# QGIS

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## I. Introduction

This note aim is to help project managers to produce map quickly using the QGIS software. QGIS (Quantum Geographical Information System) is a free open source software which functionalities are close to commercial GIS software (ArcGIS, MapInfo…).

*Some definitions:* A GIS (Geographical Information System) is organized into a series of stratified layers that each brings a part of the information, which can be:

1. **Raster layer**: models continuous shape, the layer is sliced by a grid and each cell carries information (altitude, geology, color…)
2. **Vector layer**: represents discrete data, precise shape
    a. Points (city, catchment…)
    b. Lines (road, river, border…)
    c. Polygons (country, region, lake…)

**Remark:** This note was created for QGIS 2.4, Windows 7 and Office 2010. Some differences may appear if software versions are different.

## II. New Project Setup

After opening QGIS, create a new project (document that contains the various layers) and save it with the .qgs extension.

1. Choose a Coordinate Reference System (CRS) for the project: Project →Project property →CRS
2. Filter to look for the CRS, for example: WGS 84
3. Enable 'on the fly' CRS transformation[1]
4. It's possible to change units in the General panel: General → Canvas Unit →Ex: Degree and Degrees, Minutes, Seconds
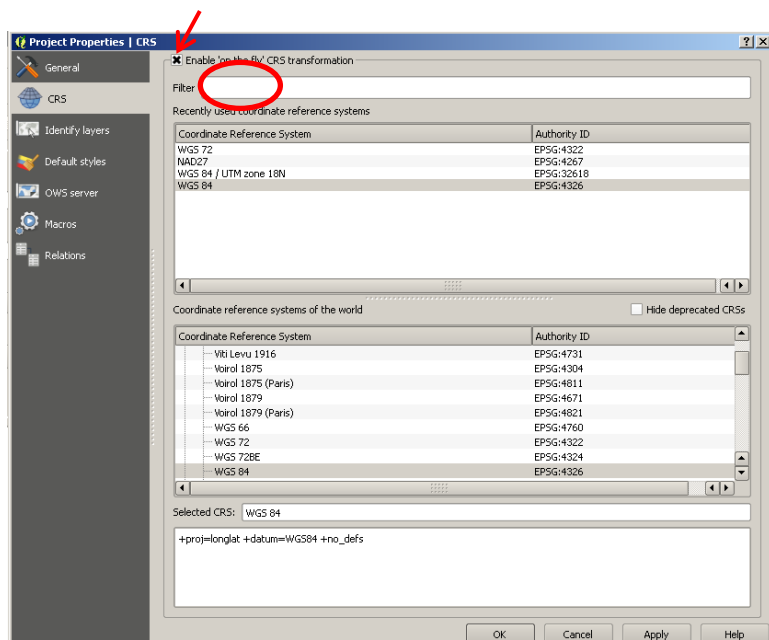


**Figure 1: Project properties**

## III. Load a Map

We wish to start the project by loading a basemap in the project. There are several choices:

- Georeferenced maps (the spatial coordinates of the map are included in the map file)
- Map in image format[2] + coordinates of at least 3 points of the map (city, houses…)
- Online map (Open Street Map, Google Map …)

### A. Georeferenced map

Add a Raster Layer ▨ (Layer → Add Raster Layer), select the georeferenced map file. The layer appears on the layer panel[3], to see it on the main screen: right click on the layer → Zoom to Layer.

Usually the georeferenced map file contains the coordinate reference system (CRS) of the map and QGIS transforms it in the coordinate system of the project ('on the fly' CRS transformation). If the map is badly placed (not on the right coordinates) the CRS of the map has to be manually entered: right click on the layer in the layer panel → Properties → General → Coordinate Reference System.

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[1] 'On the fly' CRS transformation: the coordinates of each layer are transformed into the Coordinate Reference System of the project

[2] Link to two extensive databases for topographic maps : US army map: http://www.lib.utexas.edu/maps/ams/ and soviet army map : http://maps.vlasenko.net/soviet-military-topographic-map/

[3] Activate in View→Panels→ Layers

## B. Maps in image format

There is a plugin, included in the standard QGIS install[4], which georeferences images: Raster → Georeferencer → Georeferencer.

1. Open a raster  (Image of a Map : File→ Open Raster)

2. Add point  (Edit → Add point), on the map click on a point which coordinates are known (House, city, particular point)

3. Enter the coordinates of the points chosen

4. Enter at least three points

5. Choose the transformation settings  (Settings → Transformation Settings), Transformation type : linear, then choose an output raster  with a new filename for the futur georeferenced map (ex : Mapname_georef.tif)

6. Start georeferencing  (File → Start georeferencing)

7. Close the georeferencer and load the newly created raster in QGIS (the new georeferenced map) as detailed in section A.
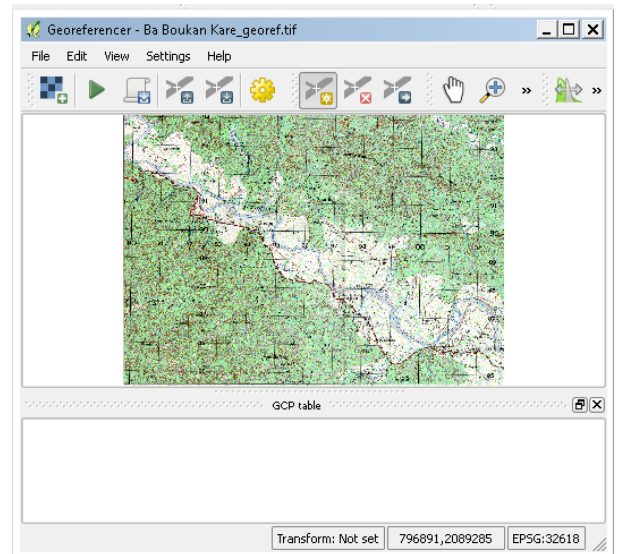
**TIP:** The georeferencer **has a useful tool when working on juxtaposed map. On step 3, instead of entering points coordinates, points can be chosen directly on QGIS main screen, by choosing points on a juxtapose / backward map** : Click on  From map canvas  then on the map on QGIS main screen at the chosen point location

## C. Online Map

Map available online can be loaded into QGIS, very useful to quickly obtain a basemap, borders, river…

**Remark:** a « good » internet connection is necessary

1. Install Open Layer Plugin : Plugins→ Manage and Install Plugins →All →OpenLayers Plugin→ Install → Close
2. Once the plugin is installed: Web→OpenLayer Plugin →Select the type of map (ex : Google satellite) or use OpenLayers Overview

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[4] If not installed: Plugins → Manage and Install Plugins → All →Georeferencer GDAL → Install → Close
To install a plugin offline → copy the plugin folder into \user\<user name>\.qgis\python\plugin for win7 (\Documents and Settings\<user name>\.qgis\... for Win XP)

# IV. Load points

There are several methods than can be used to load points under QGIS, three are described below:

1. Create points manually
2. Load points from a GPS
3. Load points from an Excel database

The formatting of data points is explained in section D on page 5.

## A. Create points manually

1. Create a vector layer: Layer →New →New Shapefile Layer→Point →Specify CRS
2. In new attribute, choose the attribute name (the label of the column of your new database):
   a) Type: Text data: city name, houses…
   b) Type: Whole or decimal numbers: points data such as number of houses in a village, of latrines, %, …)
   → Add to attributes list
3. OK → Save the layer with the shapefile format (.shp)

4. Add points : Select the layer in the layer panel → Toggle Editing ✏️ (Layer → Toggle Editing) → Add feature ✳️ (Edit → Add feature) →Click on the map on the chosen location → Fill the attribute data

5. Once all the points are entered, switch off the editing mode ✏️ and save the layer.
6. Modifications can be made by opening the attribute table: right click on the layer in the layer panel→ Open the Attribute Table. The editing mode must be switched on ✏️ to be able to modify the data.

## B. Load the points from a GPS.

1. Create a (.GPX) file with the GPS manufacturer software[5] (Map Source for the Garmin GPS)
2. Open the (.GPX) in QGIS : Vector →GPS[6]→GPS Tools→Load GPX file→Select the file and the type of data to load (points, Tracks …)
3. Modification can be made in the attribute table: right click on the layer in the layer panel→ Open the Attribute Table. The editing mode must be switched on ✏️ to be able to modify the data.

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[5] To convert various GPS files format to .GPX, the free converter GPSBabel is recommended
[6] Plugin included in the standard QGIS install. If not installed Plugins → Manage and Install Plugins → All →GPS Tools → Install → Close

## C. Load points from an Excel Database

It is useful to work from an Excel database that contains, as well as the GPS coordinates, the project data. The map will be easier to update.

1.  In Excel create a sheet with a line containing the data label followed by lines of data (do not merge cells, do not keep blank line or column inside the data field)

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| 1 | ID | Localite | X | Y | Lakou | Nb Dalles | Couverture Latrine |
| 2 | 1 | Chimowo | 798447 | 2096541 | 51 | 50 | 96% |
| 3 | 2 | Feyobyen | 797518 | 2096954 | 56 | 37 | 57% |
| 4 | 3 | Gapi (Dablèt) | 798874 | 2098372 | 65 | 55 | 72% |
| 5 | 4 | Gaya | 796966 | 2099512 | 29 | 15 | 48% |
| 6 | 5 | Gran Zèb | 797974 | 2097956 | 50 | 48 | 68% |
| 7 | 6 | Labod (Larat) | 795400 | 2098965 | 37 | 38 | 97% |
| 8 | 7 | Larat | 794973 | 2098672 | 38 | 36 | 79% |
| 9 | 8 | Maranvil | 795868 | 2098965 | 48 | 38 | 67% |
| 10 | 9 | Mislèt | 796688 | 2097996 | 40 | 33 | 53% |
| 11 | 10 | Nikola | 799811.901 | 2095517.76 | 56 | 27 | 59% |
| 12 | 11 | Ofrè | 795898 | 2100242 | 14 | 14 | 7% |
| 13 | 12 | Opisa | 797181 | 2098853 | 33 | 20 | 27% |
| 14 | 13 | Pidèm | 798356 | 2098938 | 50 | 18 | 28% |

Figure 3: Example of a table with data that can be exported

2.  Save the Excel file (to keep an usable version) then Save as →Save as type → CSV (Comma delimited)[7]→ OK (Save only active sheet) → Yes (keep this format)

3.  Open the file with QGIS : Add Delimited Text Layer (Layer → Add Delimited Text Layer) → Select the .CSV with Browse

4.  If the columns of the table that appear in the bottom of the window are not clearly separated, select the regular expression delimiter → semicolon for example, if Excel is in French.

5.  Define X and Y fields (point coordinates) if not done automatically

6.  Check data in the table. If accent marks are not shown, change the encoding (WS2 should work) → OK

7.  If points are at the wrong place, the CRS of the layer must be entered manually: right click on the layer in the layer panel → Properties → General → Coordinate Reference System (in the example in Figure 3 : WGS 84 / UTM zone 18N)

To update the layer, the update table in Excel must be saved again on the same file (replace file) with .CSV extension and refresh QGIS (View → Refresh).

## D. Data point format

All formatting modifications are done from the layer properties: right click on the layer in the layer panel → Properties

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[7] Do not select CSV Macintosh or CSV Dos which have limited encoding support (do not recognize special character)

| | General |
|---|---|
| | Style |
| | Labels |
| | Fields |

## a) Style menu:

*Single symbol:* All the points have the same symbol.

*Categorized:* Points can be differentiated depending on their attributes. For example, with the data in Figure 3 the color of the points can follow a color ramp → Select the column « Couverture Latrine »→choose a color ramp→OK

*Rule-based:* A set of rule can be created that determine the format of the points. Example: we want to color in blue the points for the villages with a latrine ratio "Couverture" of more than 80% and in red the other villages.

→Add Rule ⊕ → Label: Couverture <80% →Symbol color: Red

→Add Rule ⊕ → Label: Couverture >80% → [ ... ] →Fields and Values → Double click on «Couverture » → Expression →"Couverture" > .8 →OK → Symbol Color: Blue



**Layer Properties - Localité avec taux de latrinisation | Style**

Rule-based

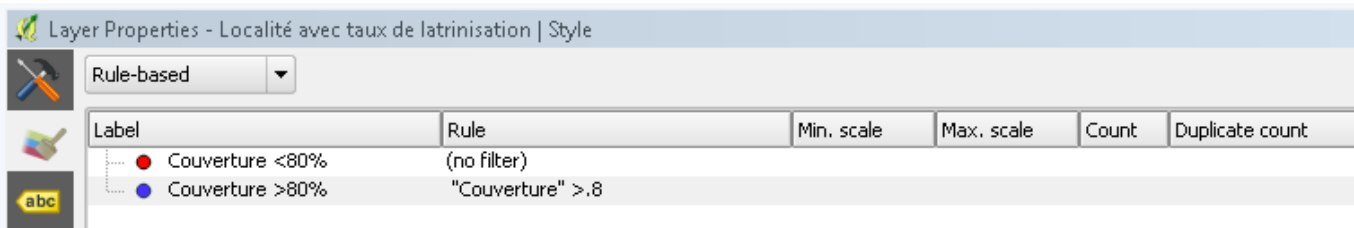| Label | Rule | Min. scale | Max. scale | Count | Duplicate count |
|---|---|---|---|---|---|
| ● Couverture <80% | (no filter) | | | | |
| ● Couverture >80% | "Couverture" >.8 | | | | |

*Figure 4: Style determined by a set of rules*

## b) Labels menu

The easiest: Label this layer with: "Name of the attribute" in our example "Localité".

Example of presentation that looks OK:

→ Text →Style: Bold → Size: 8.25 points→ Color: Same as the points color

→Buffer → Draw text buffer →Size: 1mm → Color: white

→Placement →Distance: 1mm

*A little trickier:* Click on expression dialog: [ ε ]

In function list →In Fields and Value are listed our points attributes (attributes must be between "double quote"), text can be added (between 'single quote'), mathematical expressions …

Between each expression (attribute, text, math), a string concatenation sign '||' must be inserted.

Expression

```
"Localite" || '
' ||'(' || "Lakou" || ', '|| "Nb Dalles" || ','|| "Couverture Latrine" || ')'
```



"Attribute localité" Concatenate' - 'Concatenate IF "Couverture latrine" > 80% Then 'Localité couverte'

Expression

```
'Localite' || '-' || CASE WHEN "Couverture Latrine" >.8 THEN 'Localité Couverte' END
```
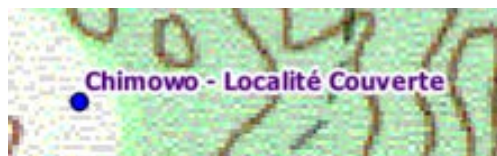


**Figure 5: Example of expression that control label content**
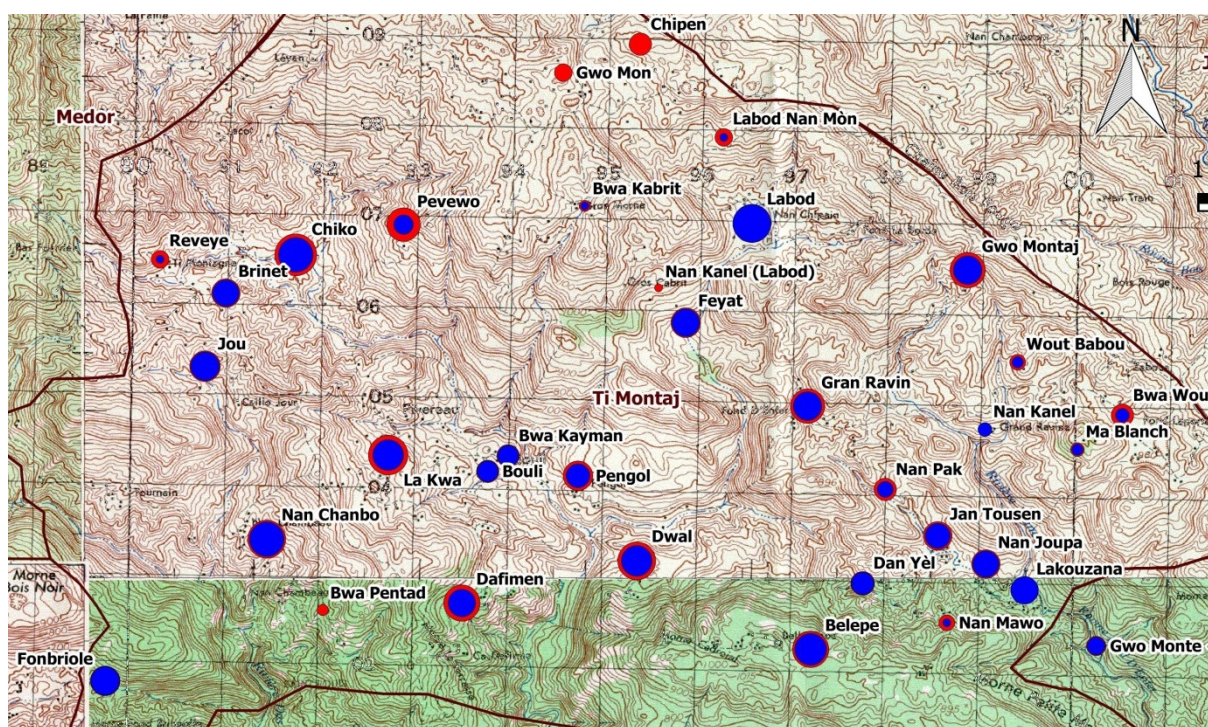
### c) Sizing the point area or diameter from data



**Figure 6: Example of point area according to the number of family (lakou) in red and latrine in blue**

1. Set the red points color: right click on the layer containing the data points in the layer panel → Properties → Style →Single symbol → Marker →Simple Marker→Color Red.

2. Set the red points diameter: In the same style menu: Click on Marker → Advanced → Size Scale Field → expression → here "Lakou" / 5 →OK. Then again Advanced → Size Scale Field →Scale Area

3. Set labels placement to avoid overlapping the points :Properties → Labels →Label this layer with : "Localite"→ Placement →Around point→Distance→  → Edit → sqrt( "Lakou" /(5*$pi))+1 [8]

4. Add the blue points: right click on the layer containing the red points in the layer panel →Duplicate. Then right click on the new layer and in Properties set the color to blue, in advanced set the area to "latrines" / 5, remove the label.

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[8] The radius of the points : $R = \sqrt{\dfrac{A}{\pi}} = \sqrt{\dfrac{Lakou\ /5}{\pi}}$ plus 1 pixel of extra space

5. In the layer panel, drag and drop the blue points layer above the red one in order for it to be on the foreground.

## E. Lines / Polygons to display border

Lines and polygons are used to draw borders, rivers…

### a) Draw borders

1. Start by loading a map where borders are clearly visible (an online map can work –see section B. on page 3)

2. Create a vector layer : Layer→ New → New shapefile layer→ Polygon → Add at least one attribute for the name of the area →OK → Save the layer as (.shp)

3. Add points: Select the layer in the layer panel → Toggle Editing Mode  (Layer→ Toggle Editing) → Add a polygon  (Edit → Add a Feature)    Click on the administrative map following the borders →Once the polygon is done right click on the map → Fill the attribute

4. Once the polygon done, points can be moved in Editing Mode by clicking on  (Edit → Node Tool)

5. When drawing a new area that has a common border with the first polygon: Settings → Snapping Option →Thick the layer that contain the border then tolerance = 1 (adjust if necessary) → Add a New Feature → click onto the common border points (automatic snapping) → once the common border is done, untick the snapping option and draw the rest of the polygon.

6. Once the areas are drawn, untick the Toggle Editing  and save the layer.

### b) Polygon formatting

Right click on the layer 'border' in the layer panel → Properties → Style →Single symbol → Simple fill →Symbol layer type : Outline : Simple line.

Line settings can then be adjusted and area label added

### c) Lines

The same process can be used to create lines (river, road…).
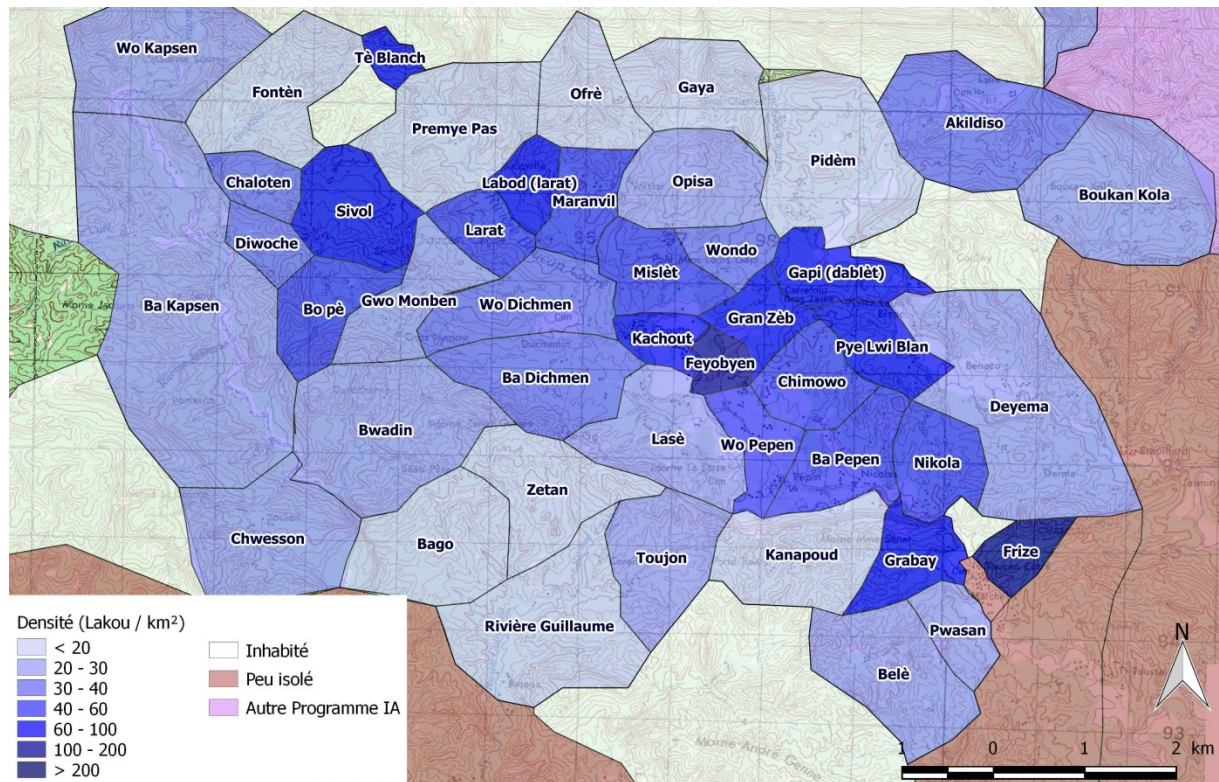
## F. Color graduation fill in polygons



Figure 7: Example of a map that shows the density of the population, each polygon (here village) is filled with a color according to its density.

1. Create polygons, as described in IV.E.a) Draw borders on page 8.

2. Open the attribute table: right click on the layer in the layer panel→ Open the Attribute Table.

3. Do a CTRL + A (select all) followed by a CTRL + C (copy) and paste in a excel spreadsheet. The first column header should be "wkt_geom" and the column should contain all the Well-Known Text (WKT) representation, the other column should contain all the information you wish to display (do not merge cells, do not keep blank line or column inside the data field). Save the excel file as .csv.

4. Open the file with QGIS : Add Delimited Text Layer ⯈ (Layer → Add Delimited Text Layer) → Select the .csv with Browse. QGIS should automatically detect the WKT geometry.

The polygon formatting can be set in the layer properties. To display a map such as the one in Figure 7, select → Properties → Style →Graduated → choose the column containing the data (here field_10 containing the population density) →number of classes (here 7). →Choose a color ramp →click on classify → the graduation can be customized by a double click on Value and Label
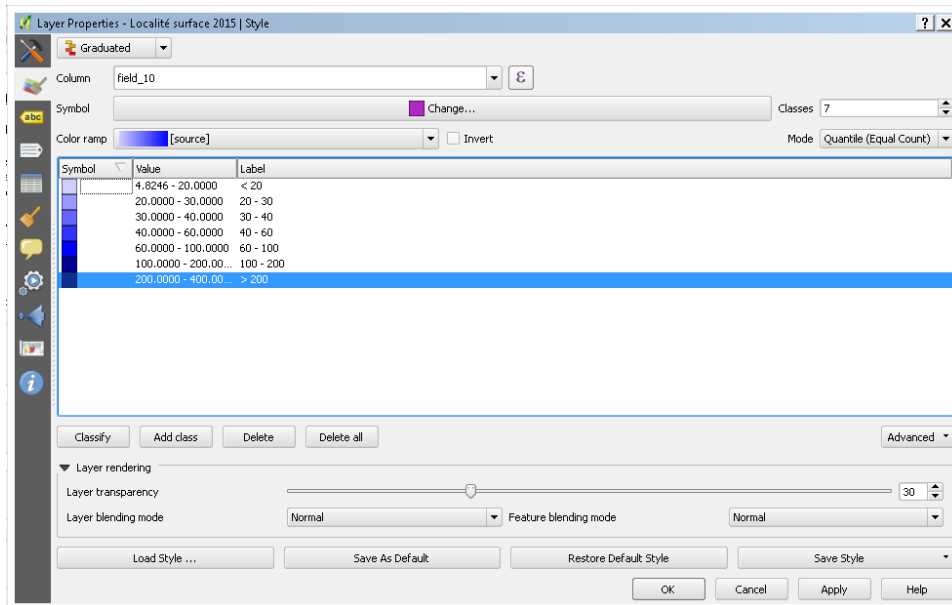
**Figure 8: Setting the graduated style to display the Figure 7 map**

# V. Publishing

## A. Compose the map

QGIS manages the publishing and printing of map from the

Print Composer : New (Project→ New Print Composer)

and the manager (Project →Composer Manager)



**Figure 9: Carriage return in the legend title**

1. Open a new print composer : Map Name → OK
2. Define the paper format : Panel on the right → Composition → Paper and quality

3. Add a new map (Layout → Add Map) → Trace a rectangle on the sheet (in the print composer, item are

   selected using the button Select / Move item)

4. Setup map extent and the scale: Click on (Layout →Move Content), keeping the left button pushed the
   map can be moved, the scale can be changed with the mouse wheel. To setup the scale more precisely, enter
   the scale value (Item Property → Scale)

5. Add a legend : (Layout → Add new legend) → Choose a title[9]→Add or remove layer from the

   legend →Select the layer in the legend item list→Edit layer title → In legend item untick "Auto Update"
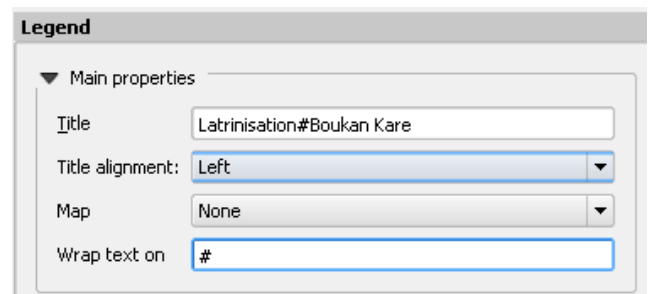
6. Then we can :

   a) Add a scale bar

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[9] Carriage return: put an unused character in the title: # then in "wrap text on":  # cf Figure 10.

b) Add a north facing arrow  → Item properties → Path : a picture of an arrow : image collection in the QGIS installation folder (for example C:/Program Files/QGIS Chugiak/apps/qgis/svg/ ) text can then be added (ex : **N** north of the arrow) 

c) A referenced grid → Select the map → Item properties →Show grid → Choose an Interval (Interval in degrees, to obtain an interval in minute 1/60 = 0,01666666)

## B. Publish the map

The composed map can:

1. Be printed directly on the composer

2. Be exported as PDF  (Composer →Export as PDF), these files are quite large[10] (Often above 10 MO).
   a) The cleanest solution is to open these file with the commercial software Adobe Acrobat Professional[11]→ File → Save as → Optimized PDF →Color Image : 100 ppi for image above 125 gives good results (Good image compression algorithm, no loss of text quality)
   b) The other solution, with a poorer quality is to change the resolution (before the PDF export) in the print composer → Composition → Export resolution → 150 dpi → Print as raster[12]

3. Be exported to an image format  (Composer →Export as image): The JPEG format has a better compression ratio, the size of the image created is managed by the export resolution (composition → Export resolution → 150 dpi). 150 dpi seems to be the lower resolution which gives an acceptable result for topographic map.

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[10] A free PDF compression solution, which as a lower quality : Install Ghostscript then GSView then open the PDF in Gview → Convert → pdfwrite → Resolution : 200 →OK (manage the text as a picture that becomes quite unreadable below 200 ppi)

[11] Not to be mistaken with the free Adobe Acrobat Reader

[12] All the layers are merged and the final result is saved as a raster (as only one image)