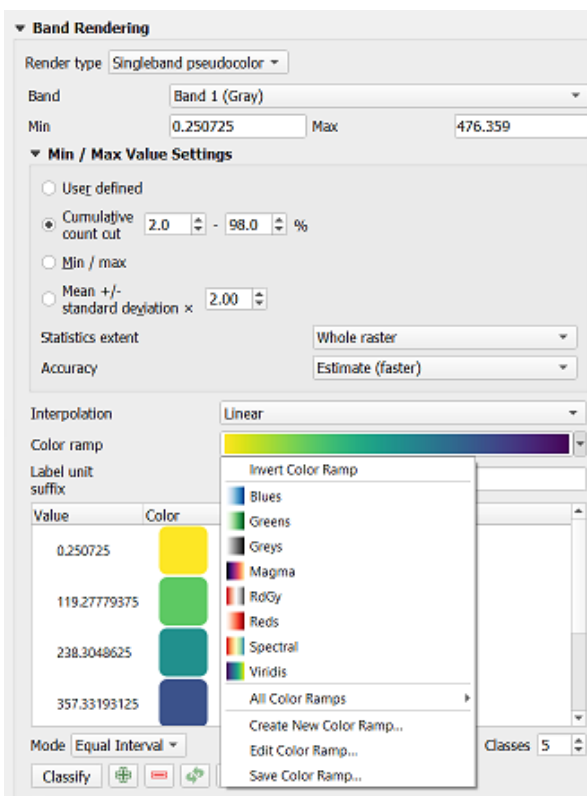
Repositories like <https://www.worldpop.org/> have demographic map layers available to download as Geotiff (.tif) files which are compatible with QGIS. The below instructions demonstrate how to add a population density layer to your map, but there are several other layers available (e.g. pregnancy density, birth density) which follow the same steps.

1. Go to <https://www.worldpop.org/> and hover over the 'DATA' heading. Select 'POPULATION DENSITY' from the list. Select the 'UN adjusted' option. Search for the country you want and select the most recent year. In the Data Files section at the bottom of the page, download the .tif file and move it into your project folder. TIF files always come with a .tif.aux file – keep them together in the same folder
2. Back in your QGIS project, select Layer > Add Layer > Add Raster Layer... Select the '...' button and navigate to your project folder. Double click the .tif file you just saved. Click Add. A black layer should appear on your map.

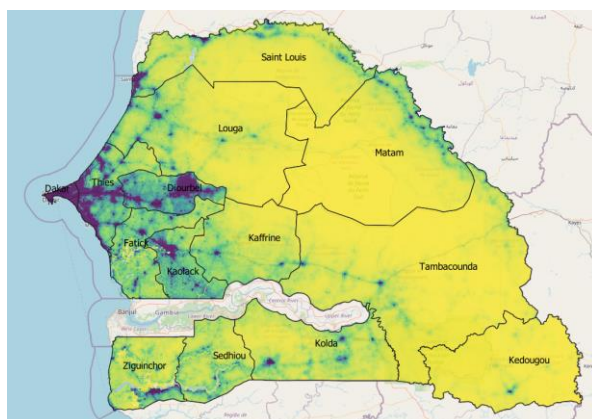
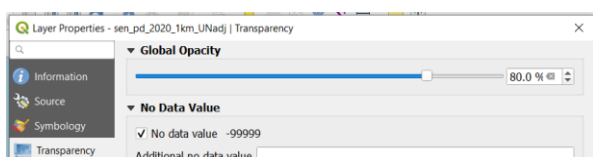


3. In the 'Layers' window, right click the layer just added and select Properties. Select Symbology from the menu options on the left of the properties window. Under 'Band Rendering', change the 'Render Type' to 'Singleband pseudocolour'. Here you can select what colour scheme you want for this layer. We recommend:

- a) Expand the Min / Max Value Settings menu and select 'Cumulative count cut 2.0 - 98.0%'
- b) Choose a colour ramp by clicking the down arrow button next to the colour bar: we recommend Viridis, or Greys if you're going to combine this with another layer (see page X).
- c) Click the down arrow button again and select 'Invert Color Ramp'
- d) Underneath the white window, change the Mode from Continuous to Equal Interval (this makes your map legend much neater).

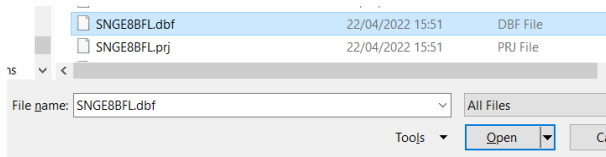


4. Sometimes it is useful to make the layer transparent so that you can see underlying layers. To adjust the transparency of the layer, right click the layer in the 'Layers' window and select Properties. Select Transparency from the menu options on the left of the properties window. Adjust the transparency under Global Opacity at the top.



## Constructing a poverty layer

There are more sophisticated methods for constructing poverty maps, but this is a simple methodology using DHS data and published coordinates of DHS clusters. There are a few options for poverty metrics in DHS data:

- [DHS Wealth Quintiles](#) (variable *v190* – code those in the lowest two wealth quintiles as ‘poor’)
  - [Multidimensional Poverty Index](#) (constructed from the most recent DHS or MICS)
  - Any other proxy variable most relevant to your programme (e.g. phone ownership, literacy, etc).
1. Make sure you are registered for access to download DHS datasets at the DHS Program website. Once granted access, log in and for the country you are mapping, download the STATA datasets for the most recent DHS survey that has a GPS dataset available to download. Make sure to also select the Geographic Data (shapefile .shp) for download as well. Once extracted, locate the .dbf file in the geographic data folder (you can delete everything else in this folder).
  2. Open Microsoft Excel and go to Open. Navigate to the folder where the .dbf file is saved. Next to the blank ‘File Name’ box, change ‘All Excel Files’ to ‘All Files’ in the drop down for file type. Navigate to the folder where your DHS geographic data is saved and double click the .dbf file to open it.
 
  3. If the columns appear very wide, highlight the first column and drag right to select all columns. Resize one column and the rest should resize as well. Change the LATNUM column header to Latitude and the LONGNUM column header to Longitude. Save the file as a .csv in your project folder.

The Global Multidimensional Poverty Index (MPI) is MSI’s preferred poverty metric for mapping and assessing poverty among our clients. We generate the MPI variables using the [publicly available STATA syntax for DHS datasets](#) (NB you will have to make small adjustments such as ensuring the cluster variable *v001* is not dropped), then create a binary variable for severe multidimensional poverty using the below code:

```
gen mpiscore = 100*(d_educ/6 + d_satt/6 + d_cm/6 + d_nutr/6 + d_elct/18 +
d_wtr/18 + d_sani/18 + d_hsg/18 + d_ckfl/18 + d_asst/18)

recode mpiscore *=. if d_cm==. | d_nutr==. | d_educ==. | d_satt==. |
d_elct==. | d_wtr==. | d_sani==. | d_hsg==. | d_ckfl==. | d_asst==.

gen mpisevpoor=0
recode mpisevpoor 0=. if mpiscore==.
recode mpisevpoor 0=1 if mpiscore>=50

label variable mpisevpoor "MPI severely poor"
label define mpisevpoor 0 "not MPI severe poor" 1 "MPI severe poor", replace
label values mpisevpoor mpisevpoor
```

4. With whichever binary poverty variable you end up using, use the below code to generate a mean value per cluster to serve as a poverty rate:

```
mean povertyvariable, over(v001)
e.g. mean mpisevpoor, over(v001)
```

5. Click and drag to select the results table, then click Edit > Copy Table. Go to the .csv file you saved earlier and open a new sheet. Paste the STATA table into the new sheet. Delete columns C-E (these are not needed) and rows 1, 3 and 4 (blank / not needed). You will notice column A (cluster numbers) corresponds to the DHSCLUST column on the other sheet.

	A	B	C	D
1		Mean		
2	1	0		
3	2	0		
4	3	0.16		
5	4	0		
6	5	0		
7	6	0.028571		
8	7	0		
9	8	0		
10	9	0.04		
11	10	0.195652		
12	11	0.071429		
13	12	0		
14	13	0		
15	14	0		

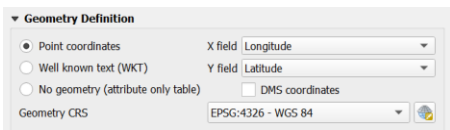
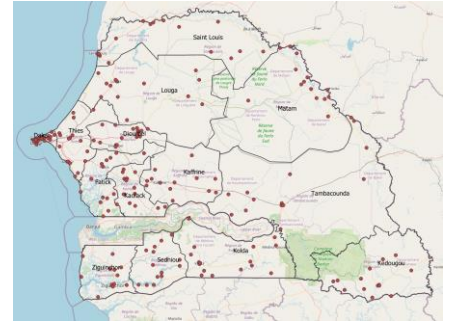
	A	B	C	D
1	DHSID	DHSCC	DHSYEAR	DHSCLUST
2	SN2019000(SN	#####	#####	1.000000
3	SN2019000(SN	#####	#####	2.000000
4	SN2019000(SN	#####	#####	3.000000
5	SN2019000(SN	#####	#####	4.000000
6	SN2019000(SN	#####	#####	5.000000
7	SN2019000(SN	#####	#####	6.000000
8	SN2019000(SN	#####	#####	7.000000
9	SN2019000(SN	#####	#####	8.000000
10	SN2019000(SN	#####	#####	9.000000
11	SN2019000(SN	#####	#####	10.000000
12	SN2019000(SN	#####	#####	11.000000
13	SN2019000(SN	#####	#####	12.000000
14	SN2019000(SN	#####	#####	13.000000
15	SN2019000(SN	#####	#####	14.000000



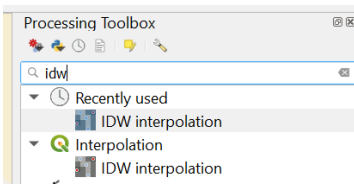
6. Give column U a header on the first sheet (e.g. 'Poverty'). You can either copy and paste the mean poverty values over from Sheet1 (clusters should be sorted in numerical order in each sheet anyway), or you can use INDEX with MATCH to bring the values in (then copy and paste as values to get rid of the formulae). Look through the rows and delete any that have no geographic data (latitude and longitude are both 0). Delete Sheet1 and save the csv file.

	P	Q	R	S	T	U	V	W	X
1	Latitude	Longitude	ALT_GPS	ALT_DEM	DATUM	Poverty			
2	14.675428	-17.448391	#####	11.000000	WGS84	0			
3	14.711251	-17.448647	#####	15.000000	WGS84	0			
4	14.731421	-17.423436	#####	6.000000	WGS84	0.16			
5	14.746539	-17.481220	#####	28.000000	WGS84	0			
6	14.712262	-17.476882	#####	35.000000	WGS84	0			
7	14.728017	-17.448290	#####	16.000000	WGS84	0.0285714			
8	14.748036	-17.445101	#####	17.000000	WGS84	0			
9	14.742008	-17.455291	#####	16.000000	WGS84	0			
10	14.786264	-17.359172	#####	8.000000	WGS84	0.04			
11	14.763150	-17.340270	#####	10.000000	WGS84	0.1956522			
12	14.779601	-17.334132	#####	12.000000	WGS84	0.0714286			
13	14.750216	-17.380110	#####	10.000000	WGS84	0			
14	14.750216	-17.380110	#####	10.000000	WGS84	0			

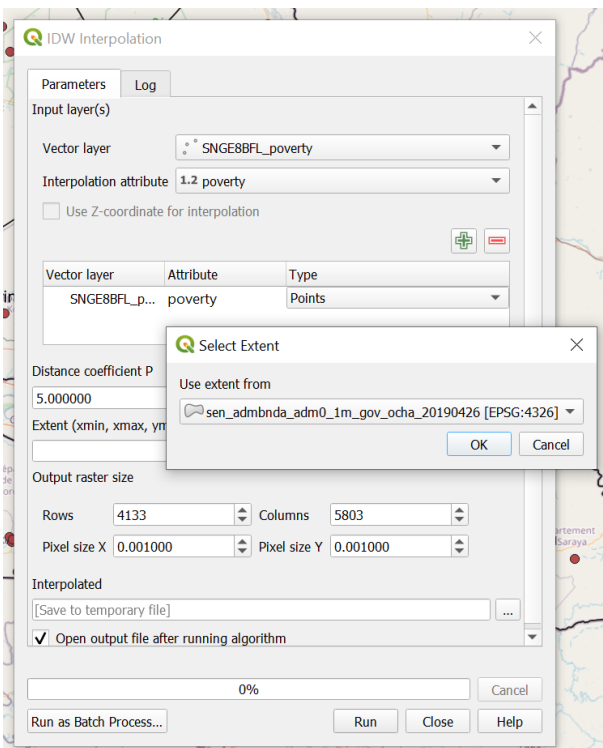
7. Back in your QGIS project, go to Layer > Add Layer > Add Delimited Text Layer. Next to the File Name box, click the '...' button and open the csv file you just saved. Under Geometry Definition, the X field should have automatically selected the Longitude columns and Y field the Latitude. Click Add.



A number of points should appear across your map.



8. Click on Processing > Toolbox to open the processing toolbox pane. Search in the toolbox pane for 'IDW interpolation' and double click it. Set the following parameter in the IDW interpolation window:

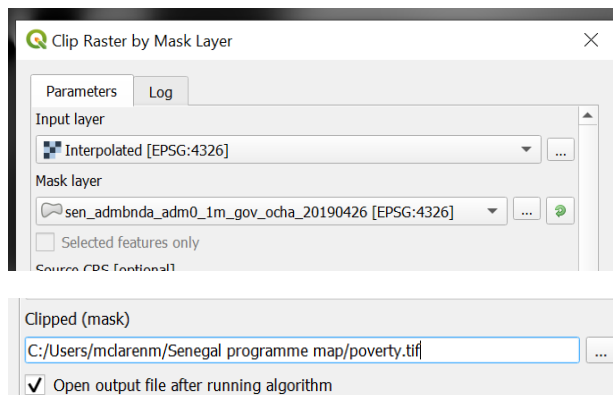


- For Vector layer, select the points layer you just loaded
- The Interpolation attribute is the poverty column. Click the green '+' button, which will bring up a new line below it
- Make sure the 'Type' is 'Points'
- Change the Distant coefficient P to 5 or 6
- Select the '...' button next to Extent and select 'Use Layer Extent'. Select the country outline layer (adm0)
- Scroll down and change Pixel size X to 0.001. Pixel size Y should automatically change as well.

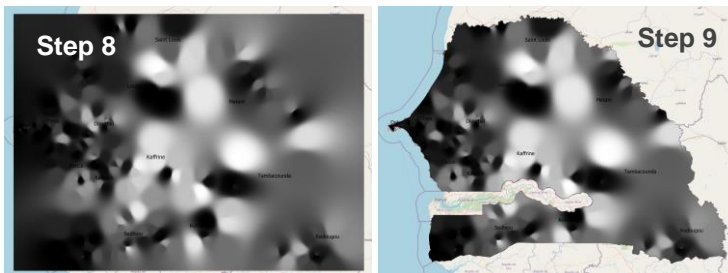
Before you click Run, be aware that this may take up to 2 hours, so make sure your laptop is connected to power and you should be able to work on something else while this runs in the background.

9. The resultant layer will not be shaped to the country outline. To clip the layer, go to Raster > Extraction > Clip Raster by Mask Layer, and enter the following parameters then click run:

- Input layer: interpolated poverty layer
- Mask layer: county outline layer (adm0)
- Scroll down to Clipped (mask). Select the ‘...’ button and click ‘Save to File’. Save it in your project folder. This is now a geotiff file; you can load it into any QGIS project by adding it as a raster layer
- If you get this error: “Cutline polygon is invalid,” it means there is a self-intersection in your boundary file, so it cannot be used to clip the interpolated poverty layer. Look online for an alternative boundary shapefile and repeat the process.



10. Rename the Clipped (mask) layer by right clicking it in the Layers pane and selecting Rename layer (e.g. ‘poverty’). Remove the Interpolated layer and the DHS cluster points layer (right click > remove).



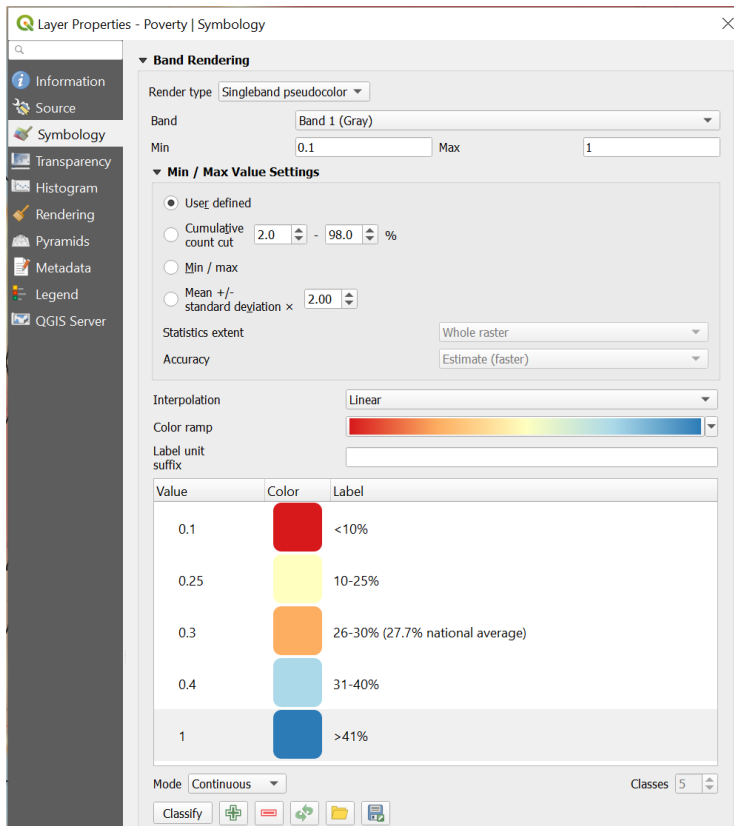
11. To colour the layer, right click it and select Properties. Select Symbology from the menu options on the left of the properties window. Enter the following parameters:

- Under ‘Band Rendering’, change the ‘Render Type’ to ‘Singleband pseudocolour’
- Expand the Min / Max Value Settings menu and select Cumulative Count Cut 2.0-98.0

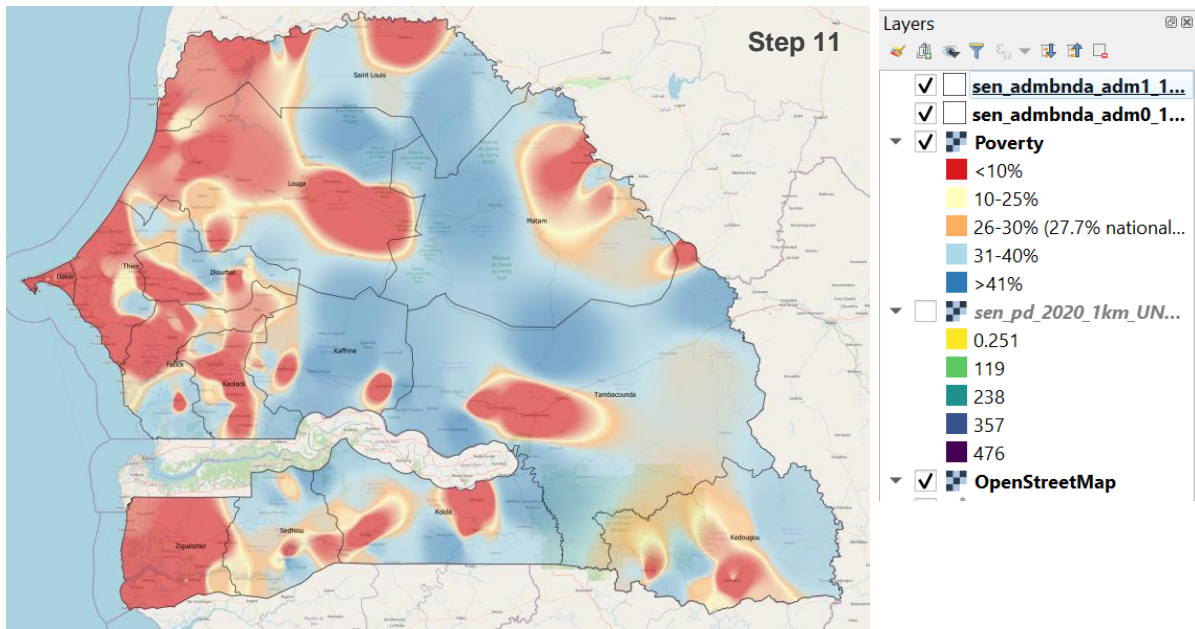
• Choose the color ramp you want. We recommend clicking the down arrow button > All Color Ramps > RdYIBu (this is more colourblind friendly). It defaults to red = less poor, blue = more poor, but you can switch this by clicking the down arrow next to color ramp again, and clicking Invert Color Ramp.

• You can either leave the colour scheme like this, or change the values it is based on. We recommend looking up the national average poverty % for the metric you are using (OPHI list these on the [country briefings](#)) and customising the grouping accordingly (with the average as the amber / middle group). Double click the values to amend them, and amend the labels accordingly – they will not automatically update. If you use custom / manual values like this, the Min / Max Value Settings will change back to User defined (this is ok)

• To amend layer transparency. Go to Transparency in the menu on the left and amend the Global Opacity. Click OK.



The layer you'll see is the poverty map. You will be able to see circular areas around the locations of the clusters, and blended colours in between them. The interpretation of your poverty map depends on how you set the colour scheme.



The interpretation of the map depends on the poverty metric, parameters and colour scheme you've chosen. In this map of Senegal we have used the % severe multidimensional poverty (Global MPI). **Blue** indicates areas where according to the 2019 DHS, the prevalence of severe poverty is higher than the national average (27.7%). **Amber** areas indicate areas that experience a similar level of severe poverty to the national average, and **red** indicates areas where severe poverty prevalence is less than the national average.

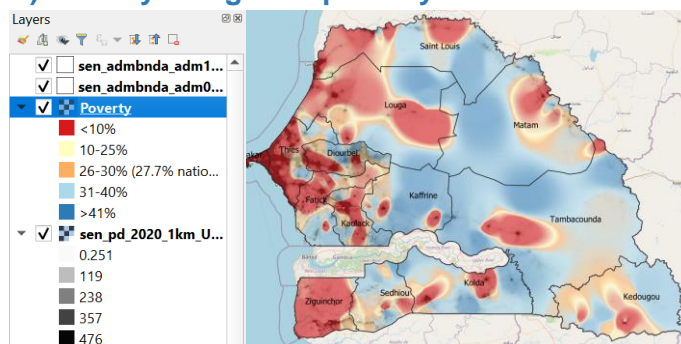
While there are limitations to this method of poverty mapping, it is a simple way to get a sense of the distribution of poverty in a country.

- It is appropriate to use such a map in high-level programming decisions to select areas to operate in, where the local population may be poorer than average.
- Using the map at a sub-regional level to identify specific sites within a district where the local population may be poorer than average and with the greatest need however would not be advised: the interpolation process makes several basic assumptions and DHS data is not powered to represent district-level populations.

## Combining layers

Sometimes it may be useful to see two demographic layers at one time, for example poverty and population density. There are two ways to do this:

### A) Overlay using transparency



1. Tick the population density layer in the Layers Pane to make sure it is visible. Set its transparency to 80-90% (Right click > Properties > Transparency)
2. Make sure the poverty layer is also ticked, place it above the population density layer, and set its transparency to 50-60%.

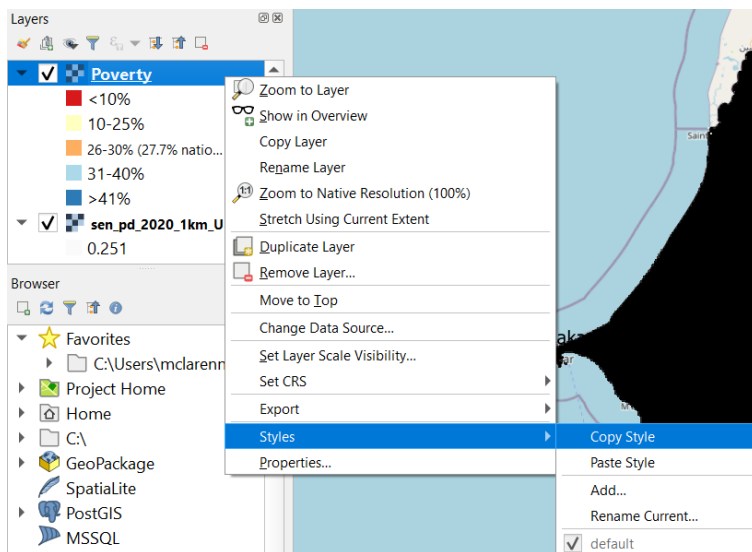
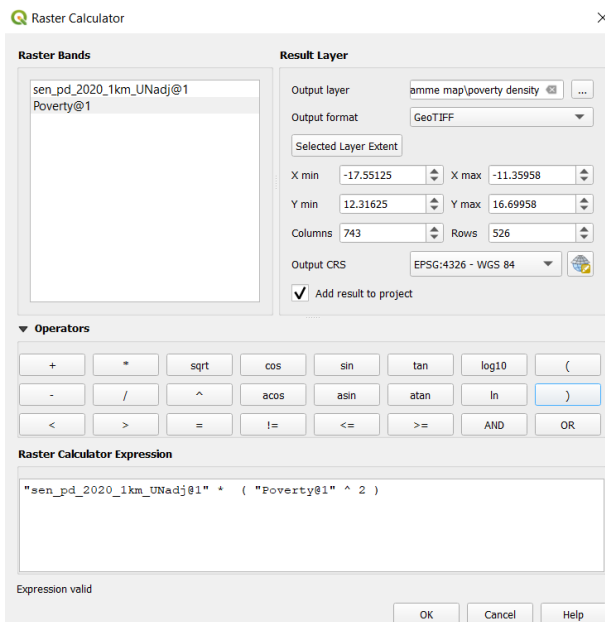
The resultant map overlays poverty on the population density context: you can identify areas of high population density (**dark**) and high poverty prevalence (**blue**).



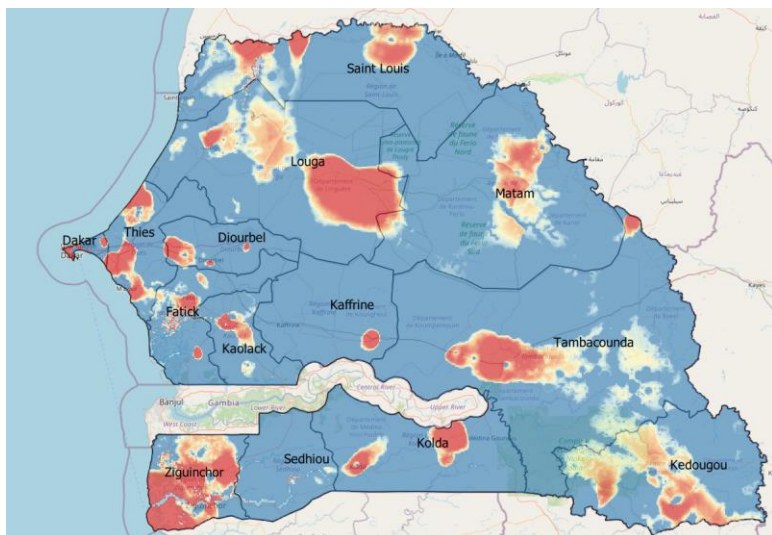
## B) Create a composite layer

1. Make sure to untick the poverty and population density layers to hide them from view. Go to Raster > Raster Calculator and use the Raster Bands fields and Operator buttons to create an expression which multiplies the population density with the square of the poverty layer (squared to give extra weight to the poverty layer). Select your project folder as the Output layer destination. Name it 'poverty density' or something appropriate and click OK.
2. The output layer will be black. To colour this layer, you have to copy the style of the poverty layer onto this layer first before you can edit it. Select the poverty layer and right click. Select Styles > Copy Style. Select the poverty density layer that the raster calculator just created and right click > Styles > Paste Style.
3. The poverty density layer will take on the same colour scheme as the poverty layer, but as the values / units are different it will need to be reclassified. Right click the layer and select Properties. On the Symbology tab, click the Classify button at the bottom of the Band Rendering section. This will readjust the colour band values. Click OK.

The resultant map shows *poverty density*. **blue** represents areas of *either* high poverty or high population density, and **red** represents areas of *either* low poverty or low population density.



### Do I use method A) or B)?



The overlay method will be more useful for general purposes. The composite layer method (generating a 'poverty density' layer) is useful for identifying if there are specific high concentrations of people living in poverty (**dark blue** hotspots). It is not intuitive however: compare Dakar in each of the maps. The poverty density layer reveals red and blue sections of the city. However this area is mostly red in the regular poverty map. This is because the poverty density layer shows blue for *either* high population density or poverty: not necessarily both. If using a poverty density layer, it is always useful to check against the 'regular' poverty layer.

## Adding events or important locations

There are several sources online of geodata. You can plot a points layer ('delimited text layer') using anything that has GPS coordinates:

- The [Armed Conflict Location & Event Data Project \(ACLED\)](#) has a data export tool for downloading coordinates and event information for reported violence and protests around the world, updated daily
- The [Humanitarian Data Exchange](#) has over 7,000 datasets with coordinates (e.g. the [Global Healthsites Mapping Project](#) has uploaded the locations of public health facilities across most low-income countries). You should download these as '.csv' files in order to upload them as a Delimited Text Layer
- [GRID3](#) has an increasing amount of high resolution data for specific countries.

You can also add any programme data you have, if you have the coordinates and save as a .csv file.

Categorised symbols can be really useful for this type of data. The below shows an example of categorising the public health sites symbols using the [Senegal healthsites](#) dataset.

Layer Properties - healthsites | Symbology

Categorized

Column: abc amenity

Symbol: + Change...

Color ramp: [Color ramp from red to yellow]

Symbol	Value	Legend
✓ +	clinic	clinic
✓ +	dentist	dentist
✓ +	doctors	doctors
✓ +	hospital	hospital
✓ +	pharmacy	pharmacy
✓ +	<i>all other values</i>	

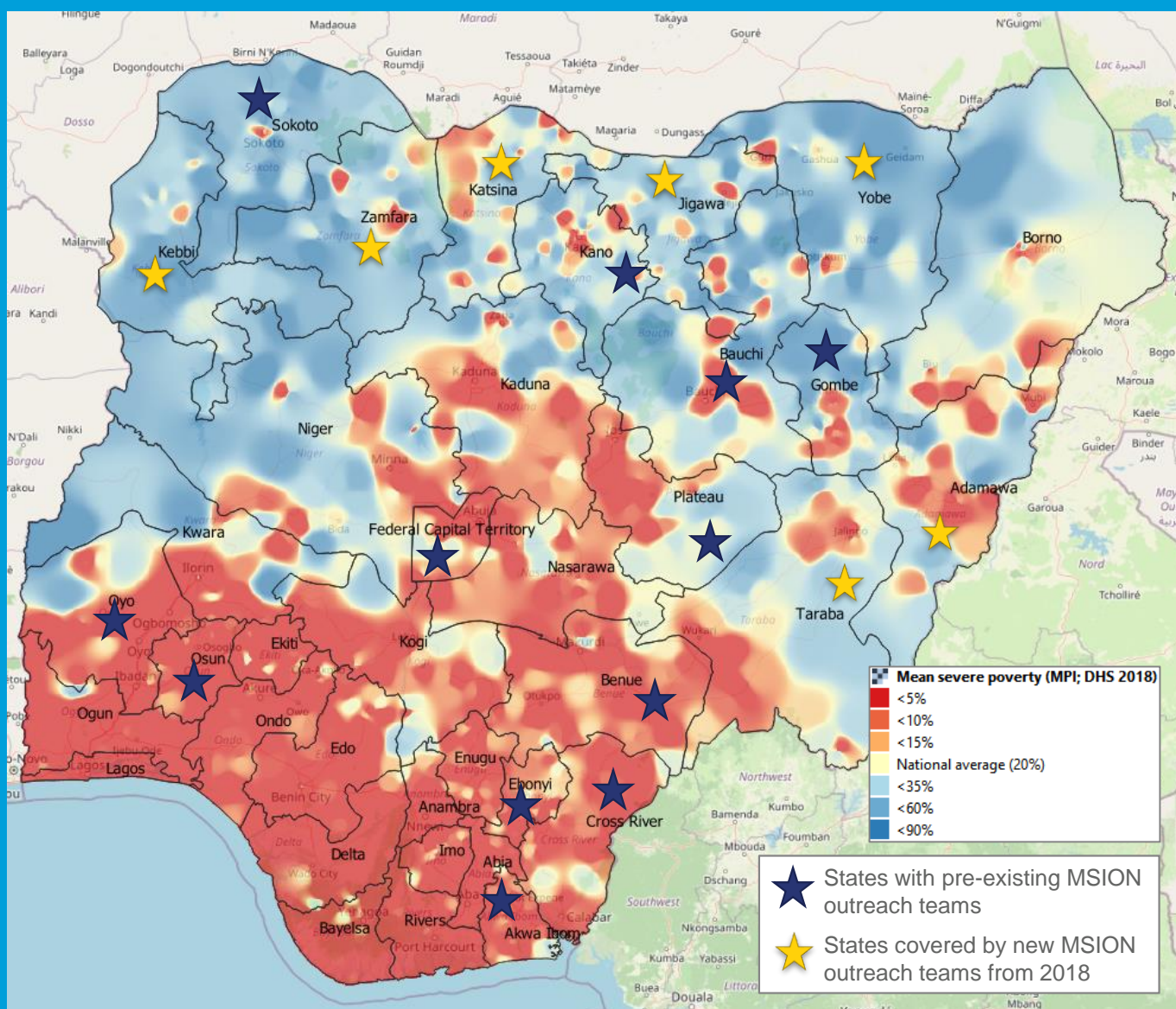
Buttons: Classify, +, -, Delete

Layer Rendering: Style



# How MSI's programme in Nigeria (MSION) used geospatial mapping to leave no one behind

The MSI team in Nigeria (MSION) had the opportunity to expand their mobile outreach service delivery with the advent of the Women's Integrated Sexual Health (WISH) programme in 2018, funded by the UK Foreign, Commonwealth and Development Office (FCDO). A key objective of the programme was to expand access to sexual and reproductive health services to the poorest communities, who face disproportionate barriers to accessing healthcare. MSION used a poverty map similar to the one below to identify states to expand coverage to. Through this process, Kebbi, Zamfara, Katsina, Jigawa, Yobe, Taraba and Adamawa were selected to be covered by new mobile outreach teams.



The expansion had an immediate impact: the estimated percentage of outreach clients likely living in extreme poverty (<\$1.90/day) was effectively double in 2018 compared to two years previously (2016 client exit interview: 20% (95% CI 16-25%); 2018: 42% (95% CI 39-44%)). NB at this time MSI was not yet measuring poverty using the Multidimensional Poverty Index). MSI outreach teams continue to provide high quality sexual and reproductive health services in these states. In 2021 alone, over 387,000 people came to receive a service from an MSION outreach provider: approximately 240,000 of those clients are estimated to live in multidimensional poverty, with over half of those actually living in 'severe' multidimensional poverty. Through this approach, we have been able to increase access to sexual and reproductive healthcare in some of the most underserved communities in Nigeria, driving equity at scale.

## Acknowledgements

This guide was compiled by Megan McLaren, Catherine Verde Hashim and Erik Munroe (MSI Reproductive Choices). To find out more, email [evidence@msichoices.org](mailto:evidence@msichoices.org).

Please cite this resource as 'Using geospatial mapping to leave no one behind', MSI Reproductive Choices (2022).

Funding for this work was provided by the Women's Integrated Sexual Health (WISH) Programme of the UK Foreign, Commonwealth and Development Office (FCDO).

The QGIS community has provided technical support to MSI's mapping techniques.

The following organisations and initiatives provide open access data or resources that make geospatial mapping to leave no one behind possible:

- Armed Conflict Location & Event Data Project (ACLED)
- WorldPop
- The DHS Program
- The Humanitarian Data Exchange
- Oxford Poverty and Human Development Initiative (OPHI).

