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

STEP-BY-STEP TUTORIAL V1.0: ADDING BELOW-GROUND BIOMASS TO A DATASET OF ABOVE-GROUND BIOMASS AND CONVERTING TO CARBON USING QGIS 1.8

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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We welcome comments on any errors or issues. Should readers wish to comment on this document, they are encouraged to get in touch via: ccb@unep-wcmc.org.

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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.

2. Produce a carbon dataset which includes above and below-ground biomass

2.1 Project ecological zones and above-ground biomass to same projection

The aim is to produce a raster dataset combining both above and below-ground biomass and to convert these values to carbon. Below-ground biomass is generated by applying IPCC conversion factors to the above-ground biomass to calculate a below-ground proportion. The conversion factors are applied depending upon ecological zone (e.g. in this example from the FAO ecological zones dataset).

a. From the QGIS toolbar click on the **add Raster layer button**.
b. Open the **above-ground biomass raster** dataset e.g. in this example **baccini_2012_LA.tif**.
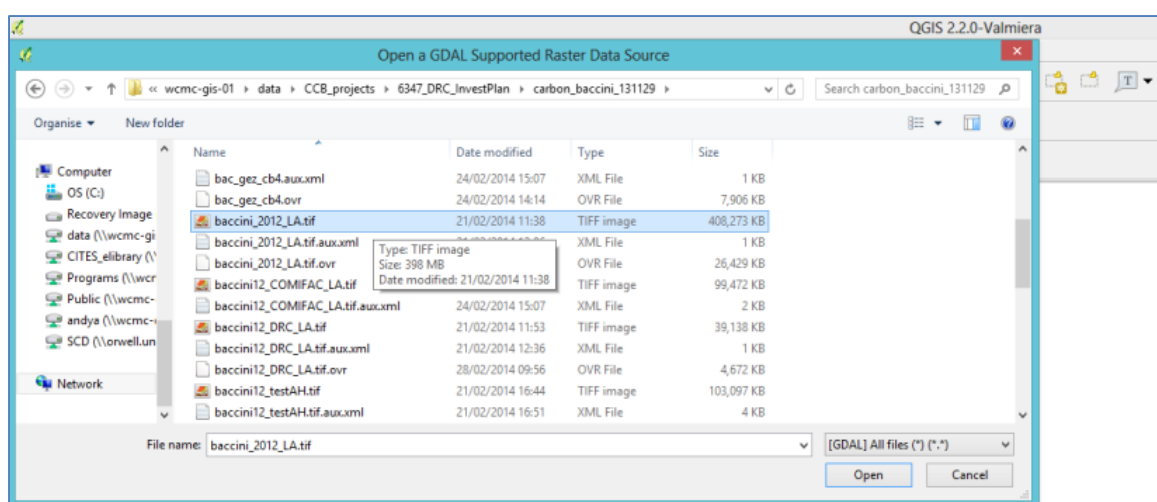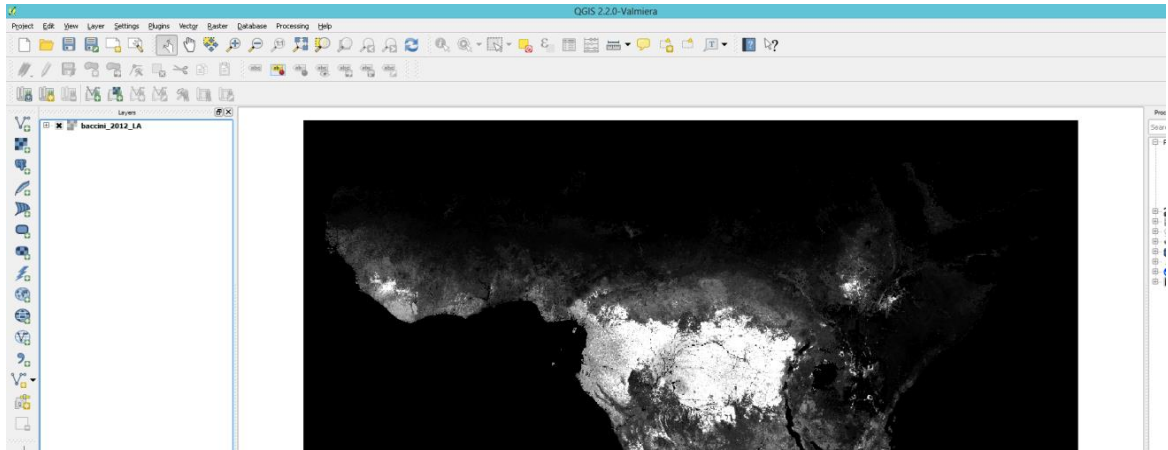
c. Click on the **add Vector layer button**
d. Open the **ecological zones vector** dataset. e.g. in this example **GEZ_2010_wgs84.shp**

e. **Check the coordinate systems of the two layers**. The vector layer is likely to 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, which may be shown as a user defined coordinate system.

In this case the ecological zones dataset is in WGS84 and needs to be converted to the same projection system as the above-ground biomass dataset.

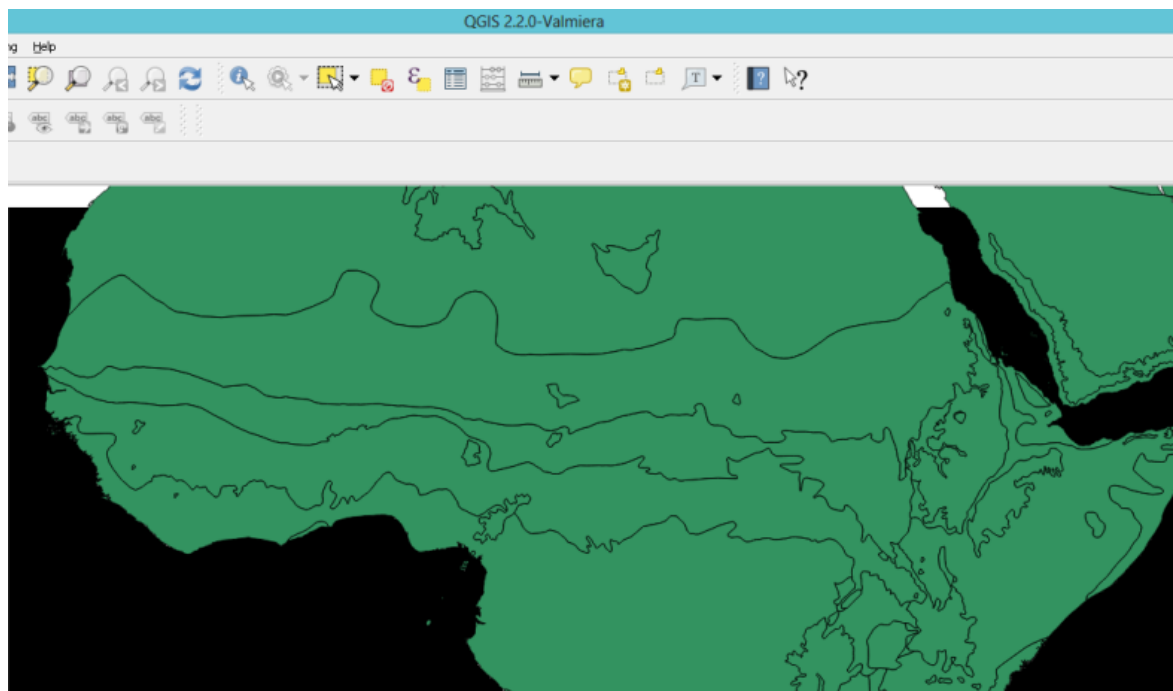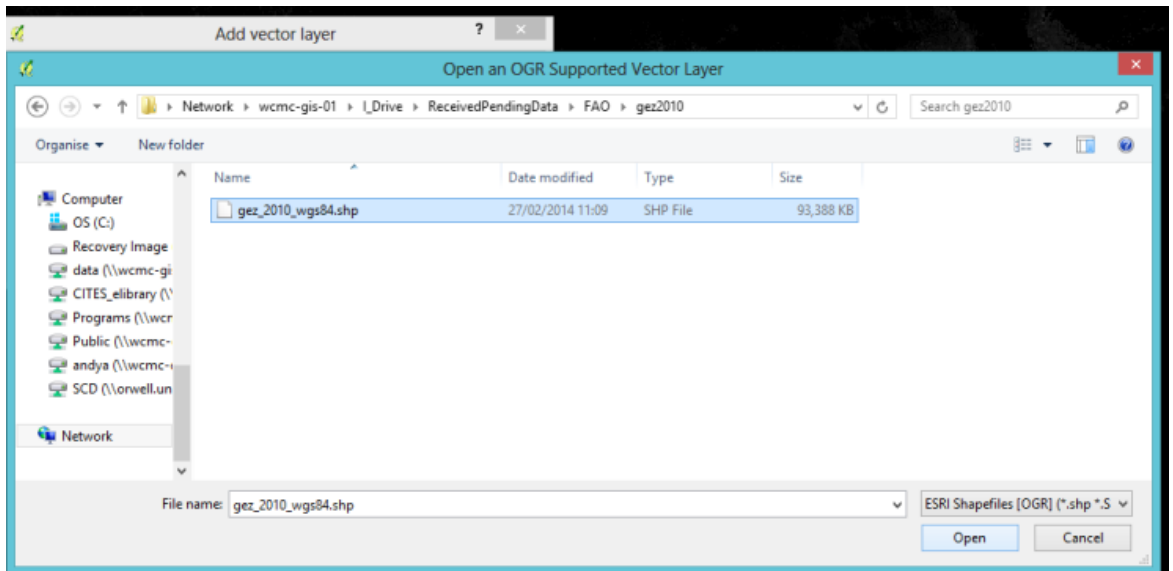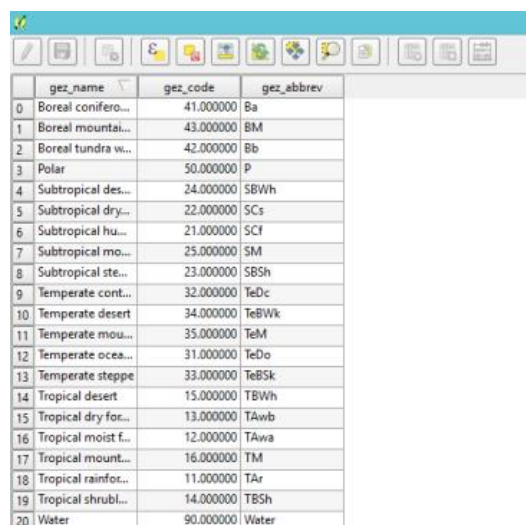*Sometimes, errors can be encountered when using the Reproject tool for this step in QGIS, hence the following approach of saving the shapefile as a new layer to project it into the correct system should be used.*

f. Right click on the ecological zones layer and click **Save as**
g. Browse to and choose an **output directory** and **name for the shapefile output**.
h. Under the **CRS heading**, browse to and select the same coordinate system as the above-ground biomass dataset.
i. Open the newly created dataset. Right click in **properties** and check that the CRS is the same as the above-ground biomass dataset.
j. 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**.
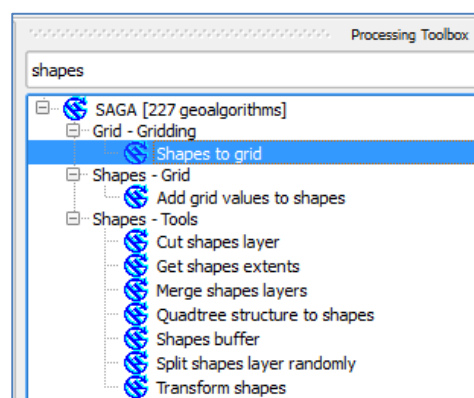
2.2 Convert ecological zones from vector to raster

a. **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.

	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

b. 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>>toolbox** to activate it.

c. Convert the file to raster using the **rasterize tool** within the processing toolbox (also referred to as the shapes to grid tool). Search for **shapes** in the toolbox

d. Double click on the **Shapes to grid** tool

Processing Toolbox

shapes

- SAGA [227 geoalgorithms]
  - Grid - Gridding
    - Shapes to grid
  - Shapes - Grid
    - Add grid values to shapes
  - Shapes - Tools
    - Cut shapes layer
    - Get shapes extents
    - Merge shapes layers
    - Quadtree structure to shapes
    - Shapes buffer
    - Split shapes layer randomly
    - Transform shapes

e. Under the **shapes** drop down box choose the **newly projected vector layer** (e.g. in this example **_gez_2010_lamb_eq_area.shp_**).

f. Under **attribute** choose **gez_code**.

g. For the two **method boxes for multiple attributes** and lines these can be left as **default**.

h. Under **preferred target** grid type choose **integer 4 byte**.

i. Under **extent** click the grey box and click **layer canvas extent** and chose **the above-ground biomass raster dataset**.

j. Under **cellsize** click the grey box and then **double click** on **the above-ground biomass layer** and then on **cellsize** which should appear below the layer name.
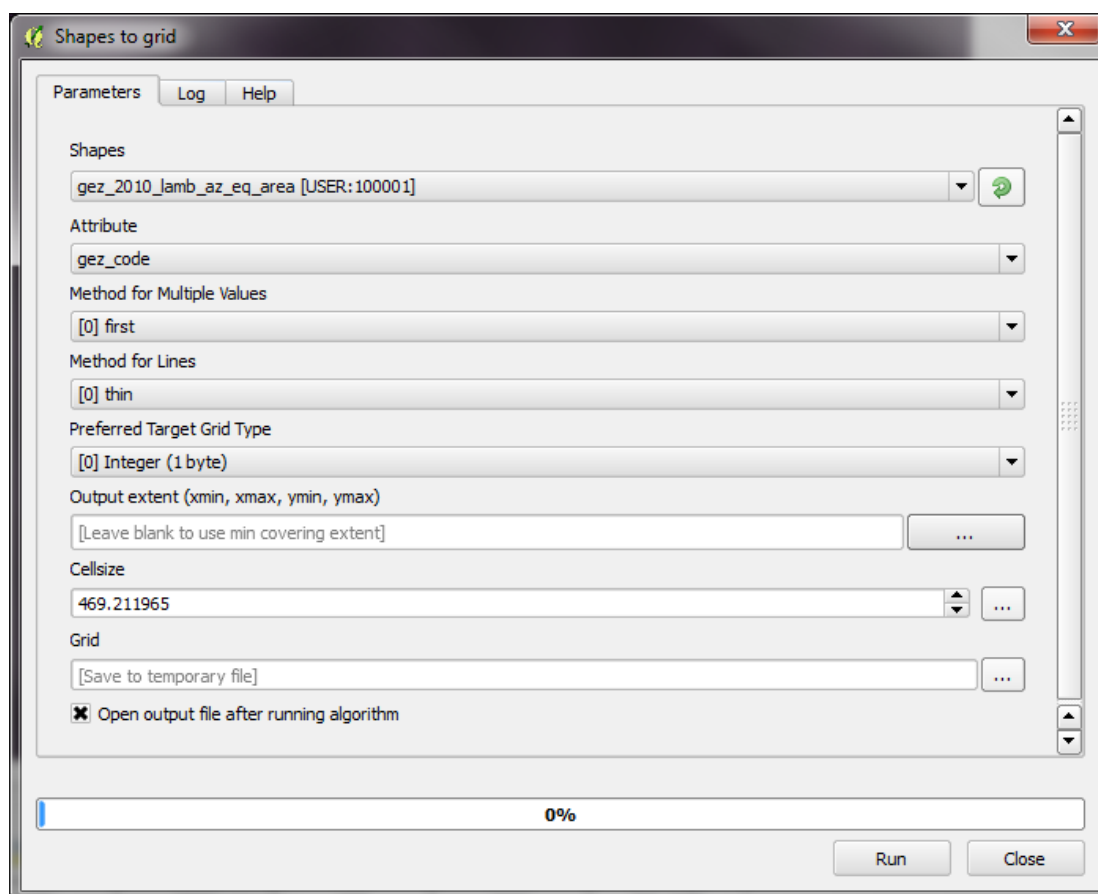
k. Choose to **save to file** and browse to appropriate folder and choose a name for the new raster layer (e.g. in this example **gez_2010_lamb_gez_code.shp**).

l. Ensure open file after running algorithm is **checked**

m. Click **Run**.

n. **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 above-ground biomass 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._

o. If there was alignment issues the new ecological zones raster layer should then realign with the old ecological zones vector layer.
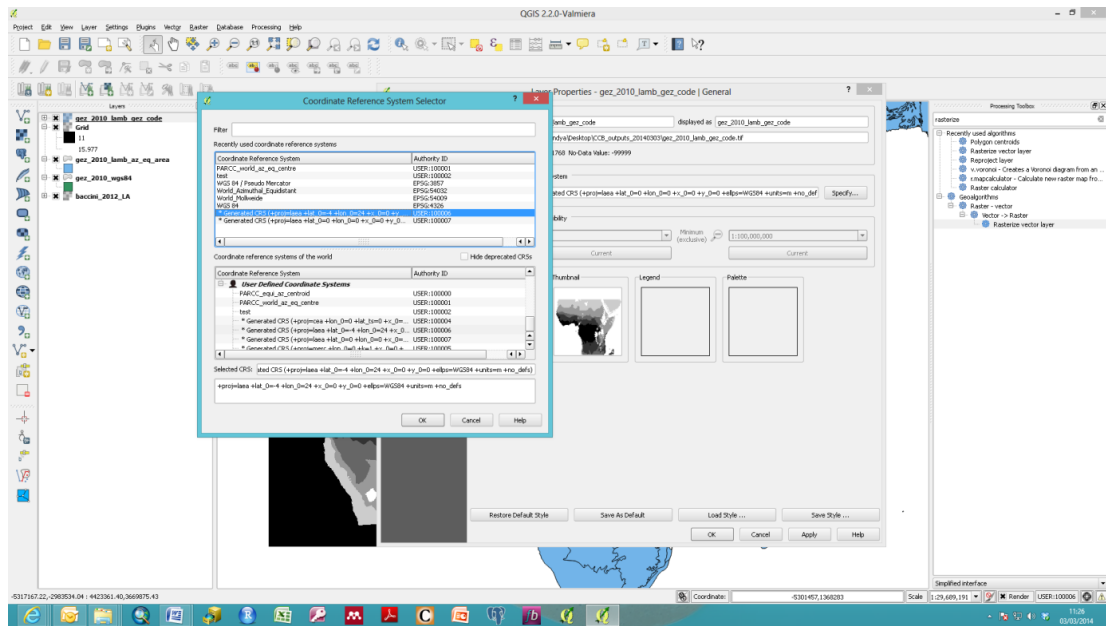
p. Visually compare the newly created raster to the ecological zones vector. It is also useful to check the values using the "**i" (information tool)** for each of the layers to confirm consistent values between the gez_code on the vector layer and the values for the new raster. This raster layer should now be in a consistent format for applying conversion factors to the above-ground biomass dataset.

2.3 Calculate below-ground biomass according to IPCC values and convert to carbon

a. The next step is to prepare a query for doing a calculation using the ecological zones and above-ground biomass data

b. Paste into a text editor the following code:

```
(((("gez_2010_lamb_gez_code@1"=11)*0.37)+
(("gez_2010_lamb_gez_code@1"=12 AND "baccini_2012_LA" <=125)*0.2)+
(("gez_2010_lamb_gez_code@1"=12 AND "baccini_2012_LA" >125)*0.24)+
(("gez_2010_lamb_gez_code@1"=13 AND "baccini_2012_LA" <=20)*0.56)+
(("gez_2010_lamb_gez_code@1"=13 AND "baccini_2012_LA" >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 "baccini_2012_LA" <=125)*0.2)+
(("gez_2010_lamb_gez_code@1"=21 AND "baccini_2012_LA" >125)*0.24)+
(("gez_2010_lamb_gez_code@1"=22 AND "baccini_2012_LA" <=20)*0.56)+
(("gez_2010_lamb_gez_code@1"=22 AND "baccini_2012_LA" >20)*0.28)+
(("gez_2010_lamb_gez_code@1"=23)*0.32))*"baccini_2012_LA")+"baccini_2012_LA")*0.5
```

N.B. This code will be used to create 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.

c. Find and replace **gez_2010_lamb_gez_code with** the **name of your ecological zones dataset** and find and replace **baccini_2012_LA** with the **name of your above-ground carbon dataset**. Check

the syntax to ensure there are no extra spaces or errors as these could cause the map calculation to fail.

d. Next open a raster calculator. A few other calculators exist, but for this we use the main raster calculator from the drop down menu:

From the main menu Click on **Raster>>raster calculator**.
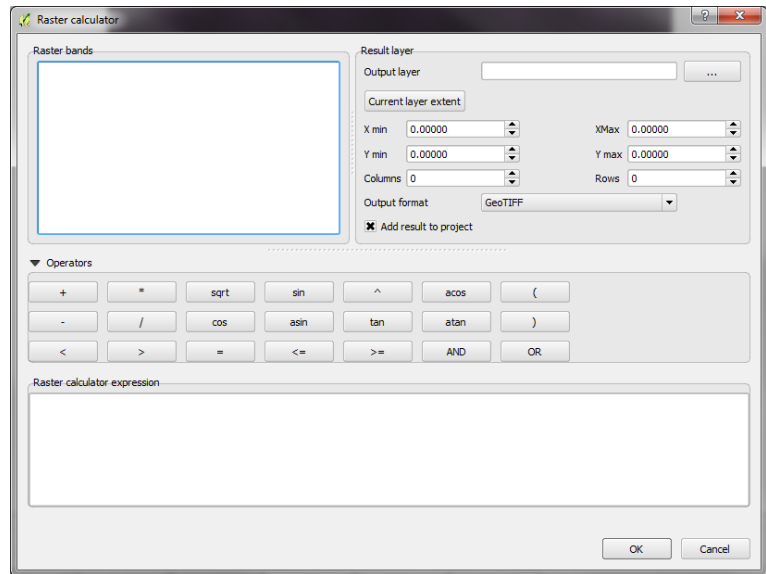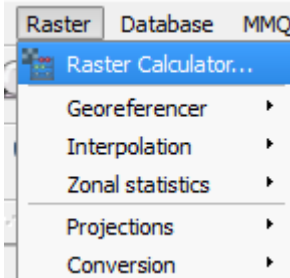
e. Browse to **output location** and type in an appropriate file name (e.g. in this example baccini_2012_combined.tif).

f. Copy and paste the new edited text from the text editor into the main box in the raster calculator
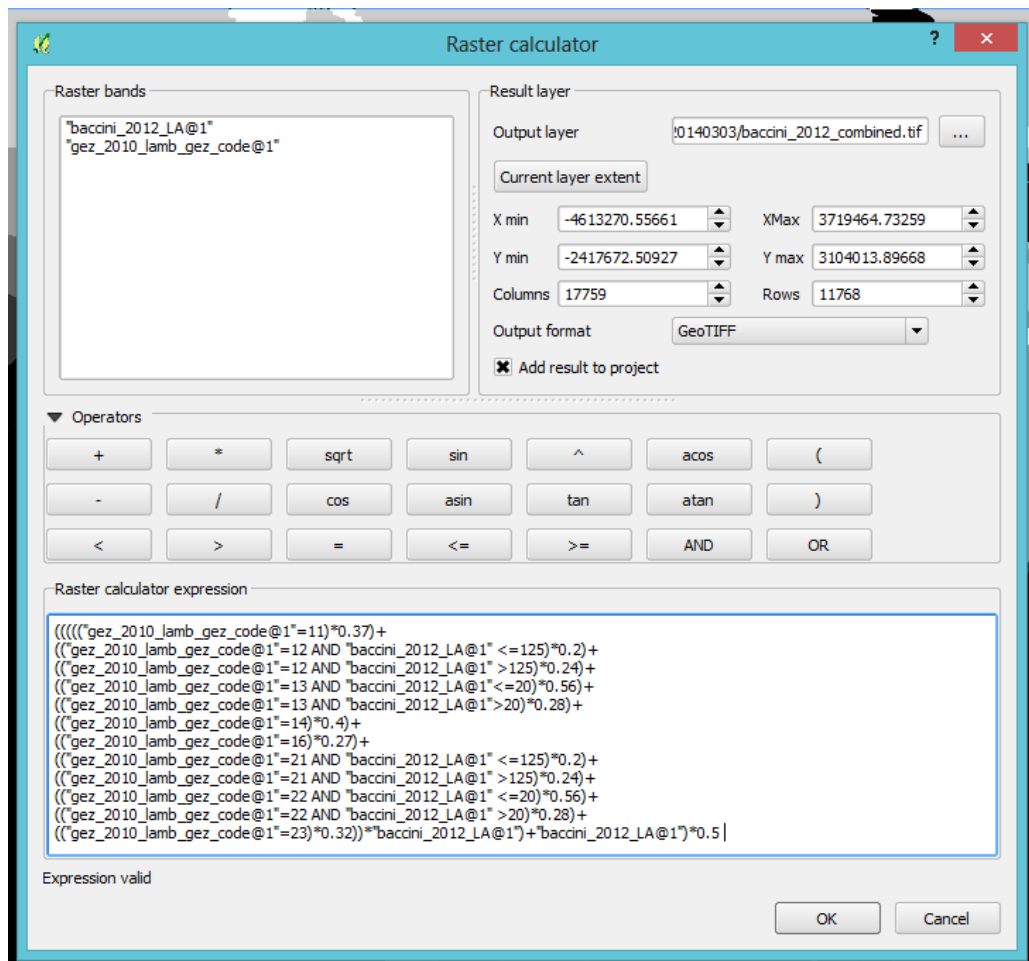
g. After the code is pasted in the main box, the message at the bottom should change from "Expression invalid" to "**Expression valid**".

h. Navigate to an **output folder** and give it a new name e.g. in this example **baccini_2012 _combined**.

i. 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.

j. 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.

k. 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**.
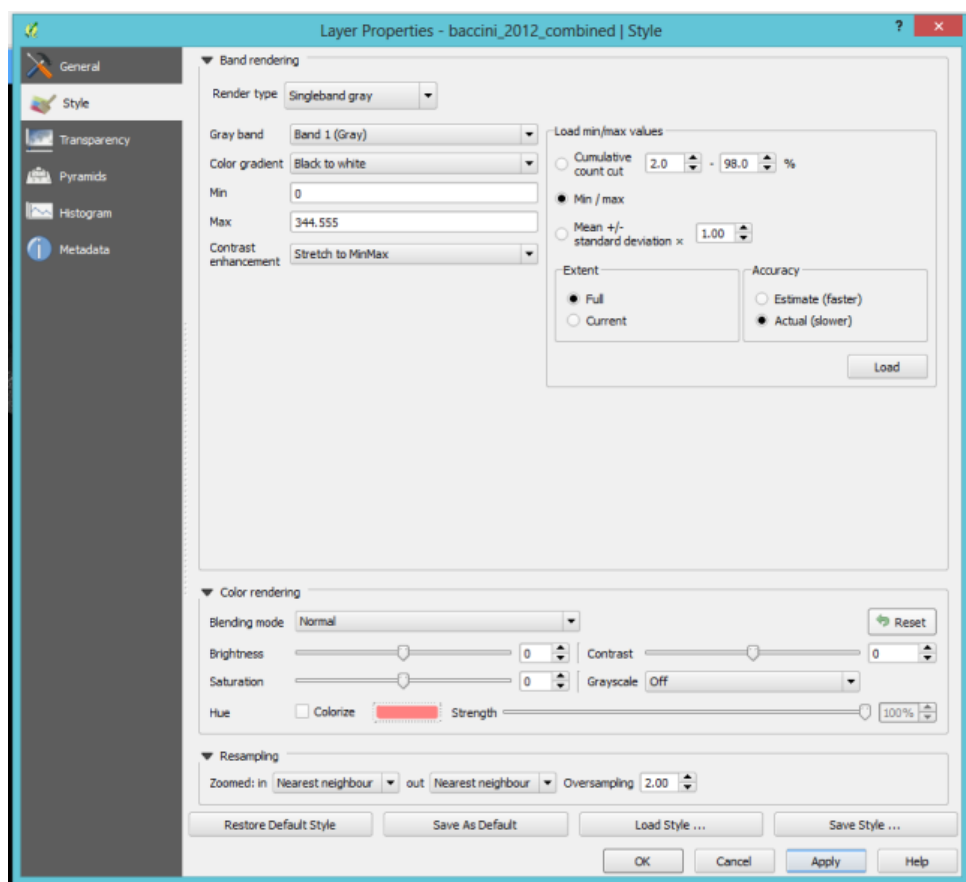
l. The full range of raster values for the combined carbon output layer should now be present in the legend. This is the final product.