

**USING SPATIAL INFORMATION TO SUPPORT DECISIONS ON
SAFEGUARDS AND MULTIPLE BENEFITS FOR REDD+**



**STEP-BY-STEP TUTORIAL:
ADDING BELOW-GROUND BIOMASS TO DATASET OF
ABOVE-GROUND BIOMASS AND CONVERTING TO
CARBON USING QGIS 1.8**

UN-REDD
PROGRAMME



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The UN-REDD Programme is the United Nations Collaborative initiative on Reducing Emissions from Deforestation and forest Degradation (REDD) in developing countries. The Programme was launched in September 2008 to assist developing countries prepare and implement national REDD+ strategies, and builds on the convening power and expertise of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP).

The United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) is the specialist biodiversity assessment centre of the United Nations Environment Programme (UNEP), the world's foremost intergovernmental environmental organisation. The Centre has been in operation for over 30 years, combining scientific research with practical policy advice.

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These training materials have been produced from materials generated for working sessions held in various countries to aid the production of multiple benefits maps to inform REDD+ planning and safeguards policies using open source GIS software.



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1. Introduction

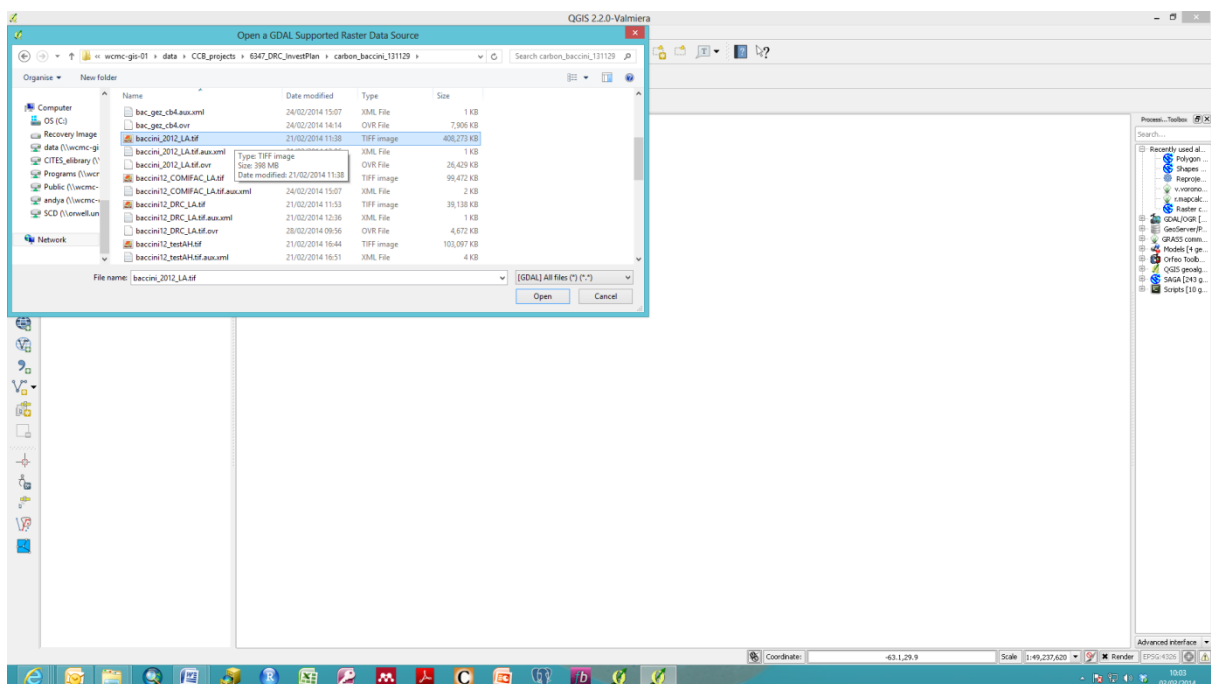
REDD+ has the potential to deliver multiple benefits beyond carbon. For example, it can promote biodiversity conservation and secure ecosystem services from forests such as water regulation, erosion control and non-timber forest products. Some of the potential benefits from REDD+, such as biodiversity conservation, can be enhanced through identifying areas where REDD+ actions might have the greatest impact using spatial analysis.

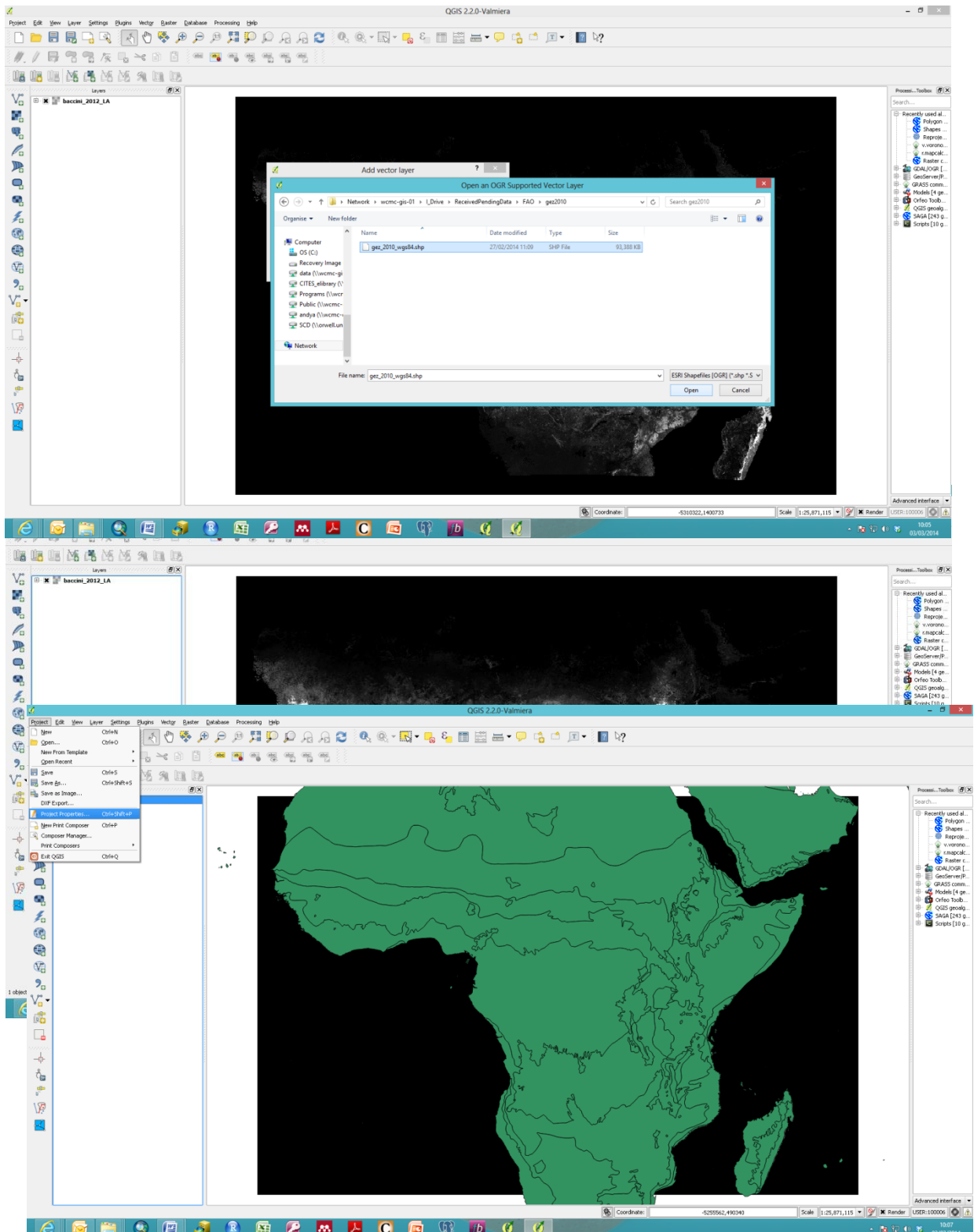
Open Source GIS software can be used to undertake spatial analysis of datasets of relevance to multiple benefits and environmental safeguards for REDD+. Open-source software is released under a license that allows software to be freely used, modified, and shared (<http://opensource.org/licenses>). Therefore, using open source software has great potential in building sustainable capacity and critical mass of experts with limited financial resources.

1.1 Produce a raster dataset combining both above and below ground biomass

First we will aim to produce a raster dataset combining both above and below ground biomass. This is derived from the combination of the above ground biomass (e.g. the Baccini dataset) and conversion factors applied to this layer to produce below ground biomass. The conversion factors are applied depending upon the FAO ecological zone (from the GEZ_2010_wgs84 dataset).

a) Open the **above ground biomass raster** dataset.




b) Open the **ecological zones vector dataset**.c) Check the **coordinate systems of the two layers**. The vector layer should be in wgs84 and the above ground biomass raster layer may be in another projection e.g. in this example in Lambert Azimuthal Equal area projection, it may be shown as a user defined coordinate system.

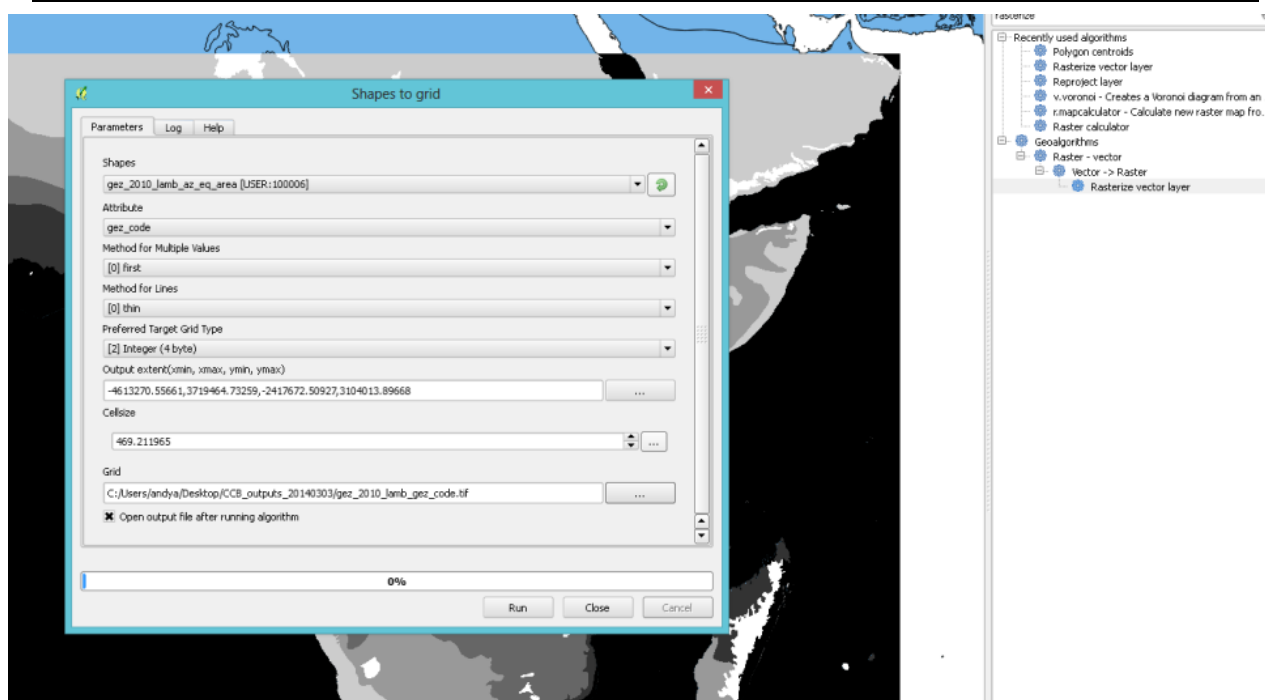
In this case the ecological zones dataset needs to be converted to the same projection system as the above ground biomass dataset.

Sometimes, errors can be encountered when using the Reproject tool for this step in QGIS, hence the following approach of saving the shapefile as a new layer to project it into the correct system should be used.

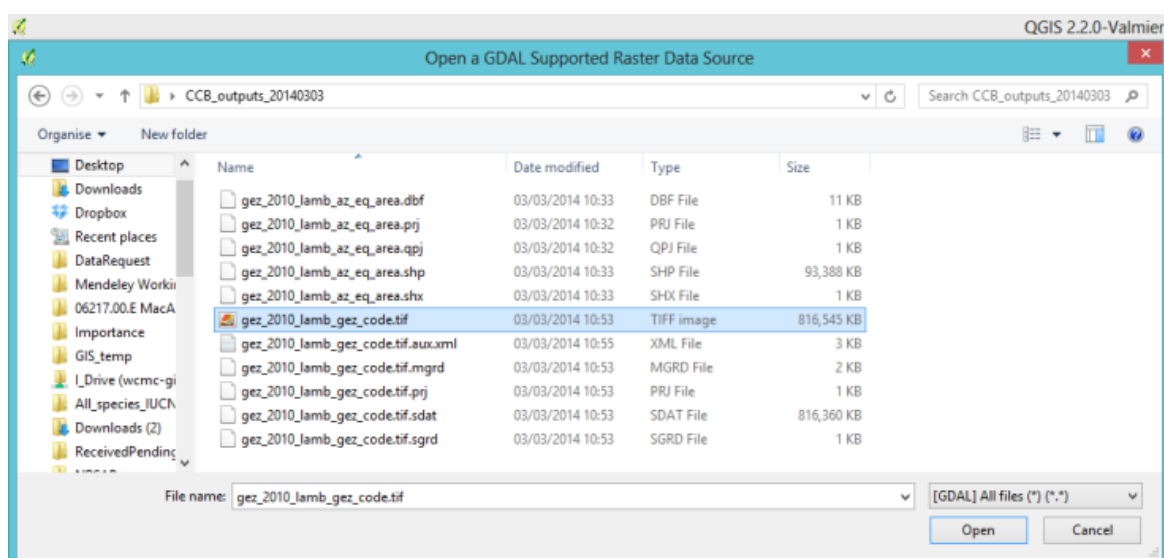
- d) Browse to and choose an output directory and name for the shapefile output.
- e) Under the **CRS heading**, browse to and select the coordinate system of the above ground biomass dataset.
- f) Open the newly created dataset. Right click in **properties** and check that the CRS is the same as the above ground biomass dataset.
- g) It is useful to ensure consistent CRS for outputs by making sure the project reference system for the project is consistent with these layers: right click on the above ground biomass raster layer, and select **set project CRS from layer**.
- h) View and check the attribute table from the ecological zones vector dataset – making sure individual codes (in the `gez_code` column) are present. These values relate to the names of the ecological zones (in the `gez_name` column) and will be chosen to be transferred to become raster values when converting from a vector to a raster layer in the next step.
- i) Make sure the processing toolbox is open – it should appear in the right hand side of the screen. If it is not active then click on the processing drop down menu, and click toolbox to activate it.
- j) Convert the file to raster using the **rasterize tool** within the processing toolbox (also referred to as the shapes to grid tool):
 - Under the shapes drop down box choose the newly projected vector layer (in this case `gez_2010_lamb_eq_area`).
 - Under **attribute** choose `gez_code`.
 - For the two method boxes for multiple attributes and lines these can be left as default.
 - Under **preferred target** grid type choose *integer 4 byte*.
 - Under extent click the grey box>layer canvas extent> choose the above ground biomass raster dataset.
 - Under cellsize click the grey box and then **double click on cellsize** of the above ground biomass layer – it should appear in the box below.
 - Choose to **save to file**> browse to appropriate folder and choose a name for the new raster layer (e.g. in this case `gez_2010_lamb_gez_code`).
 - Click **Run**.



	gez_name	gez_code	gez_abbrev
0	Boreal conifero...	41.000000	Ba
1	Boreal mountai...	43.000000	BM
2	Boreal tundra w...	42.000000	Bb
3	Polar	50.000000	P
4	Subtropical des...	24.000000	SBWh
5	Subtropical dry...	22.000000	SCs
6	Subtropical hu...	21.000000	SCf
7	Subtropical mo...	25.000000	SM
8	Subtropical ste...	23.000000	SBSH
9	Temperate cont...	32.000000	TeDc
10	Temperate desert	34.000000	TeBWk
11	Temperate mou...	35.000000	TeM
12	Temperate ocea...	31.000000	TeDo
13	Temperate steppe	33.000000	TeBSk
14	Tropical desert	15.000000	TBWh
15	Tropical dry for...	13.000000	TAwb
16	Tropical moist f...	12.000000	TAwa
17	Tropical mount...	16.000000	TM
18	Tropical rainfor...	11.000000	TAr
19	Tropical shrubl...	14.000000	TBSH
20	Water	90.000000	Water



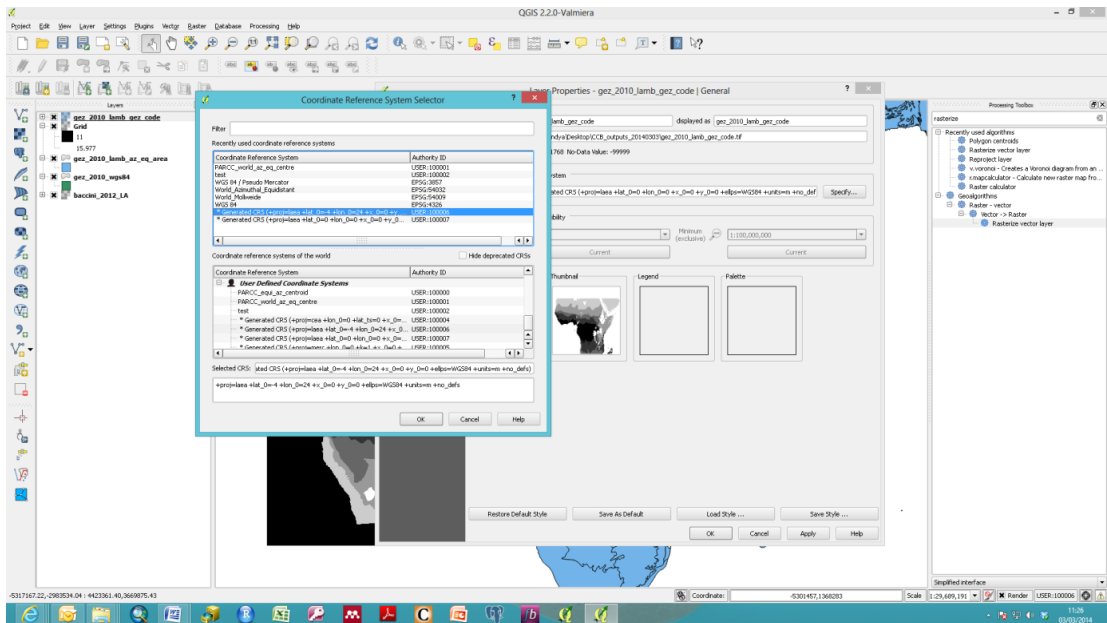
k) Open the raster output file from the chosen location.



l) Check the CRS of the layer. Occasionally the new layer may have a missing/different CRS shown for the new layer potentially causing the new raster layer to be misaligned. This may be a bug from the rasterize process and the layer coordinate system can be redefined:

- Right click on the layer, click **properties>general>under CRS>specify>** choose the CRS of the NAFORMA layer. Click OK.
- *N.B. Before redefining the coordinate system, make sure you have carried out the correct conversions in previous steps as this is important.*

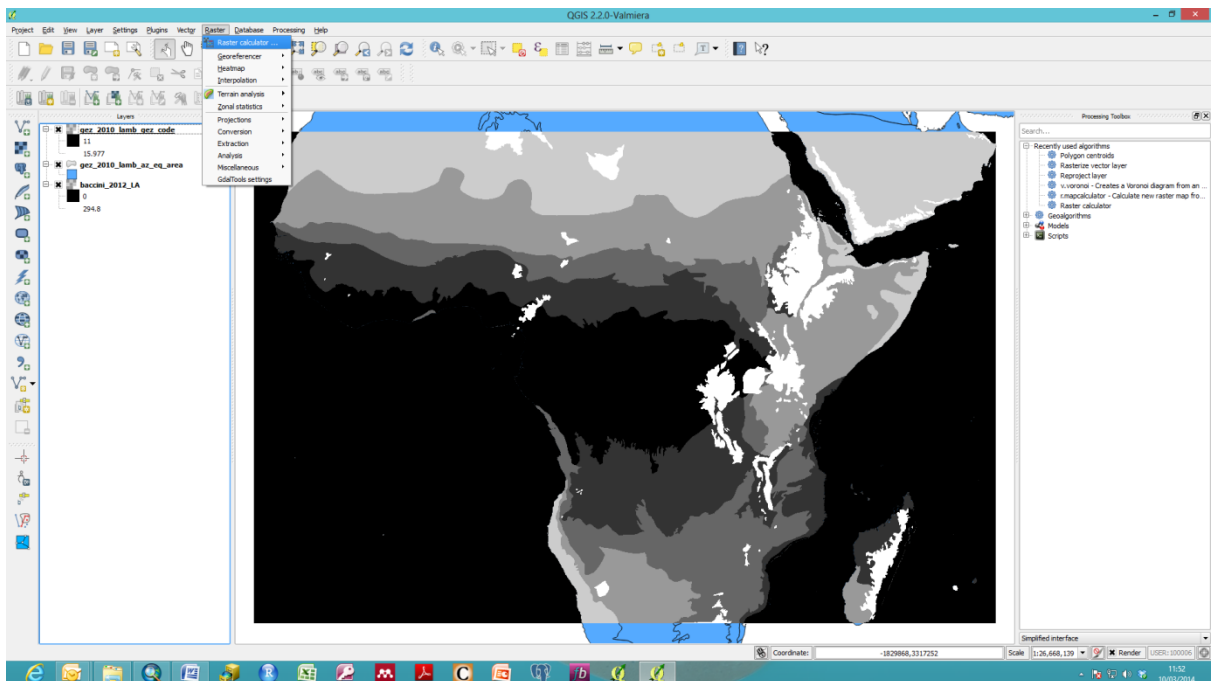
m) If there was alignment issues the new ecological zones raster layer should then realign with the old ecological zones vector layer.



n) Visually compare the newly created raster to the ecological zones vector. It is also useful to check the values using the “i” (**information tool**) for each of the layers to confirm consistent values between the *gez_code* on the vector layer and the values for the new raster. This raster layer should now be in a consistent format for applying conversion factors to the above ground biomass dataset.

o) The next step uses the raster calculator. A few other calculators exist, but for this we use the main raster calculator from the drop down menu:

- Select **Raster>raster calculator**.



p) Browse to output location and type in an appropriate file name (such as *bm_5km_clip2* used here).

q) Paste into the main box in the raster calculator the following code:

```

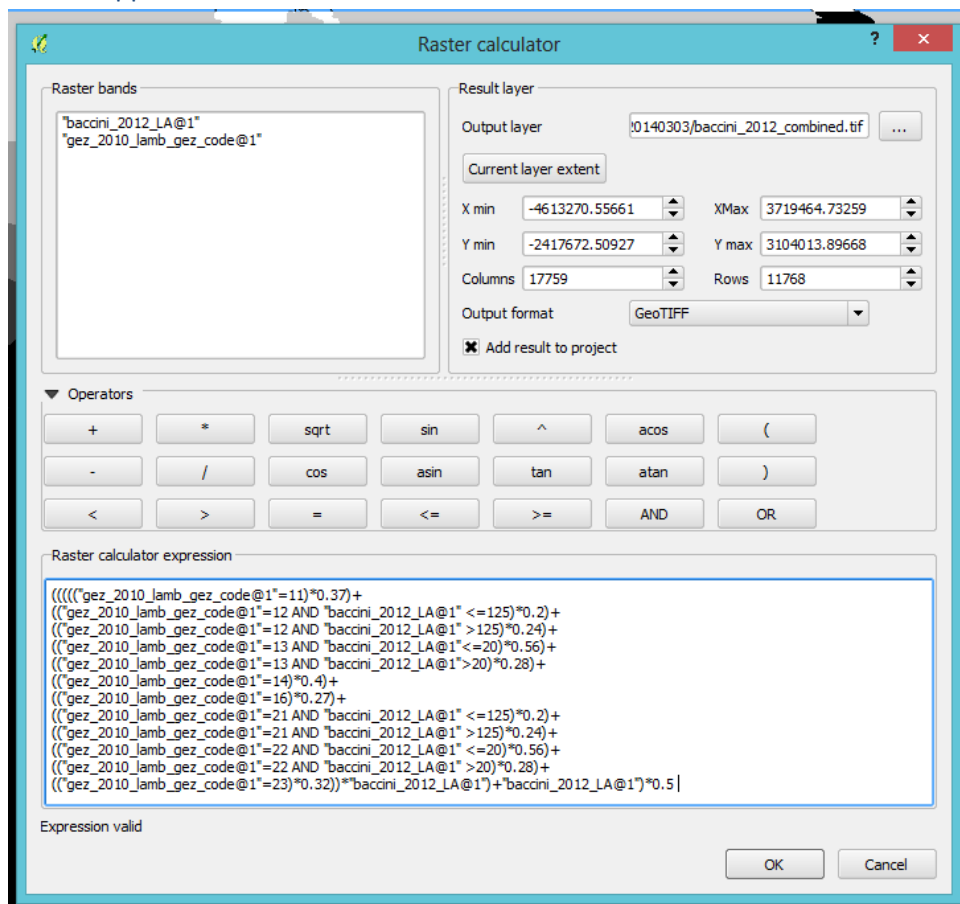
((((("gez_2010_lamb_gez_code@1"=11)*0.37)+
(("gez_2010_lamb_gez_code@1"=12 AND "bm_5km_clip2" <=125)*0.2)+
(("gez_2010_lamb_gez_code@1"=12 AND "bm_5km_clip2" >125)*0.24)+
(("gez_2010_lamb_gez_code@1"=13 AND "bm_5km_clip2"<=20)*0.56)+
(("gez_2010_lamb_gez_code@1"=13 AND "bm_5km_clip2">20)*0.28)+
(("gez_2010_lamb_gez_code@1"=14)*0.4)+
(("gez_2010_lamb_gez_code@1"=16)*0.27)+
(("gez_2010_lamb_gez_code@1"=21 AND "bm_5km_clip2" <=125)*0.2)+
(("gez_2010_lamb_gez_code@1"=21 AND "bm_5km_clip2" >125)*0.24)+
(("gez_2010_lamb_gez_code@1"=22 AND "bm_5km_clip2" <=20)*0.56)+
(("gez_2010_lamb_gez_code@1"=22 AND "bm_5km_clip2" >20)*0.28)+
(("gez_2010_lamb_gez_code@1"=23)*0.32))*"bm_5km_clip2")+ "bm_5km_clip2")*0.5

```

r) This codes a new raster layer from summing together above and below ground biomass and multiplying by 0.5 to calculate the final carbon values. The below ground biomass is calculated from multiplying the above ground biomass layer by conversion factors. These conversion factors vary by ecological zone and the amount of above ground biomass.

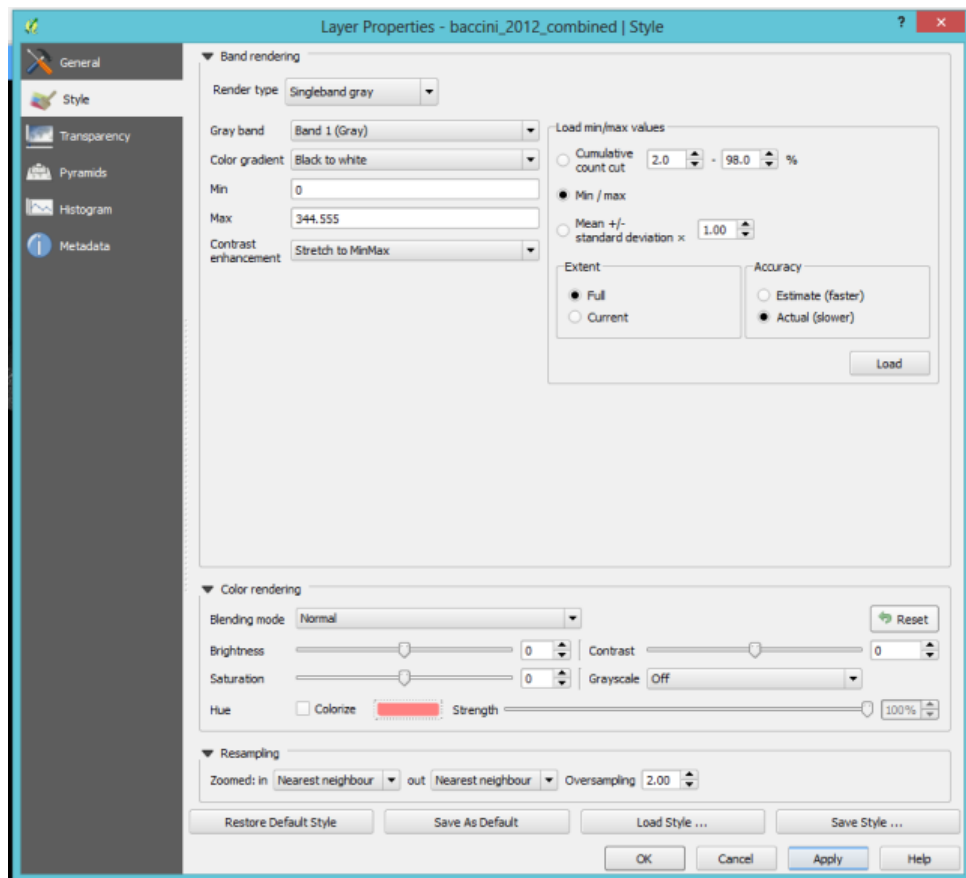
s) After the code is pasted in the main box, the message at the bottom should change from "Expression invalid" to "Expression valid".

t) Click **OK** to perform the calculation. The processing progress bar should come up and the resulting output layer should appear in the table of contents.



N.B. When using the raster calculator, be careful to make sure there are no misspell names for layers or other similar errors in the code. From experience it seems the calculator may allow an expression to run and appear valid, even when errors exist such as incorrect file names, resulting in an output raster of Null and Zero values.

- u) Check the final layer produced makes sense, using the “**i**” (**information tool**) to check that some of the values make sense, considering the magnitude of the conversion factors and the original datasets used to derive the final output.
- v) Note that to get the full range of values to show for this layer (and the other raster layers) you will need to right click the **layer>properties>style**. Under the Load min/max values option choose **min /max** and under accuracy choose **Actual**. Click the **Load** button, and then press **Apply**.



- w) The full range of raster values for the combined carbon output layer (name it **bm_5km_clip2_combined**) should now be present in the legend.

