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

STEP-BY-STEP TUTORIAL:

ANALYSING FOREST COVER CHANGE WITH RESERVED LAND AND FOREST CARBON STOCKS IN QGIS 2.X

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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.

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.

Contents

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. Create a forest cover change map, displayed with forest carbon stocks and reserved land

In 2013, a global forest cover change (loss and gain) dataset was released by Hansen et al (2013)[1], showing the change over the period 2000-2012. In this tutorial, we are using this dataset and overlaying it with carbon stocks inside and outside natural forest as well as reserved land.

2.1 Clip Vector layers to the area of interest

a) Clip the protected areas to the area of interest. Any part of the protected area that falls outside of these regions will be excluded from the analysis. In this example we are using the April 2014 version of the World Database on Protected Areas, which includes international protected areas such as Ramsar sites and World Heritage Sites.

c) Clip the natural forest extent (note that depending on the definition being used, *natural forest* can include, for example, montane and coastal forest, open and closed woodlands, mangroves, bushlands and thickets).

(For clipping: Vector >> Geoprocessing tools >> Clip)

## 2.2 Clip Hansen Tree cover, Loss, Gain and Loss year data to the area of interest

The Hansen tiles are available for download. They then need to mosaiced together and clipped to the area or country boundary being used in the working session. **For details of this process see Annex 1**.

We will now clip the three datasets (tree cover, tree loss and tree gain) to the area of interest.

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[1] Hansen, M.C. 2013. High-resolution Global Maps of 21st – century Forest Cover Change. Science, 342 (6160):850-853. Available at http://www.sciencemag.org/content/342/6160/850

a) For Clipping Raster: use the Processing toolbox **"Clip raster by mask layer"** (part of the GDAL tools). Right click on the tool and select "Execute as batch process".
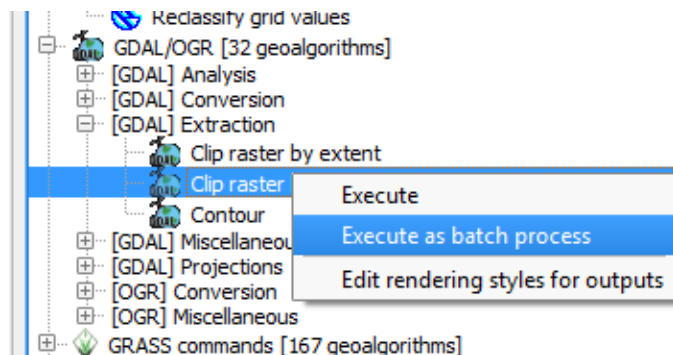

b) Click on the top left dotted grey box and navigate to the Hansen folder. Then click on the top dotted box in the "mask layer" column. Navigate to the area of interest shp. file.
After selected, double click on the column header to populate the rows below.
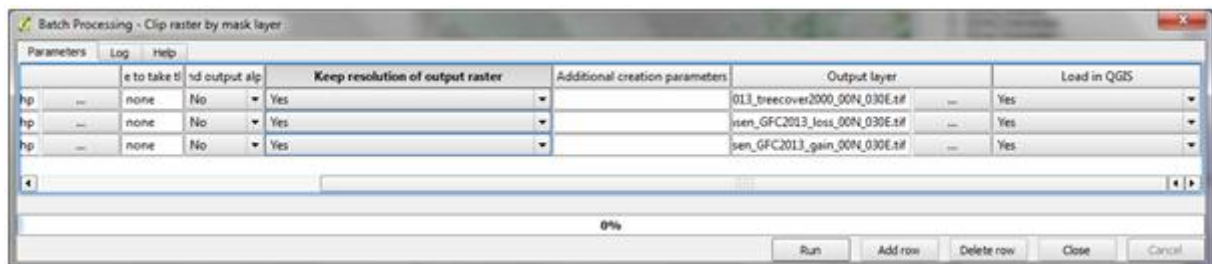
c) Scroll along and change the values in "keep resolution of output raster" to **Yes**. Double click on the column header to populate all rows.

d) Under **output layer**, click on the dotted box and navigate to the Hansen_clipped folder where you want the outputs to be placed. Write any name in the file name, e.g. clip_.tif. Then click save. In the box that appears, "Autofill mode" is changed to "**fill with parameter values**" and "parameter to use" is set to "**Input layer**". This action will use "clip_" in combination with the input file name as the output file name.
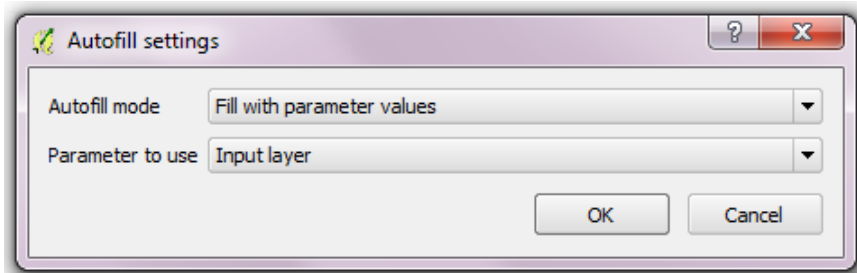

You should now have six layers in the project clipped to the area of interest:
1. WDPA
2. Forest loss
3. Forest gain
4. Tree cover
5. Natural forest
6. The area of interest boundaries

2.3 Project the six clipped datasets to the region of interest

Next, we want to project all these layers in Lambert Azimuthal equal area projection (centre lat and centre long correspondent to your area of interest).

a) In the processing toolbox search for "reproject". Right click on **Reproject layer** and choose "execute as batch process". The input layers will be the area of interest boundaries, the clipped WDPA and the clipped natural forest layers.
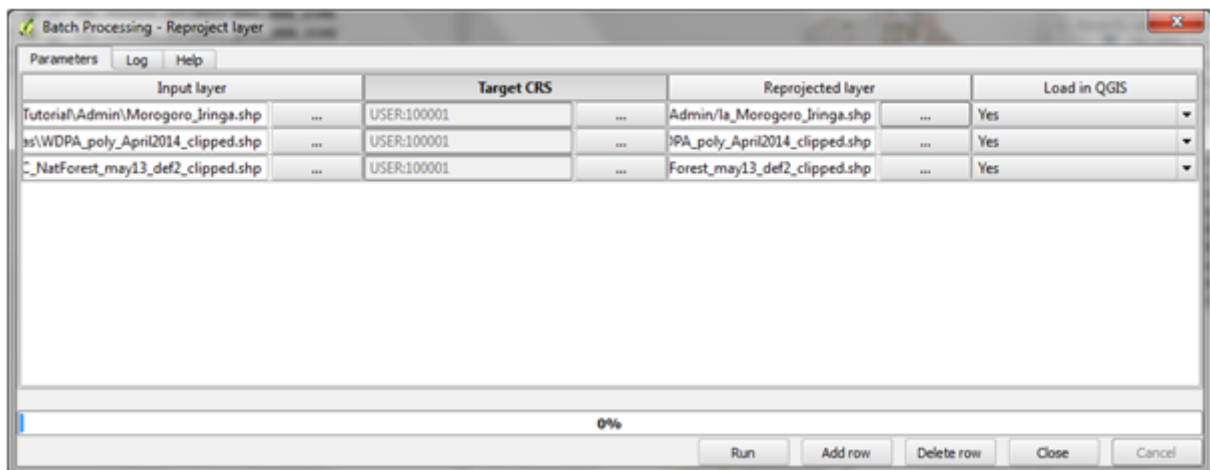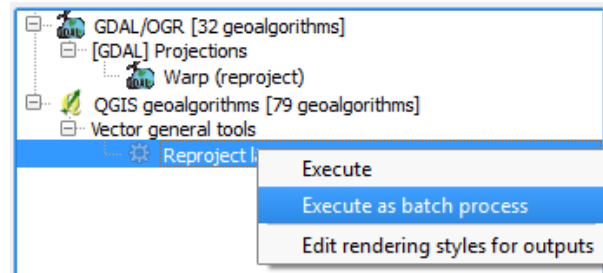

b) Under "target CRS" select your custom projection for **Lambert Azimuthal equal area** (centre lat and centre long correspondent to your area of interest). Double click on the heading to populate.

c) For the reproject layer click on the dots and for each dataset go to the location of where it was originally stored and give it a filename the same as before, adding "la_" at the end.

d) When the autofill settings pop up, change to **fill with parameter values** as before. Leave "load into QGIS" as yes and click run. You should get a message saying "Batch processing successfully completed". Close the reprojecting window.
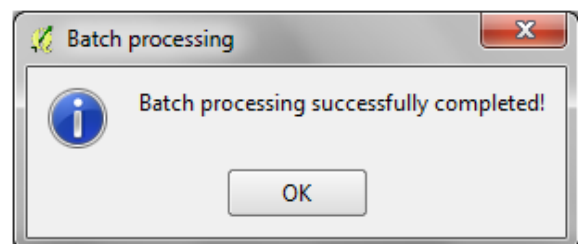
2.4 Project rasters

Now we need to reproject the data to an equal area projection for calculating statistics. This will give a true representation of the area and give the output in area instead of decimal degrees.

a) Find the GDAL tool **Warp (reproject)** and right click on it. Select **Execute as batch process**.
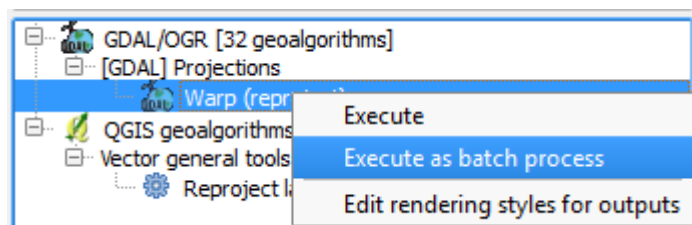
b) Click on the dots of the input file and select the clip_Hansen gain, loss and tree cover files. The second column shows the current projection of the dataset. The third column contains the destination projection (what you want to project to). Here you want to select your custom Lambert projection. It is helpful to type "laea" in the filter box. This enables you to more easily find your custom projection.

c) Click on your custom projection and make sure that it is selected in the **custom CRS box**.

d) Double click on the destination heading we can populate the custom CRS for the three rows/datasets. Scroll to the output layer column and navigate to the place where the clipped Hansen raster layers are stored. In the file name box type "la_" and click **save**. When the autofill settings box appears, change to fill with parameter values. **Click ok**.

The output name will begin with **la_** and end with the same name as the input file. **Click run**.

If the tool fails, alternatively right click on each of the Hansen datasets and save as, making sure that you select your custom projection.

It is important to make sure both the rasters and vectors are in identical Lambert Azimuthal equal area projections otherwise the statistics tools we are going to use will fail.

2.5 Calculating statistics

We would like to calculate some statistics that tells us the percentage of forest gain and loss inside protected areas. Before calculating any statistics remove any of the unprojected datasets from the table of contents so that you only have the five lambert azimuthal layers left.

a) The function **grid statistics for polygons** uses the file name to add attributes to new fields at the end of the attribute table. Each new field will be named Filename_AttributeName. Right click on every data layer in the project and choose Properties >> general. Change layer name to something very small, e.g.:

- ➢ tree cover to "tc"
- ➢ protected areas to "pa",
- ➢ region to "reg"
- ➢ loss to "l"
- ➢ gain to "g"
- ➢ natural forest to "nf"

b) Symbolize the data by loading the pre-created QML style file in the QML folder on the USB.
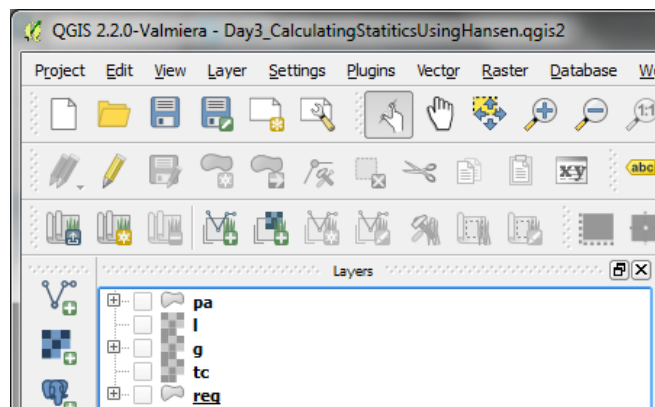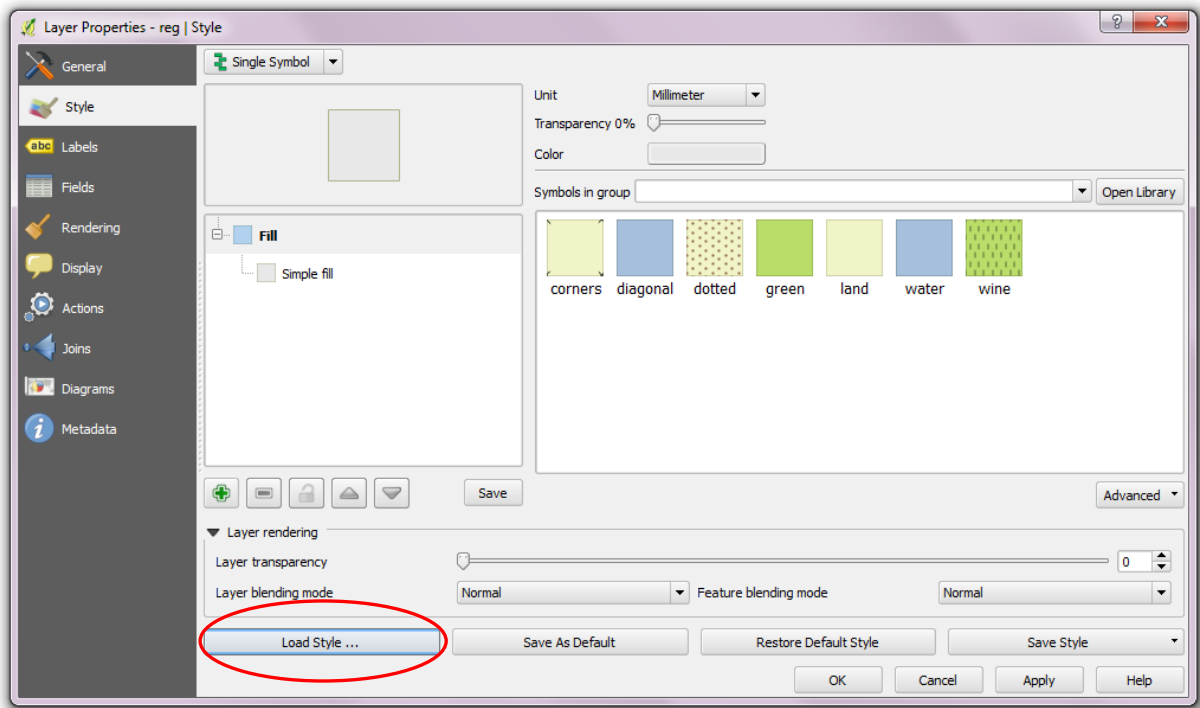
c) In the processing toolbox filter by "grid stat". Select the tool under SAGA called grid statistics for polygons. We are going to create statistics for the following:

➢ Area of loss in individual protected areas
➢ Area of gain in protected areas

d) Select the loss grid to be analyzed. For polygons choose the protected areas layer. The rest of the settings can be set to "**No**" except for "**Sum**" which should be yes. Click on the dots next to "Statistics" and save in the Statistics folder called "*pa_loss_stats.shp".* Click **run**.
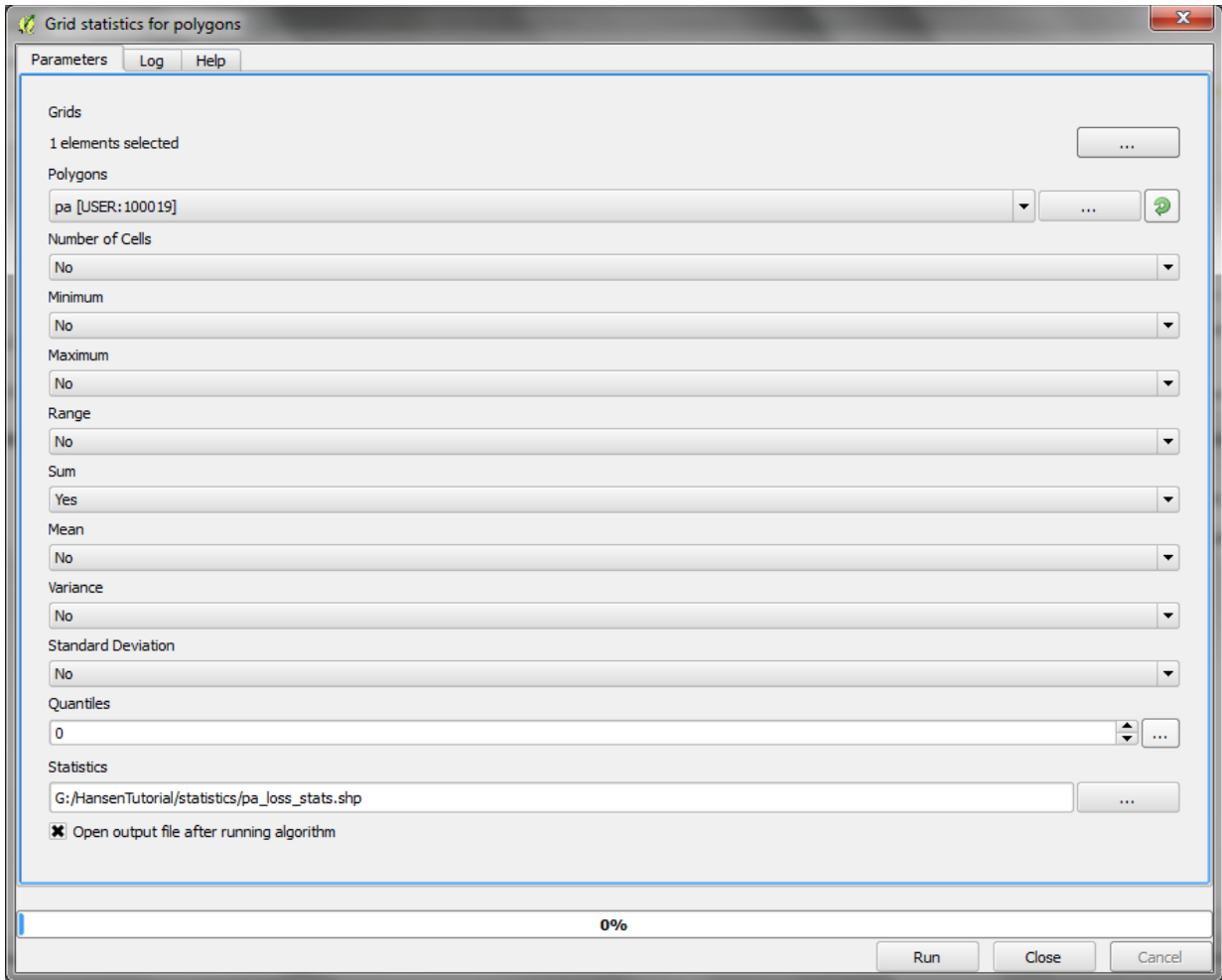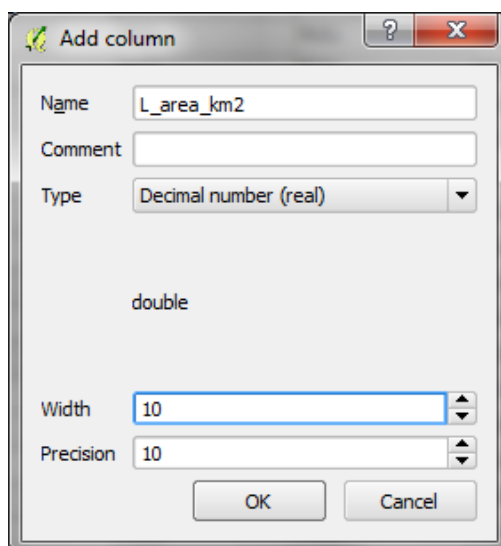
e) Repeat the same process as (a) using the gains grid to be analyzed.

IT IS VERY IMPORTANT TO CHECK THAT THE OUTPUT OF ANY STATISTIC CALCULATIONS IS REALISTIC AND CORRECT. SOME TOOLS IN QGIS MAY GIVE INCORRECT CALCULATIONS UNDER SOME CIRCUMSTANCES. We have had some issues with the zonal statistics functions in QGIS 1.8.

f) Open the attribute table of the results. See that a new filed called L[Sum] has been added to the end of the attribute table.

g) Now explore the data – zoom in on individual protected areas and look at the amount of loss on the screen. Look at the L[Sum] value for that protected area. Does it look reasonable? Has QGIS calculated the values correctly?

h) To calculate the actual area of loss inside protected areas, and the proportion of each protected area experiencing loss, we now add two new fields:
   ➢ L_area_km2
   ➢ L_perc

i) Run the **grid statistics for polygons** tool again (start on bottom of page 7) BUT THIS TIME, instead of the protected area layer; use the area of interest boundary. The results will show how much loss and gain there are in the 2 regions.

Next we will create some summary statistics for nationally designated protected areas only. We will first dissolve the boundaries so we have a protected areas layer with no overlapping polygons.

a) Click on the protected area layer in the TOC and from the **Layer menu** select **Query**.

b) Do the following query: double click on STATUS in the fields menu, then **click on All** in the Values menu. Then **click on =** in the operator menu. Then double **click on "Designated"** in the Values menu. **Click on AND** (operator). Double **click on "DESIG_TYPE"** (fields). **Click on all** (values). **Click on =** (operator). Double **click on National** (values).

In the "Provider specific filter expression" field, your query should now be ready. Click **OK**.
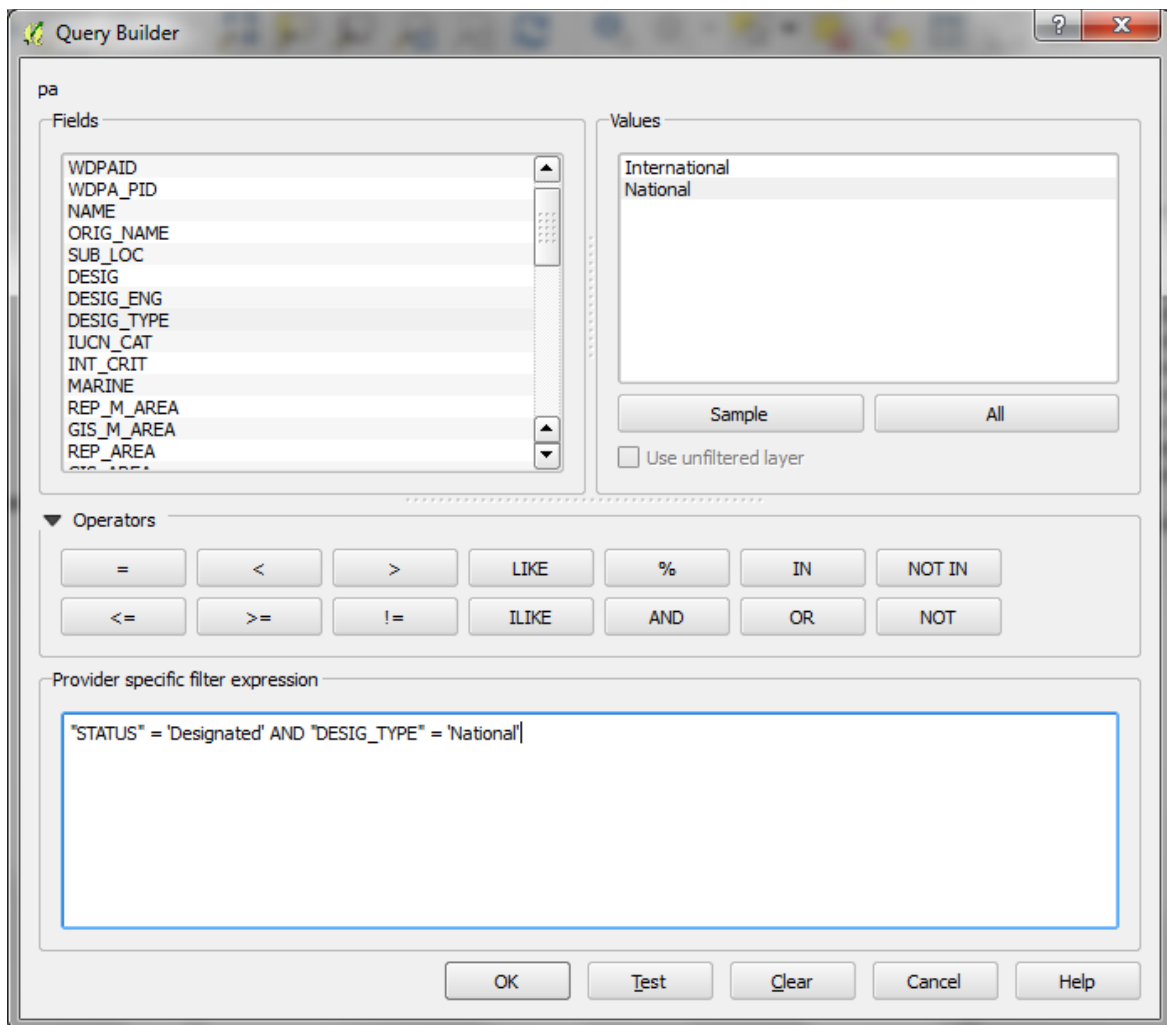
c) You can then export the attribute table as a csv. file and open it using Excel. The data can then be used to make pivot tables and make graphs.

Annex 1: Summary of first steps (already prepared in advance of the working session)

In this process, all datasets are in geographic projection and will need to be reprojected to Lambert Azimuthal after some initial clipping steps.

The Hansen dataset is global and we have already clipped it for you to save in on processing time.
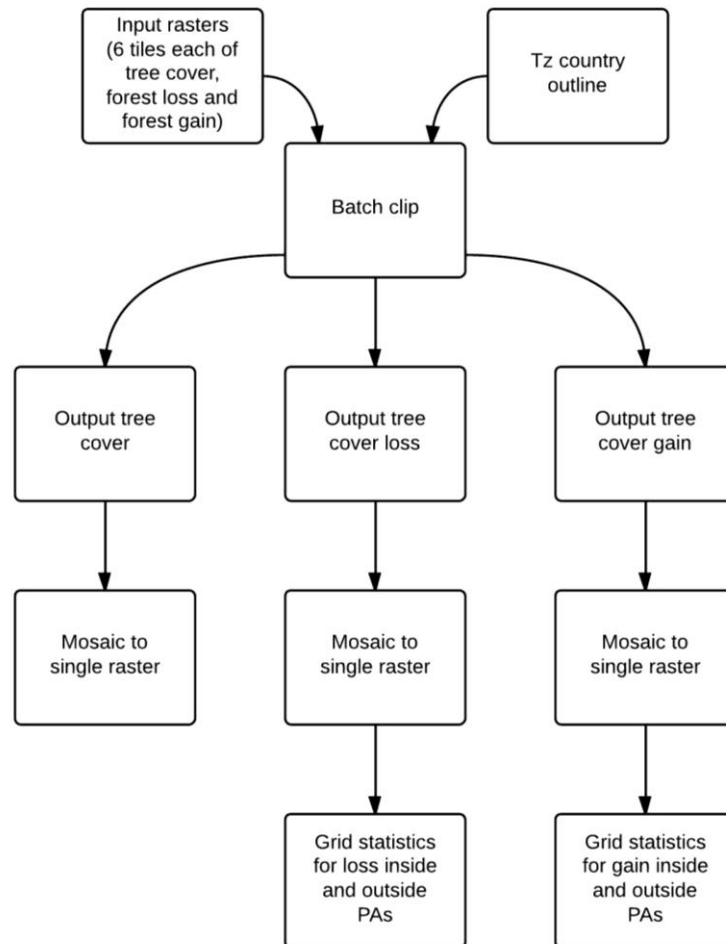
a) In the processing toolbox, filter using the word "clip".

b) Right click on "**clip grid with polygons**". Click on "execute as batch process".

c) In the window that opens, you will see three rows and three columns for inputting data. Click on the top left grey box with dots on it.
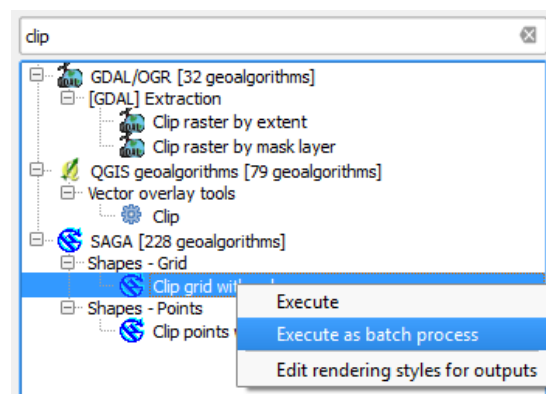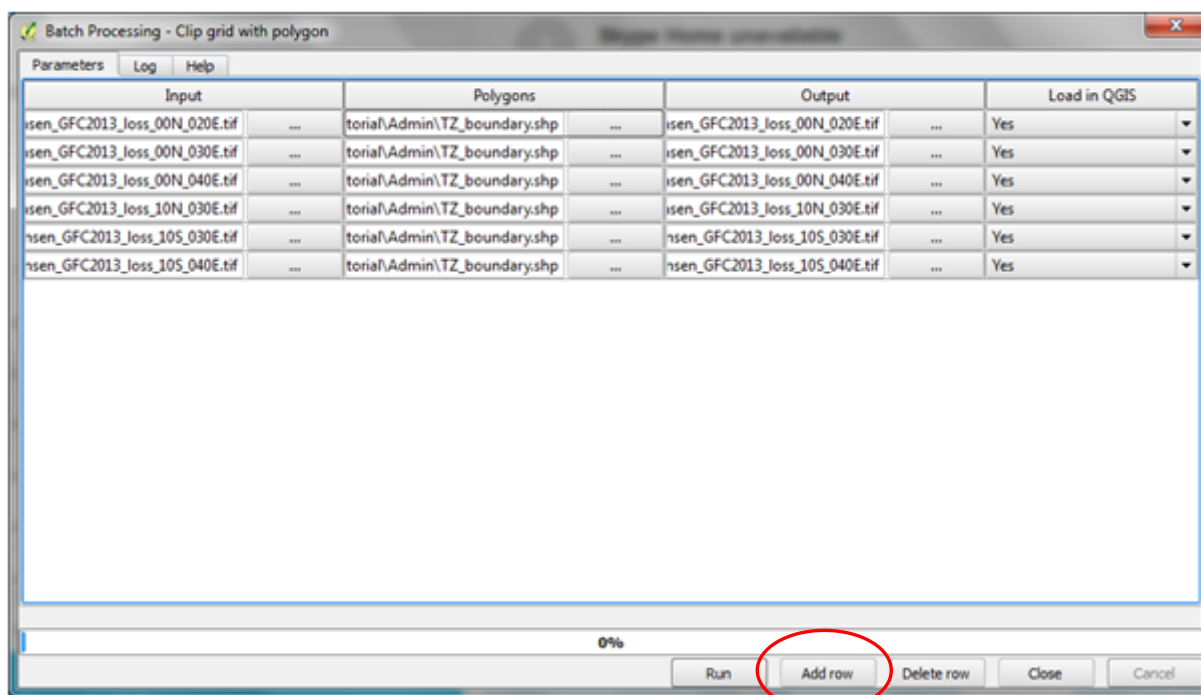
d) Navigate to the Hansen data folder. Hold Shift and add all six tiff files. Click **open**. At the bottom of the window, click **add row** to add a new blank row. Click again on the left had dotted box in the empty row.

e) This time navigate to the gain data and add the six tiff files in the same way.

f) Click add row again to add another empty row. This time navigate to the loss data and add the six files.

g) The input layers that you wish to clip have now all been added into the batch process.

h) Next we will fill out the polygons column. Click on the top dotted box in this column and navigate to the area/country boundary shapefile in the Admin folder. Click **open**. We want to use this layer for all the rows. Double click on the word polygons and the boundary file path will populate all the rows.

i) Under output, click on the top dotted box and navigate to where you want to save the data. Save it in the Hansen_clipped folder. Give a name to the output and then click save.

j) The autofill settings box will appear. Change the autofill mode to "**fill with parameter values**". Leave the "**parameter to use**" as input. Click **ok**.

k) Leave Load in QGIS as "**yes**".

l) Click **run**.