

OnSSET/Global Electrification Platform

Hands-on 3: Working with raster data¹

Useful links:

1) Follow the <u>instruction</u> "QGIS 3.10 Installation Instructions" if you haven't already installed QGIS on your computer.

Learning outcomes

By the end of this exercise, you will be able to:

- 1) Import raster data to QGIS
- 2) Perform different key processes (such as projecting, clip) with raster data
- 3) Perform resampling and reclassification on the raster data

Data Acquisition

Download and unzip the folder named "Benin_raster" available <u>here</u>. Within this folder there is a number of additional folders and files. For this exercise make sure that the following files/folders are included:

1. A folder named "Administrative_Boundaries". Within this folder there should be files named **Administrative_boundaries**.

¹ This exercise is an exercise developed by Khavari, B., 2019. Exercise 3: Working with raster data [WWW Document]. OnSSET Teaching Kit. URL https://onsset.github.io/teaching_kit/courses/module_1/Excercise%203/ (accessed 2.18.21).

All images are screenshots from <u>QGIS</u> 3.10, which is licensed under Attribution-ShareAlike 3.0 Unported (<u>CC BY-SA 3.0</u>) unless stated otherwise.



2. A folder named "Wind_Capacity". In this folder there are two wind capacity maps named **Benin_windcap_north** and **Benin_windcap_south**.

Note! It is good practice to use underscore (_) when naming folders or datasets in GIS (instead of space) in order to avoid unexpected errors while processing.

Working with rasters

NOTE : An extensive tutorial of QGIS is available <u>here</u>.

Import

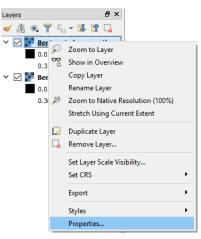
- 1. In the initial step of the exercise, you will import the two wind capacity maps.
- Importing rasters can be done in two different ways; either simply drag the raster file onto your map canvas, or go to the top roll-down menu and click on Layer → Add Layer → Add Raster Layer... (For rasters we usually work with the .tif-file).

For now you will need only the wind capacity maps, so leave the administrative boundaries.

Raster properties

- 1. Next, it is time to examine the properties of the rasters.
- 2. By right-clicking on your raster layer you will be able to examine and/or change properties of your raster files.





3. First, click on the **Information** tab. Here you will find general information about your layer, which can provide more in-depth knowledge of the data that you are working with.

🔇 Layer Properties - ghana_	windcap_south Information	?	×
Q	Information from prov	ider	^
Information			- 1
<u> </u>	Original	ghana_windcap_south	
	Name	ghana_windcap_south	
🔇 Source	Source	D:/EMP-A SouthAfrica 2019/Ghana_raster/Wind_capacity/ghana_windcap_south.tif	
	Provider	gdal	
🧹 Symbology	CRS	EPSG:4326 - WGS 84 - Geographic	
_	Extent	-4.5019378330000004,4.3413494420000003 : 3.8406331279999995,8.1958963849999993	
Transparency	Unit	degrees	
	Width	3337	
📉 Histogram	Height	1542	
Histogram	Data type	Float32 - Thirty two bit floating point	
	GDAL Driver Description	GTiff	
🖌 Rendering	GDAL Driver Metadata	GeoTIFF	
•	Dataset Description	D:/EMP-A SouthAfrica 2019/Ghana_raster/Wind_capacity/ghana_windcap_south.tif	1
da Dunanida	Compression		
Pyramids	Band 1	 STATISTICS_MAXIMUM=0.47783625125885 STATISTICS_MEAN=0.14811069471583 	
📝 Metadata		 STATISTICS_MINIMUM=0.011434582062066 STATISTICS_STDDEV=0.066715477439408 	
	More information	AREA_OR_POINT=Area	
Legend	Dimensions	X: 3337 Y: 1542 Bands: 1	
	Origin	-4.50194,8.1959	
📝 QGIS Server	Pixel Size	0.00250002,-0.00249971	
	Identification		
	Identifier		_
	Parent Identifier		
	Title		
	Туре		
	Language		
	Abstract		
	Categories		
	Keywords		
	Extent		
			_

4. One of the most important tabs for the appearance of your dataset is the **Symbology** tab. Here you can change many different aspects of the dataset.

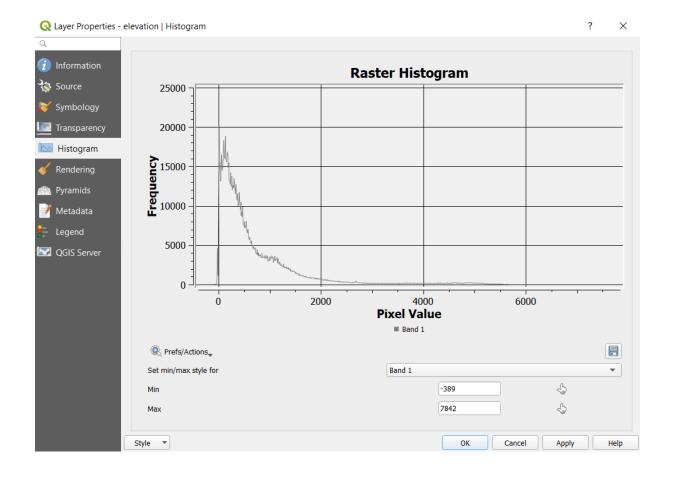


You can change the colour, style, and legend range of the raster, which is very useful when you wish to highlight different aspects of your data.

🔇 Layer Properties - eleva	ation Symbology	?	\times
۹. 🗸	Band Rendering		
information	Render type Singleband gray		
Source 👩	Gray band 1 (Gray)	•	
Symbology c	Color gradient Black to white	•	
Iransparency	Min -389 Max 7842		
	Contrast enhancement Stretch to MinMax	•	
🞸 Rendering	Min / Max Value Settings		
🚔 Pyramids 🚽	Color Rendering		
Metadata B	Blending mode Normal	👆 Reset	
E Legend B	Brightness O 🗢 Contrast	0	
C QGIS Server S	Saturation Grayscale Off	•	
н	Hue Colorize Strength	100% 🜩	
•	Resampling		
z	Zoomed: in Nearest neighbour 👻 out Nearest neighbour 💌 Oversampling 2.00 💠		
	Thumbnail Legend Palette		
			•
Sty	tyle Cancel Ap	pply He	elp

5. Next, we will move on to the tab named **Histogram**. Here you will be able to examine the number of occurrences for the different values in your data. This may be very useful when you want a summary of your raster data or to identify outliers.





Merging Raster layers

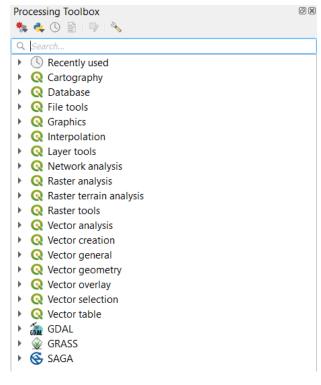
Sometimes you have several rasters that are representing the same type of data in different parts of your study area. In these situations, it is often useful to merge the rasters into one dataset. To do this, you can use a tool called **Merge**. The wind capacity map for Benin has been given to you in two pieces. Now, you will use the Merge tool to merge these datasets into one raster.



 Make the tool bar visible by going to the roll-down menu and click on Processing → Toolbox.

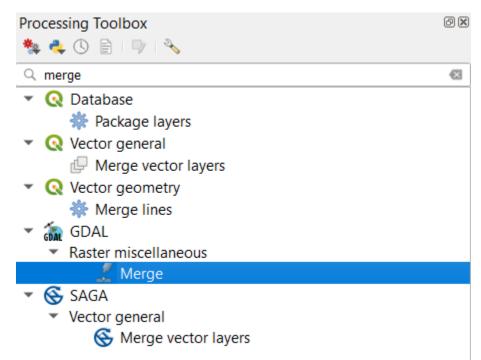
🔇 *Untitled Project - QGIS		
Project Edit View Layer Settings Plugins Vector Raster Database	Processing Help	
📄 🗅 💳 🖶 🔜 💽 😫 🜓 🏘 🗩 🗩 💭 💯 💭	* <u>T</u> oolbox Ctrl+A	lt+T
	Sraphical Modeler Ctrl+A	lt+M
	∐istory Ctrl+A	lt+H
🥬 📖	Results Viewer Ctrl+A	lt+R

This opens up the toolbox on the right-hand side of the QGIS interface. In this toolbox you can search for all the tools that you need.



2. Now, search for "merge". This will show all the tools containing the word "merge".





- 3. Select the merge tool within the GDAL-package (the one highlighted in the image above).
- 4. In the window that opens up, choose the two datasets that you wish to merge in the field that says "Input layer" by clicking on the three dots at the right-hand side of the field. The rest you can leave as they are. Click "Run in Background" to execute the tool. When your layers have been successfully merged you can remove the two original maps from the QGIS interface.

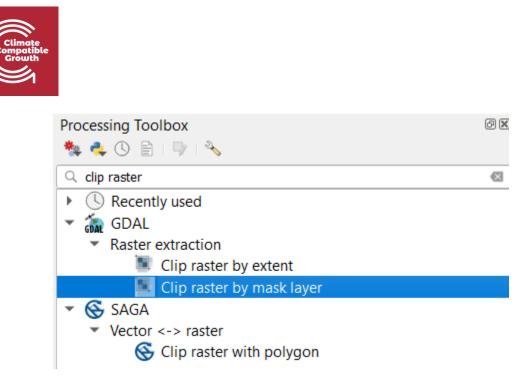


🔇 Merge			? ×
Parameters Log			
Input layers			
0 elements selected			
Grab pseudocolor table from first layer			
Place each input file into a separate band			
Output data type			
Float32			
Advanced parameters			
Input pixel value to treat as "nodata" [optional]			
Not set			٠
Assign specified "nodata" value to output [optional]			
Not set			-
Additional creation options [optional]			
Profile Default			•
Name	Value		
	, and c		
🕀 🥅 Validate Help			
Merged			
[Save to temporary file]			
✓ Open output file after running algorithm			•
0%			Cancel
Run as Batch Process	Run	Close	Help

Clip

You will now notice that the dataset covers an area much larger than the study area. We will fix this by clipping this raster with the administrative boundaries of Benin. In order to do so we are using the **Clip Raster by Mask Layer.**

- 1. Import the administrative boundaries of Benin that you were given in the Benin_raster folder. Do this by directly dragging the .shp file onto the map canvas.
- 2. Search for **Clip Raster by Mask Layer** in the **Toolbox**. Select the tool included in the GDAL-package (the one highlighted below).



3. As an "Input layer" enter the raster that you want to clip (in this case the merged wind capacity map you created in the previous step). As "Mask layer" enter the polygon you want to clip by. Since we want the wind capacity in Benin we choose the administrative boundaries of the country. In the field that says "Assign a specified nodata value to output bands", enter "0". This will make sure that all the values that are not a part of Benin are set to no data. The rest you can leave as it is. Click on "Run in Background" to run the tool.



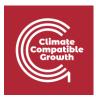
Q Clip Raster by Mask Layer	? ×
Parameters Log	
Input layer	^
Merged wind capacity [EPSG:4326]	▼
Mask layer	
Cadministrative_boundaries [EPSG:4326]	▼ 🦻
Selected features only	
Assign a specified nodata value to output bands [optional]	
0,000000	
Create an output alpha band	
$\ensuremath{\boxdot}$ Crop the extent of the target dataset to the extent of the cutling	2
Keep resolution of output raster	
Advanced parameters	
Additional creation parameters [optional]	
Profile Default	•
Name	Value
译 Validate Help	
	0% Cancel
Run as Batch Process	Run in Background Close Help

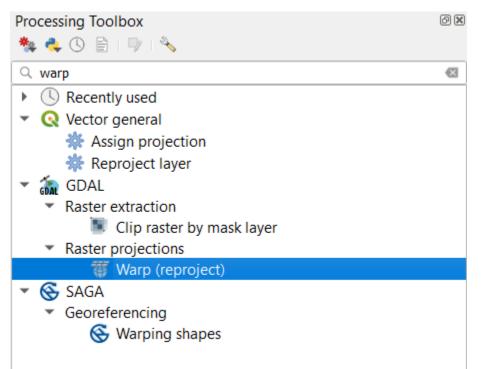
NOTE: In order to see your clipped wind capacity map, uncheck all of the other layers in the table of contents.

Projecting rasters

The coordinate system is very important when representing data. When projecting an area onto a map there will always be a certain distortion. When choosing the coordinate system, it is important to make compromises and choose the system that gives the least distortion. For this exercise you will have to choose a coordinate system that works for Benin, as that is the current study area. In this case, choose the coordinate system named **WGS 84/UTM zone 31N.** Now, you should project the wind capacity map that was clipped in the previous step. To reproject raster files you can use a tool called **"Warp"**.

1. In the toolbox search for "warp" and double-click on it to use the tool (in the GDAL-package).





2. First, in the "Input layer"-field choose the dataset that you wish to project (this will be the clipped wind capacity map from the previous step).



🔇 Warp (Reproject)		?	×
Parameters Log			
Input layer			^
Clipped wind capacity [EPSG:4326]		•	
Source CRS [optional]			
		-	
Target CRS			
EPSG:4326 - WGS 84		-	
Resampling method to use			
Nearest neighbour		•	
Nodata value for output bands [optional]			
Not set		\$	
Output file resolution in target georeferenced units [optional]			
Not set		÷	
Advanced parameters Additional creation parameters [optional]			-
Profile Default		-	
Name	Value		
			~
	0%	Cano	el
Run as Batch Process	Close	Help)

- 3. You do not need to specify the current projection system used for the raster, so the second field ("Source CRS [optional]") can be left empty.
- 4. Now, click on the button next to the field named "Target CRS".



🔇 Warp (Reproject)		?	×
Parameters Log			
Input layer			^
Clipped wind capacity [EPSG:4326]		•	
Source CRS [optional]			
		-	
Target CRS			
EPSG:4326 - WGS 84		-	
Resampling method to use			
Nearest neighbour		•	
Nodata value for output bands [optional]			
Not set		* *	
Output file resolution in target georeferenced units [optional]			
Not set		*]
▼ Advanced parameters			
Additional creation parameters [optional]			
Profile Default		•	
Name	Value		
			~
1			
	0%	Cance	4
Run as Batch Process Run in Background	Close	Help	

This will open the following window:



Q Coordinate Reference System Selector	?	×
Define this layer's coordinate reference system This layer appears to have no projection specification. By default, the project, but you may override this by selecting a different projection	his layer will now have its projection set to that	of the
Filter Q		
Recently used coordinate reference systems		
Coordinate Reference System	Authority ID	4
WGS 84 / UTM zone 36S	EPSG:32736	-
* Genererad projektion (+proj=merc +lon_0=0 +k=1 +x_0=0 +y_0=	=0 USER:100000	
WGS 84 / UTM zone 31N	EPSG:32631	
WGS 84 / Pseudo-Mercator	EPSG:3857	
WGS 84 / World Mercator	EPSG:3395	
Arc 1960 / UTM zone 36N	EPSG:21096	
WGS 84	FPSG:4326	
Coordinate reference systems of the world	Hide deprecate	ed CRS
Coordinate Reference System	Authority ID	-
WGS 72BE	EPSG:4324	
WGS 84	EPSG:4326	
WGS72	IGNF:WGS72G	
WGS_1984_(G1150)	EPSG:104013	
WGS_1984_(G1674)	EPSG:104014	
WGS 1984 (G1762)	FPSG:104015	•
Selected CRS WGS 84		
Extent: -180.00, -90.00, 180.00, 90.00 Proj4: +proj=longlat +datum=WGS84 +no_defs		M N IN
	OK Cancel	Help

In the filter field start typing the name of the coordinate system you want to use ("WGS 84/UTM zone 31N"):



Q Coordinate Reference System Selector			? >
Define this layer's coordinate reference This layer appears to have no projection specification. E of the project, but you may override this by selecting a	y default, this layer will n		on set to th
Filter 🔍 utm zone 31 N			
Recently used coordinate reference systems			
Coordinate Reference System	Authority I	D	
< Coordinate reference systems of the world		Hide dep	precated CF
Coordinate Reference System	Authority I		
Nord Sahara 1959 / UTM zone 31N	EPSG:30731		
WGS 72 / UTM zone 31N	EPSG:32231		
WGS 72BE / UTM zone 31N	EPSG:32431		
WGS 84 / UTM zone 31N	EPSG:32631		
<			>
Selected CRS WGS 84 / UTM zone 31N Extent: 0.00, 0.00, 6.00, 84.00 Proj4: +proj=utm +zone=31 +datum=WGS84	Employ	2	
Extent: 0.00, 0.00, 6.00, 84.00	CK CK	Cancel	Help

Click on OK to pick this coordinate system

NOTE: For future studies the following site <u>https://epsg.io/</u> can be used to determine which coordinate system to use.

5. Set the resampling method to nearest neighbour and leave the rest as it is.

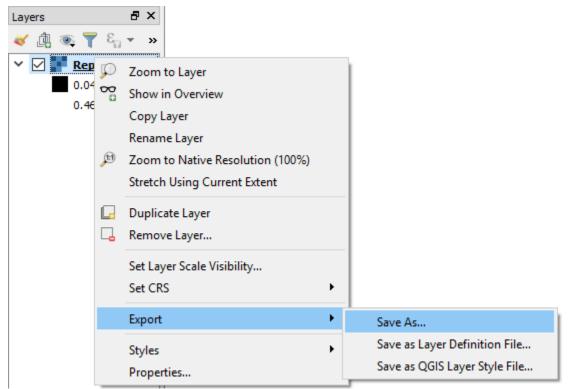
🔇 Warp (Reproject)		?	×
a mark (nebrolect)			~
Parameters Log			
Input layer			^
Clipped wind capacity [EPSG:4326]		•	
Source CRS [optional]			
		•	٠
Target CRS			
EPSG:25000 - Leigon / Ghana Metre Grid		•	٠
Resampling method to use			
Nearest neighbour			•
Nodata value for output bands [optional]			
Not set			-
Output file resolution in target georeferenced units [optional]			
Not set			+
Advanced parameters			
Additional creation parameters [optional]			_
Profile Default			•
Name	Value		
	0%	-	
	0%	Ca	ancel
Run as Batch Process	Run in Background Close	H	Help

6. Execute the tool by clicking "Run in Background".

Export

- You will now export the reprojected wind capacity layer to the folder named wind_capacity. This is necessary when you want to save manipulated data on your computer for usage in other programmes or at a later point.
- 2. Right-click on the wind capacity layer that you just projected and click on Export
 → Save As...





3. Choose to export your raster file as GeoTiff and click on "Browse" next to filename and navigate to the wind_capacity folder that you received. Name your layer "Wind_capacity". Make sure that the box saying **Add saved file to map** is checked (see figure below).

ormat GeoTIFF Create VR						
$\label{eq:lilename} $$ Users\babak\OneDrive\Skrivbord\wind_capacity\wind_capacity.tif $$ \babak\OneDrive\Skrivbord\wind_capacity\wind_capacity.tif $$ \babak\OneDrive\Skrivbord\wind_capacity\wind_c$						
Layer name						
CRS	PSG:25000 - Leigo	n / Ghana M	etre Grid			-
✓ Add saved fi	le to map					
▼ Extent (cu						
		7101101 00	~~			
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Current I Resolution Horizonta Columns	South ayer Extent Ca (current: layer) 1 1125.12 13609 Options	alculate from	661 Layer 🔹)	anvas Exten Layer Reso	lution

4. Keep the rest as given in default.

NOTE: As in the case of vectors, if you do not export the maps they will only be saved in memory and not exist next time you restart the programme.

Resample and reclassify

Resample

If you open the **Properties** of the wind capacity layer (by right-clicking) and go to **Metadata,** you will be able to see the spatial resolution of the wind capacity raster. It is stated that the pixel size is approximately 276.

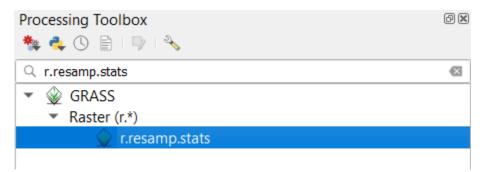


Q Layer Properties - Wind_capacity | Information

Information	Information from prov	
Information	Original	Wind_capacity
_	Name	Wind_capacity
Source	Source	D:\EMP-A SouthAfrica 2019\Ghana_raster\Wind_capacity\Wind_capacity.tif
	Provider	gdal
Symbology	CRS	EPSG:25000 - Leigon / Ghana Metre Grid - Projected
	Extent	24071.19239999999999069,7596.8559999999124557 : 517546.3881999999866821,720056.8477000000420958
Transparency	Unit	meters
	Width	1787
Histogram	Height	2580
listogram	Data type	Float32 - Thirty two bit floating point
	GDAL Driver Description	GTiff
Rendering	GDAL Driver Metadata	GeoTIFF
	Dataset Description	D:\EMP-A SouthAfrica 2019\Ghana_raster\Wind_capacity\Wind_capacity.tif
Pyramids	Compression	
- yranius	Band 1	 STATISTICS_MAXIMUM=0.57844245433807
		 STATISTICS_MEAN=0.13793762587821
Metadata		 STATISTICS_MINIMUM=0.021369555965066
		 STATISTICS_STDDEV=0.049906289205205
lagend	More information	AREA_OR_POINT=Area
Legend	Dimensions	X: 1787 Y: 2580 Bands: 1
	Origin	24071 2 720057

As the unit of the coordinate system is in metres, this is equivalent to a spatial resolution of 276 m². We want the spatial resolution to be 1 km, in other words, we want the wind capacity raster to have a cell size larger than the one we have now. This can be done by resampling the map, using a tool named **r.resamp.stats**.

1. Search for "r.resamp.stats" in the **Toolbox** (the tool that you will use is a part of the GRASS-package).



2. When opening the tool you will see the following screen:

?

 \times



Parameters Log				
Input raster layer				
Wind_capacity [EPSG:25000]			•	
Aggregation method [optional]				
average				•
 Quantile to calculate for method=q	uantile [optional]			
0,500000				-
Propagate NULLs				
Weight according to area (slow	er)			
Advanced parameters				
GRASS GIS 7 region extent (xmin, : [Leave blank to use min covering e				
GRASS GIS 7 region cellsize (leave				
1000,000000				
Output Rasters format metadata o	ptions (metaopt) [optional]			
Dutput Rasters format metadata o	otions (metaopt) [optional]			
Dutput Rasters format metadata o	ptions (metaopt) [optional]			
	ptions (metaopt) [optional]		_	
Resampled aggregated	ptions (metaopt) [optional]			
Resampled aggregated	ptions (metaopt) [optional]			
Resampled aggregated [Save to temporary file]				
Resampled aggregated		0%		

As **Input layer** enter the dataset that you wish to resample (in this case the wind capacity map that you exported previously).

As **aggregation method** choose "average". This field determines how the resampling is done. By putting "average" we are telling QGIS that the cells with the size of 1 km² should have the average value of all the cells with cell size 276 that overlaps it.

In **GRASS GIS 7 region cellsize (leave 0 for default)** enter 1000. This tells QGIS that we want cells that are 1000 m x 1000 m (1 km²).



Leave all other fields as they are, and click on **Run** to execute the tool.

3. Next, open the properties of the resampled layer and check that the cell size is now approximately 1000m x 1000m.

Q	Layer Properties - Resam	pled aggregated Information		?	×
Q					~
a	Information	Information from prov	ider		_
	Information	Original	Resampled aggregated		
3~	0	Name	Resampled aggregated		
- S	Source	Source	C:/Users/adm.desa/AppData/Local/Temp/		
			processing_f53c790951fd4ca58519115f0b666e42/		
~	Symbology		b7fbd73b3e364351be16871e3712f1ac/output.tif		
	, ,,	Provider	gdal		
1.00		CRS	USER:100000 - * Generated CRS (+proj=tmerc +lat_0=4.66666666666666666		
1 Y Y	Transparency		+lon_0=-1 +k=0.99975 +x_0=274319.51 +y_0=0 +a=6378249.145		
			+b=6356514.96582849 +towgs84=-130,29,364,0,0,0,0 +units=m +no_defs) - Projected		
\sim	Histogram	Extent	24071.1923999999999999069.7596.8560000000288710 :		
	, in to grant	Latent	517546.3881999999866821,720056.8477000000420958		
1		Unit	meters		
~	Rendering	Width	493		
		Height	712		
rillion .	Pyramids	Data type	Float64 - Sixty four bit floating point		
1973	r yrannas	GDAL Driver Description	GTiff		
		GDAL Driver Metadata	GeoTIFF		
1	Metadata	Dataset Description	C:/Users/adm.desa/AppData/Local/Temp/		
			processing f53c790951fd4ca58519115f0b666e42/		
<u>-</u>	Legend		b7fbd73b3e364351be16871e3712f1ac/output.tif		
•	Legenu	Compression	LZW		
		Band 1	 STATISTICS_MAXIMUM=0.50902862846851 		
	QGIS Server		 STATISTICS_MEAN=0.13797788837883 		
			 STATISTICS_MINIMUM=0.01136479107663 		
			 STATISTICS_STDDEV=0.049248869718869 		
		More information	AREA_OR_POINT=Area		
		Dimension	TIFFTAG_SOFTWARE=GRASS GIS 7.4.1 with GDAL 2.2.4 X: 493 Y: 712 Bands: 1		
		Dimensions	X: 493 Y: 712 Bands: 1 24071 2 720057		
		Pixel Size	1000.96,-1000.65		

Reclassify values

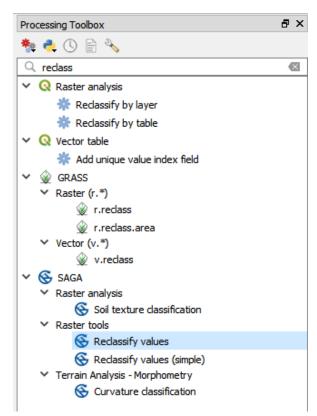
Reclassifying raster files is a common practice. It is useful when you wish to either create classes within your datasets or to change values of different classes. Reclassifying a raster can also be useful if you wish to highlight any specific areas based on different characteristics. In this exercise we will use the resampled wind capacity layer and reclassify it. The purpose is to highlight areas that have high capacity factors.

The wind capacity factor is measured in percentages. As you can see in the QGIS window the minimum is around 0 and the maximum around 50%.



In this example, we would like to install our wind turbines in areas where the wind capacity resources are favourable. We are interested in areas with at least 20% wind capacity factor. Therefore, we will turn all values between 0 and 20 to 0, and keep the rest as they are.

- 1. In the toolbox search for "reclassify values".
- 2. Amongst the tools that appears choose reclassify values in the SAGApackage.



3. When you open the tool, the following screen will be displayed (you will only work with the fields that are in the red boxes):

Q Reclassify Values	? ×
Parameters Log	
Grid	^
Wind_capacity [EPSG:25000]	▼
Method	
[1] range	▼
old value (for single value change)	
0,000000	•
new value (for single value change)	
1,000000	▲
operator (for single value change)	
[0] =	-
minimum value (for range)	
0,00000	•
maximum value (for range)	
0,200000	≪ ≑
new value(for range)	
0,000000	≪ 🗧
operator (for range)	
[0] <=	▼
Lookup Table	
Fixed table 3x3	
operator (for table)	
[0] min <= value < max	▼
☑ replace no data values	
new value for no data values	
0,000000	
replace other values	
new value for other values	
0,000000	•
Reclassified Grid	
[Save to temporary file]	
🖂 Open output file after running algorithm	v

In **Grid** choose the resampled wind capacity map from the previous step.

In **Method** there are three different options. Since we want to reclassify everything between 0 and 20 we will use "**range**".

In **minimum value** enter 0. This is the minimum value that will be reclassified.

In **maximum value** enter 0,20. This is the maximum value that will be reclassified.



In **new value** enter 0. This is the new value for that the range will be reclassified to. By entering 0 here we make sure that all the values between 0 and 20 are given 0.

Check the box that states **replace no data values** and uncheck the box that states **replace other values**.

- 4. Now run the tool by clicking on **Run**.
- 5. Export this layer in the same way we did previously into the folder named "wind_capacity". Name the dataset "modified_wind_capacity".

Extract values to point

Extract raster values to points

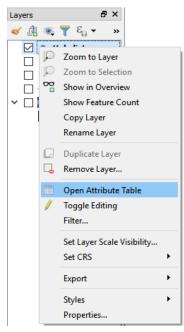
Thus far we have made sure that the wind capacity map is covering Benin, that it has the right coordinate system and cell size, and that it highlights areas with favourable capacity factors. Raster data might sometimes be difficult to properly examine and work with due to the data missing attribute tables and discrete boundaries. Therefore, it is often useful to transform the raster data to point layers or extract the raster values to existing point layers.

At the end of the vector exercise (Hands-on 2), you were left with a point layer with the distances to the current and planned transmission lines. Import this point layer by dragging it onto the map canvas. To make it easier to keep track of everything, first remove all layers except for the modified_wind_capacity layer.

In this exercise you will export the raster values from the modified wind capacity layer to the distance layer. In this way, you will have two types of information in every location.

1. Right-click on the distance point layer and open the attribute table.





2. In the attribute table you will see column named "HubDist". This is the distance between the transmission lines and every point of the country.

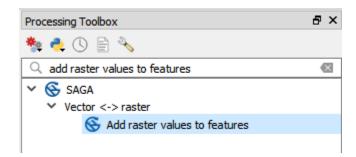
Q	dist	:: Features Tota	al: 136	5945, Fil	tered: 136	945, Selec	ted: 0
1	Ĭ	6 2 6	$\widehat{\Box}$	≻ € 🖞	2 8		💊 🍸 🗷
		FID		Hu	bName	Hu	ubDist
1		8	5291	N/A			2,61948
2		1	2052	N/A			2,85695
3		1	4420	N/A			3,91059
4			6814	N/A			3,94710
5		2	9897	N/A			4,79826
6		2	7692	N/A			5,08317
7		7	3426	N/A			5,17525

You will now add the values from the modified wind capacity raster to this attribute table.

3. Close the attribute table of the distance map.



4. Go to the tool bar and search for "add raster values to features". You will be using the tool that comes in the SAGA-package.



5. When you open the tool, you will see the following screen.

Q Add Raster Values to Features	?	×
Parameters Log		
Shapes		
° transmission_lines_distance [EPSG:4326] ▼	• •••	2
Selected features only		
Grids		
1 elements selected		
Interpolation		
[0] Nearest Neighbor		-
Result		
[Save to temporary file]		
Open output file after running algorithm		
0%	Can	cel
Run as Batch Process Run Close	He	lp



In the field "Shapes", enter the distance point layer. This is the vector file which the attribute table will be used as base for the analysis.

In the field named "Grids", select the modified wind capacity layer.

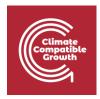
Leave everything else as it is and click on "Run".

6. After the tool is finished you will have a new point layer named "Result". If you open the attribute table on this layer, you will see that apart from the distance column, there are also wind capacity values and coordinates.

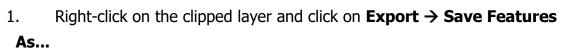
Q Result :: Features Total: 136945, Filtered: 136945, Selected: 0						
/ 🕅 🛱 🎽 🕯 🕯 😽 🖓 👘						
	FID	HubName	HubDist	Windcap		
1	8	N/A	15,3760700000	0,3008156419		
2	9	N/A	163,1556300000	0,3006379902		
3	7	N/A	188,2976700000	0,3004633188		
4	18	N/A	68,5932500000	0,2997071445		
5	16	N/A	419,1802400000	0,2987762093		
6	17	N/A	243,8231900000	0,2984927595		
7	10	N/A	391,2536400000	0,2984584570		

This means that you have now combined the wind capacity layer with the distance layer that you had originally.

Export a layer as csv



We will now export the point layer in which we combined the wind capacity factor and the distance to transmission lines as a csv-file.





 Choose to export your vector files as Comma Separated Value file (CSV). Click on "Browse" next to filename and navigate to the folder you wish to save the layer in. Name your file "distance_to_grid_and_capacity". Click "OK" to export (make sure that "Add saved file to map" is NOT checked).



🔇 Save Vecto	r Layer as				? ×		
Format	Comma Separated Value [CSV]				-		
File name	C: \Users \adm.desa \Desktop \QGIS \test.cs	iv.			■ …		
Layer name							
CRS	EPSG:25000 - Leigon / Ghana Metre Grid				-		
Encoding	and a shared from the same	UTF-8			•		
Add save	selected features						
	elds to export and their export opti	ions —					
▼ Geomet							
Geometry t		Automat	He .		•		
	ulti-type	Automa	uc				
	z-dimension						
	nt (current: layer)						
Layer 0	-						
CREATE_CS	NO				•		
GEOMETRY	<default></default>				-		
LINEFORMA	T <default></default>				•		
SEPARATO	COMMA				•		
WRITE_BO	NO				•		
Custom	Custom Options						
			ОК	Cancel	Help		

Finally, locate the new csv-file that you created and open it.

This completes the last part of this exercise.