SocScape

Exploring High Resolution Demographic Grids

Working with demographic grids in QGIS

Anna Dmowska
dmowska@amu.edu.pl

1. Introduction

SocScape (Social Landscape) is a research project which provides open access to high resolution (30 m) population, subpopulation (separate race/ethnicity group) and racial diversity grids for the entire conterminous United States for 1990, 2000, 2010.

High resolution grids are available for download using ***SocScape*** - GeoWeb application (http://sil.uc.edu/webapps/socscape_usa/) or ***SocScape data website*** (http://sil.uc.edu/cms/index.php?id=socscape-data)

SocScape - GeoWeb application provides an access to population and racial diversity grids for the entire U.S and it allows to download data for selected region (up to 100 000 km^2).

SocScape data website provides ***population, subpopulation and racial diversity*** grids **for each county and for 363 metropolitan area (MSA)** as a zip archive containing data for 1990, 2000, 2010. In addition, for urban areas within 351 MSA are available ***racial diversity change maps*** for 1990-2000, 2000-2010, 1990-2010 comparison.

Data are saved as GeoTiff and shapefiles (change map) and can be opened in GIS software.

QGIS is a free, user friendly Open Source Geographic Information System (GIS) software http://qgis.org/en.
QGIS is available on Windows, MacOS X, Linux and can be downloaded from
http://qgis.org/en/site/forusers/download.html

2. SocScape data

SocScape data is a website, which provides data for each county and 363 metropolitan areas as a zip archive. This website is available at

http://sil.uc.edu/cms/index.php?id=socscape-data

This website made available high resolution demographic grids **for each county in the conterminous U.S. and for 363 MSA for 1990, 2000 and 2010**. Data are organized as a zip archive.

Each archive contains 3 directories:

- ***population*** - contains population grids for each year (4 grids)
- ***diversity*** - contains racial diversity classification grids for each year (4 grids)
- ***race*** - contains separate grids for 7 race/ethnicity groups for each year (27 grids)

All data are provided in Albers Conical Equal Area projection (EPSG: 5070).

Additionally for urban areas within metropolitan areas we made available **racial diversity change map**, which shows temporal changes in racial diversity as a single map. This map is available as shapefile for 1990-2000, 2000-2010 and 1990-2010 comparison.

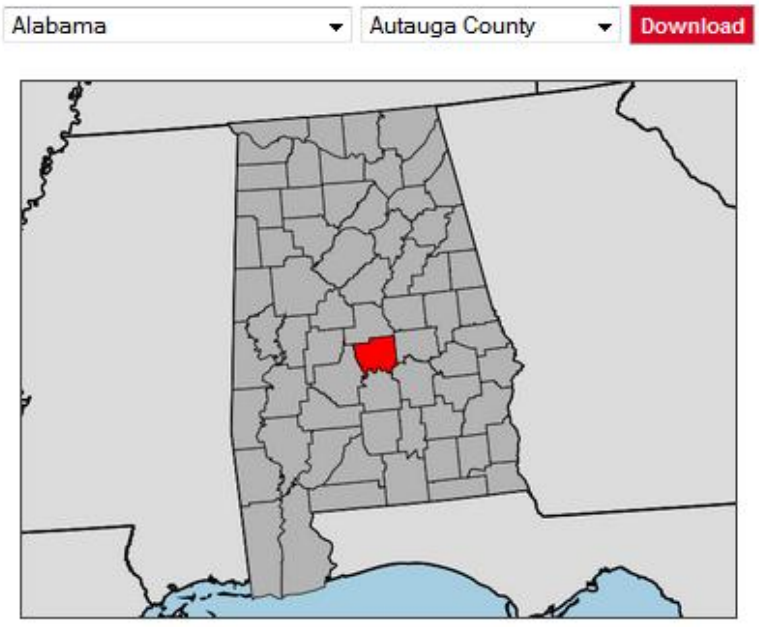


Fig. 1. Download SocScape data by county and MSA

3. Download SocScape data for selected county

Download high resolution grids for Cook County, IL.

From the dropdown menus select the **Illinois** as a ***state name*** (left menu) and next **Cook County** as a ***county name*** (right menu). Selected county will be shown below the dropdown menu. Click on **"Download"** button to download a zip archive.

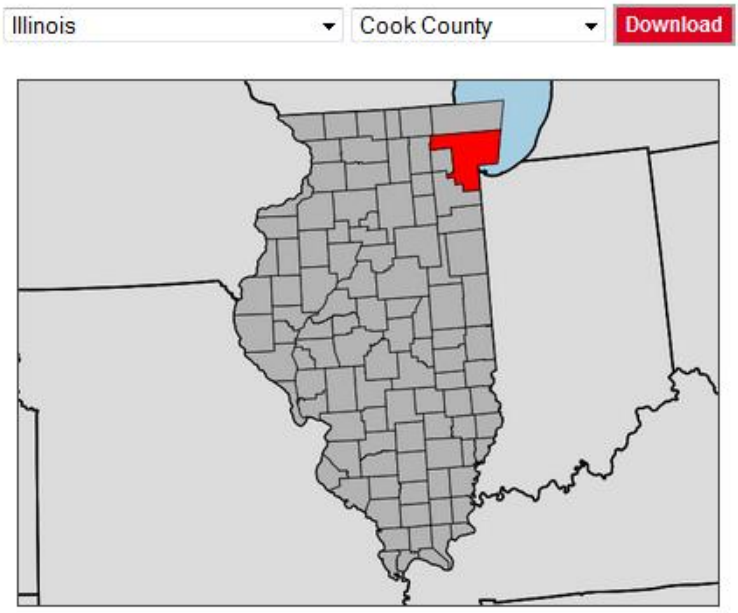


Fig.2. Download SocScape data for Cook county, IL.

Name of each zip archive contains 2-letters state code and county name. In this example file will be named *il_cook.zip*, which indicates Cook county in the state of Illinois.

Unzip a zip archive. Zip archive contains 3 directories: population, race, diversity.

Visit http://sil.uc.edu/cms/index.php?id=high-resolution-demographic-grids-data-description for more detailed information about data.

4. Getting started with QGIS

QGIS is available on Windows, MacOS X, Linux and can be downloaded from http://qgis.org/en/site/forusers/download.html
To install QGIS download version for your operating system and follow the wizard installation instruction.

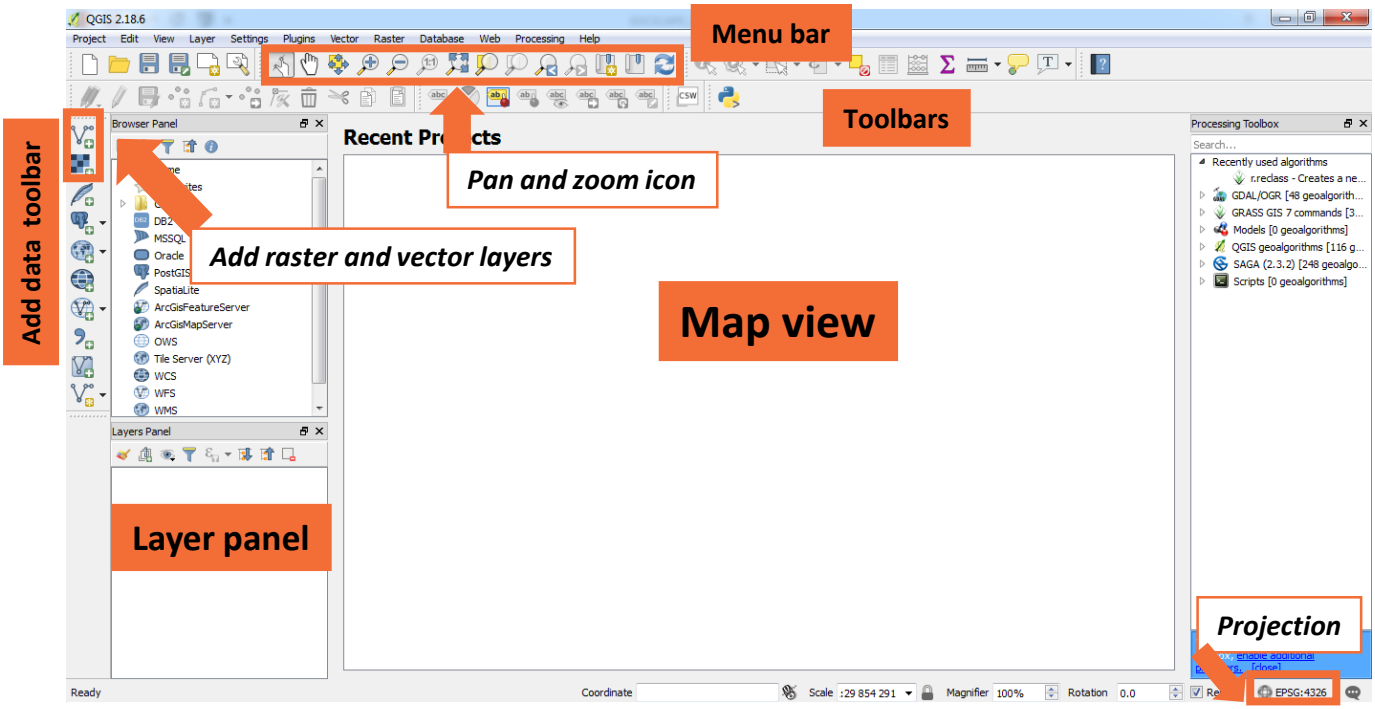


Fig.3. QGIS main window

QGIS has a lot of documentation which is available at http://docs.qgis.org
Please visit http://docs.qgis.org/2.18/en/docs/user_manual/index.html
for detailed user manual.

QGIS GUI is described here:
http://docs.qgis.org/2.18/en/docs/user_manual/introduction/qgis_gui.html

This short guide assumes using QGIS v2.18 for Windows.

4. Getting started with QGIS

Load raster or vector data into QGIS

Load raster data to QGIS

- from main menu choose ***Layer – Add Layer - Add Raster Layer*** or clik on the icon  in the left panel of QGIS window.

- Browse to the folder with data, select ***name of raster layer*** and open it.

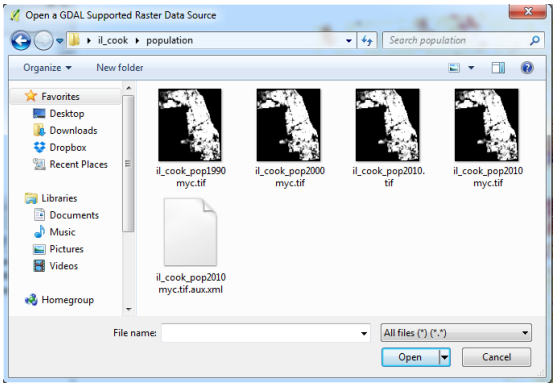
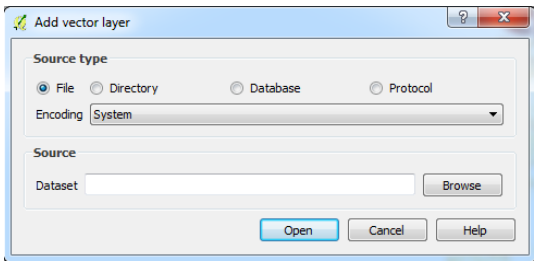


Fig.4. Add raster layer dialog

Load vector data to QGIS

- from main menu choose ***Layer – Add Layer - Add Vector Layer*** or choose the icon  in the left panel of QGIS window.

- Browse to the folder with data and select ***name of vector layer with shp extension*** and open it.



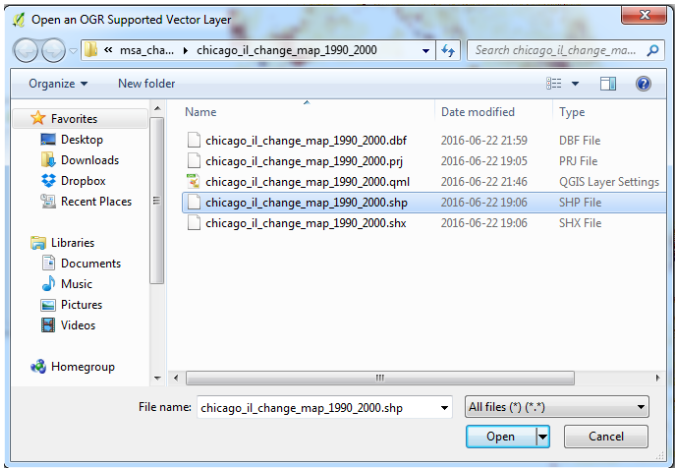
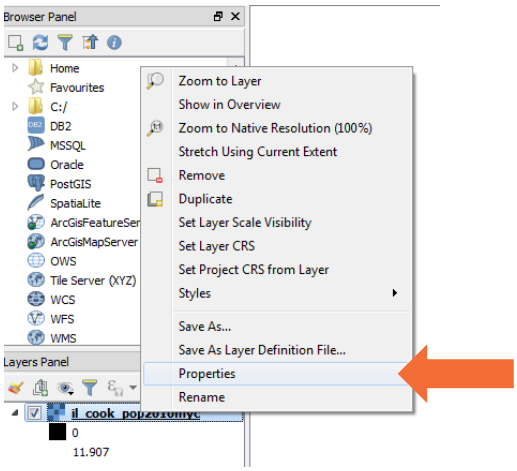


Fig.5. Add vector layer dialog and open vector layer

Symbolizing Layer using color map form text file



To view and set the properties for a raster layer, double click on the layer name in the map legend, or right click on the layer name and choose ***Properties*** from the context menu. This will open the ***Raster Layer Properties*** dialog

Fig.6. Properties from context menu

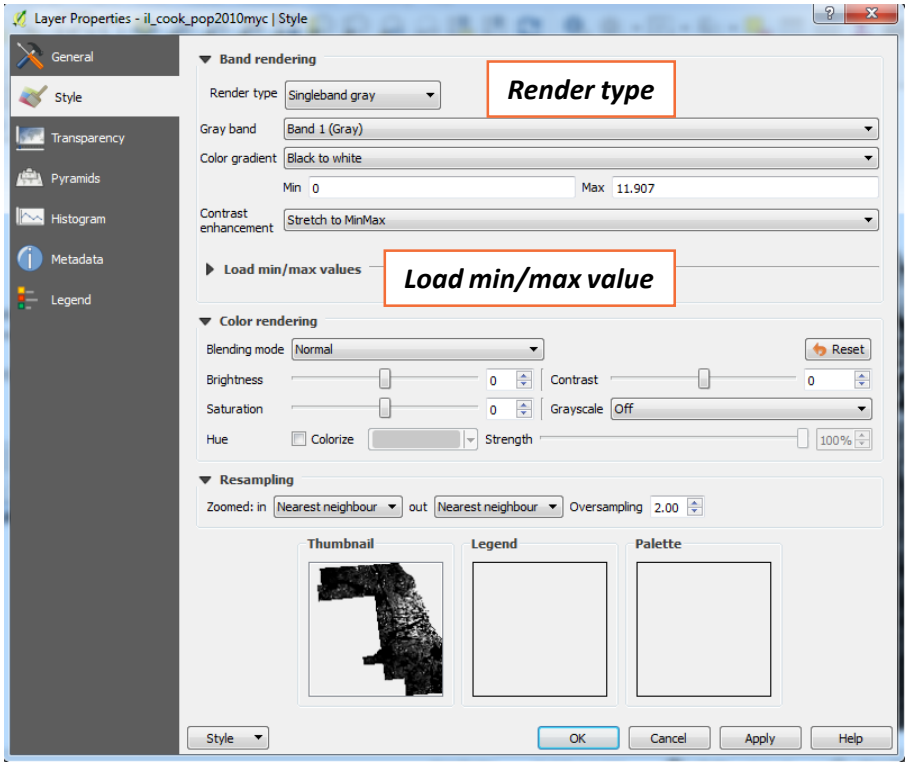


Fig.7. Layer properties dialog

More information:
http://docs.qgis.org/2.14/en/docs/user_manual/working_with_raster/

4. Getting started with QGIS

Go to ***Style menu*** in ***Raster Layer Properties*** dialog.

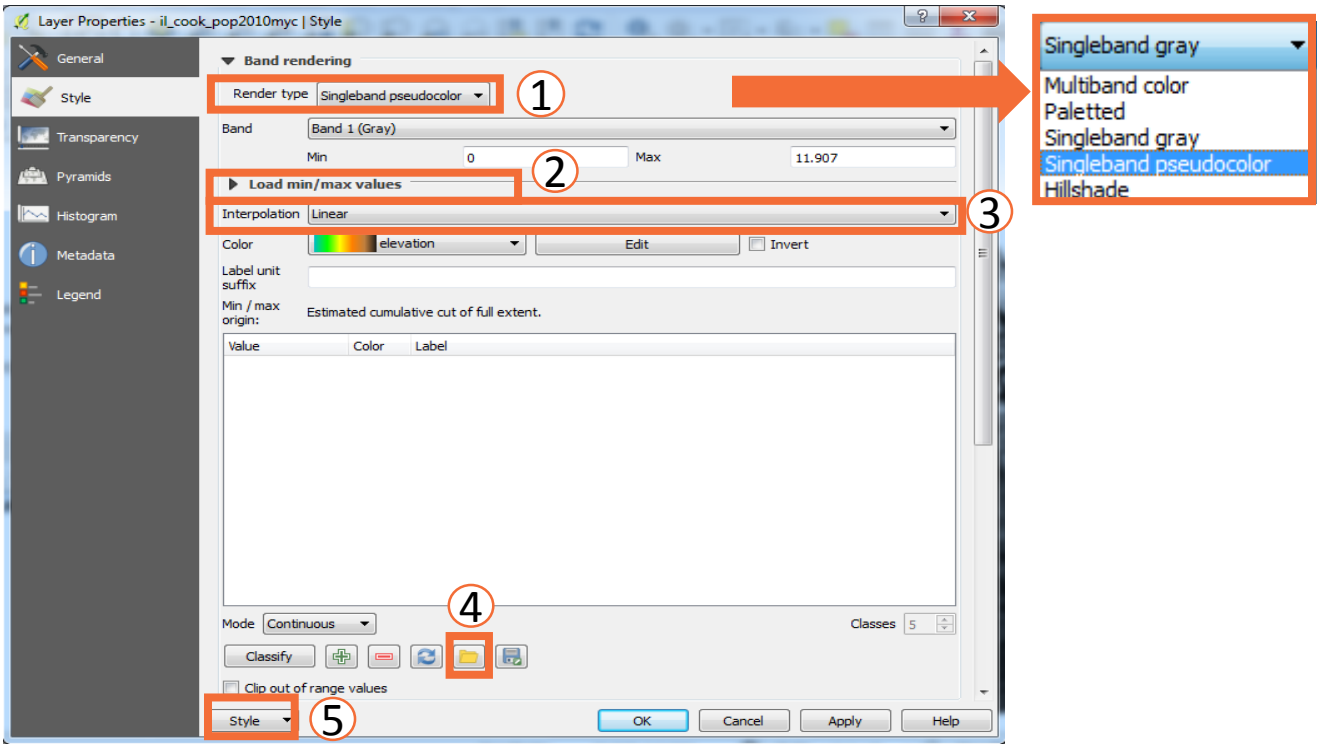


Fig.8. Raster layer properties dialog

① As a render type choose Singleband pseudocolor

② **Load min/max value**

Click on ▶ to show min/max value option.
Choose (A) Min /Max, (B) Accuracy – Actual (slower)
and click on Load button (C)

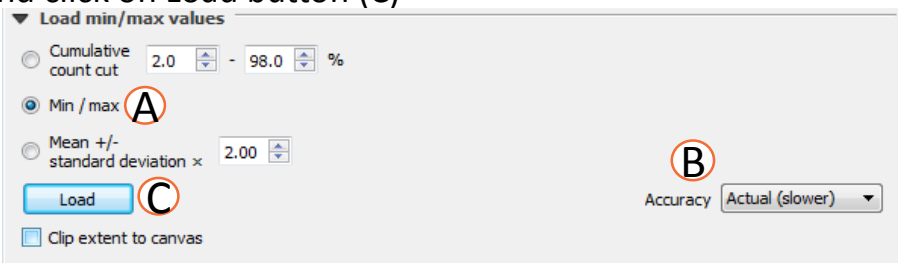


Fig.9. Load min/max value in Raster layer properties

③ Select „Discrete” as interpolation method.

④ Load color map from file using icon  in the Layer Properties for a singleband pseudocolor window and choose an appropriate color map text file.

Calculating new maps in QGIS

Calculations on the basis of existing raster can be perfomed using **Raster Calculator** in the ***Raster*** menu. The results of calculation are written to a new raster layer.
Raster calculator allows to calculate ***population density*** based on population grids or ***percentage maps*** based on race and population grids.

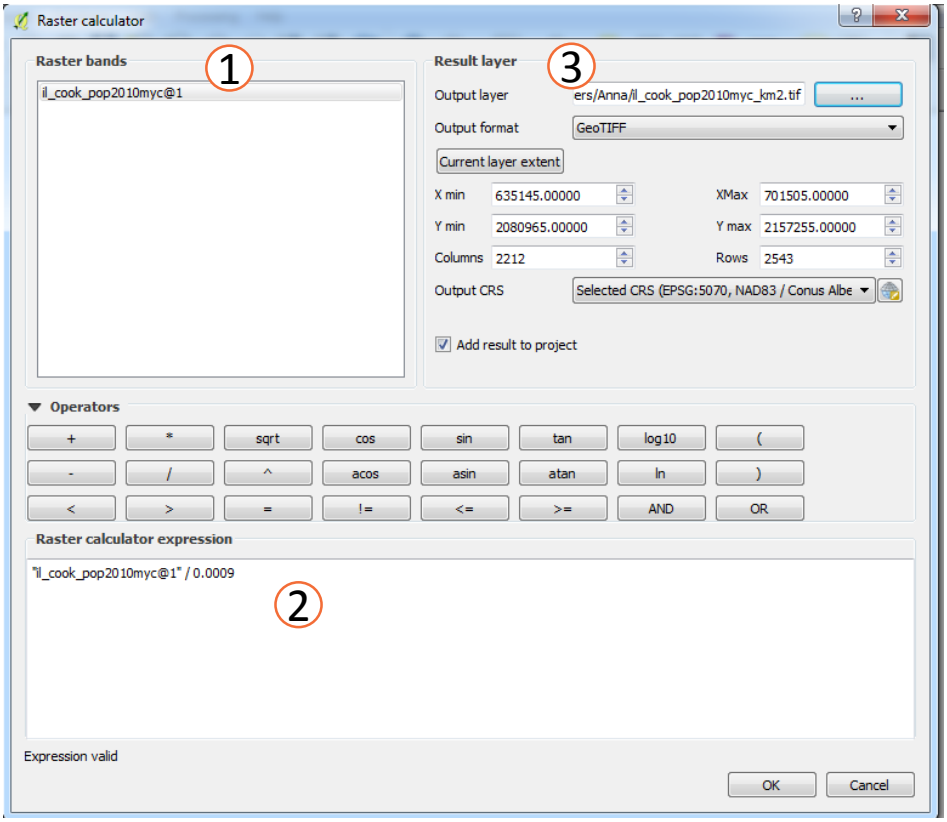


Fig.10. Raster calculator window

① ***Raster bands*** - contains all loaded raster layers that can be used for calculations.

② ***Raster calculator expression field –*** contains formula used in calculations. To add a raster to the raster calculator expression field, double click its name in the *Raster band fields list*. You can then use the operators to construct calculation expressions, or you can just type them into the box.

③ ***Result layer*** section define an output layer: name of the output layer, output format, output CRS and the extent of the calculation area (based on an input raster layer, or based on X,Y coordinates and on columns and rows, to set the resolution of the output layer).

5. Working with racial diversity grids in QGIS

Open racial diversity map in QGIS

Open QGIS Desktop

Load raster data to QGIS

- from main menu choose ***Layer – Add Layer – Add Raster Layer*** *or* choose the icon  in the left panel of QGIS window.

- select ***il_cook_div2010myc.tif*** from ***il_cook/diversity*** directory and open it.

Racial diversity map is displayed in QGIS already with the right color map.

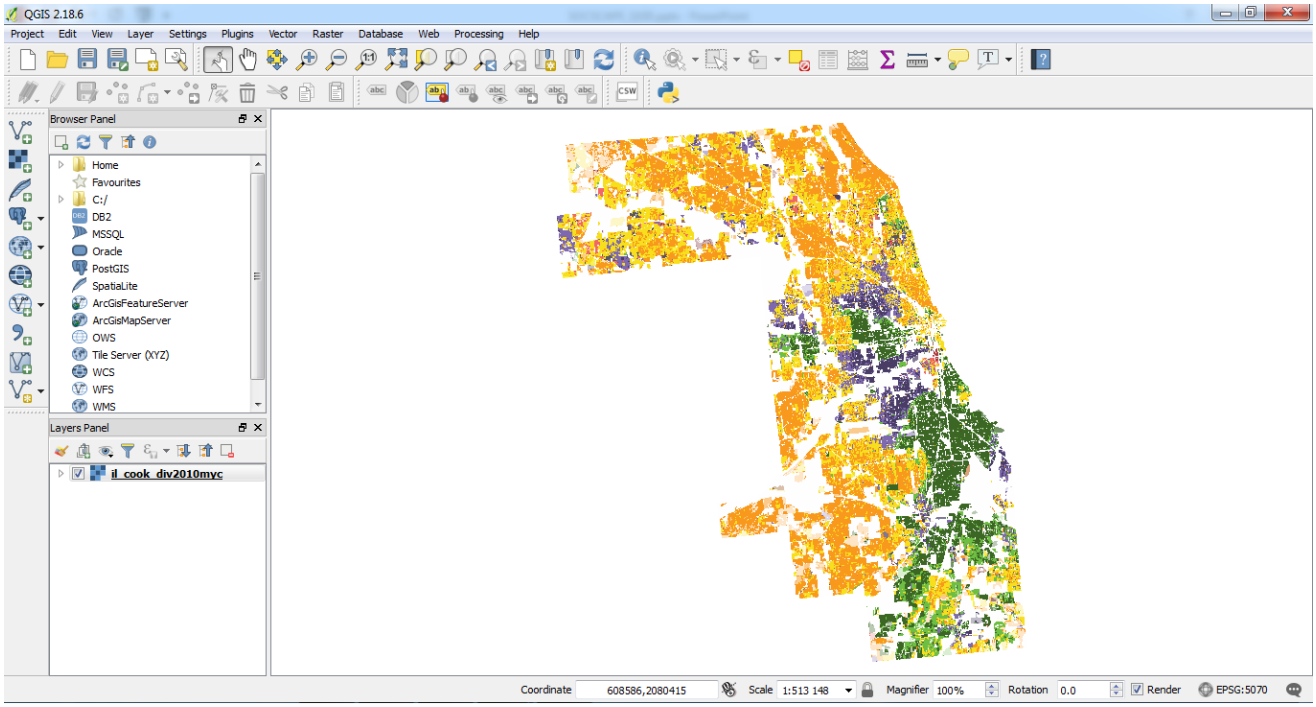


Fig.11. Racial diversity of Cook county, IL area in 2010 loaded to QGIS

Save map as image

Map displayed in Map window in QGIS can be **saved as image** (PNG, JPG) using ***Projects – Save as image*** from main menu.

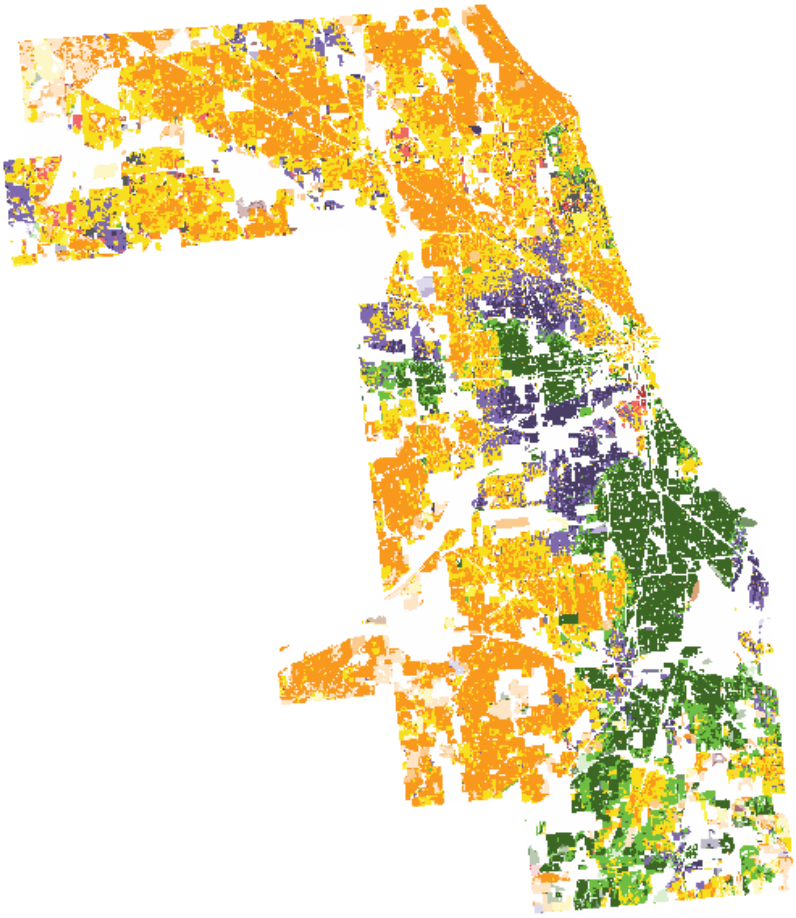


Fig.12. Racial diversity of Cook county, IL area in 2010

Open population data in QGIS

Open QGIS Desktop

Load raster data to QGIS

- from main menu choose ***Layer – Add Layer – Add Raster Layer*** *or* choose the icon  in the left panel of QGIS window.

- select ***il_cook_pop2010myc.tif*** from ***il_cook/population*** directory and open it.

Population map is displayed in grey colors. A color map for population map is provided in a text file (**population_color.txt**)

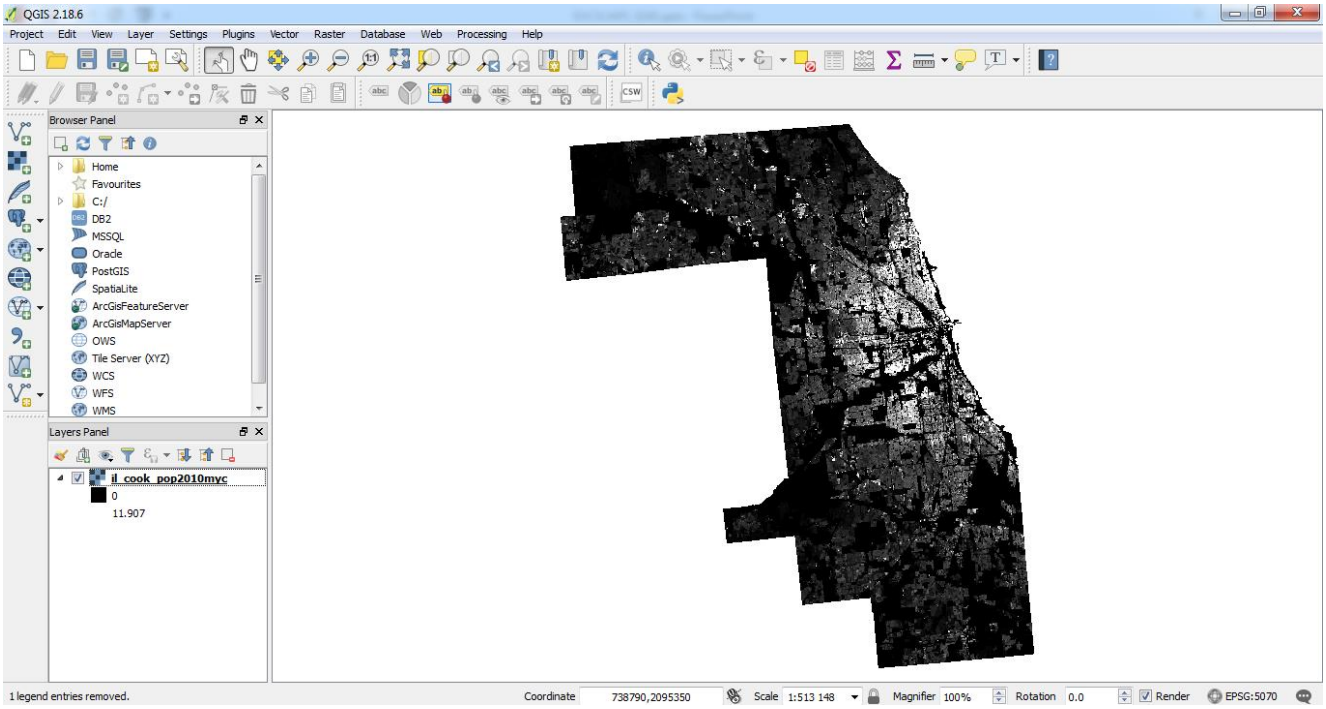


Fig.13. Population distribution of Cook county, IL area in 2010 loaded to QGIS

Symbolizing Layer using user define color map

Following an instruction ”***Symbolizing Layer using color map from text file***” from the section ***Getting started with QGIS*** set color to ***il_cook_pop2010myc*** map:

- Right click on the ***il_cook_pop2010myc*** name in Layer Panel
- Choose ***Properties*** from the context menu.
- Go to ***Style menu*** in ***Raster Layer Properties*** dialog.
- As a render type choose ***Singleband pseudocolor***
- In Load min/max values options set Min /Max, Accuracy – Actual (slower) and click on Load button
- Select ”Discrete” as interpolation method.
- Load color map from file using icon  in the *Layer Properties* for a singleband pseudocolor dialog window.
  Color file is saved as ***population_color.txt***
- Click on OK in ***Raster Layer Properties*** dialog.

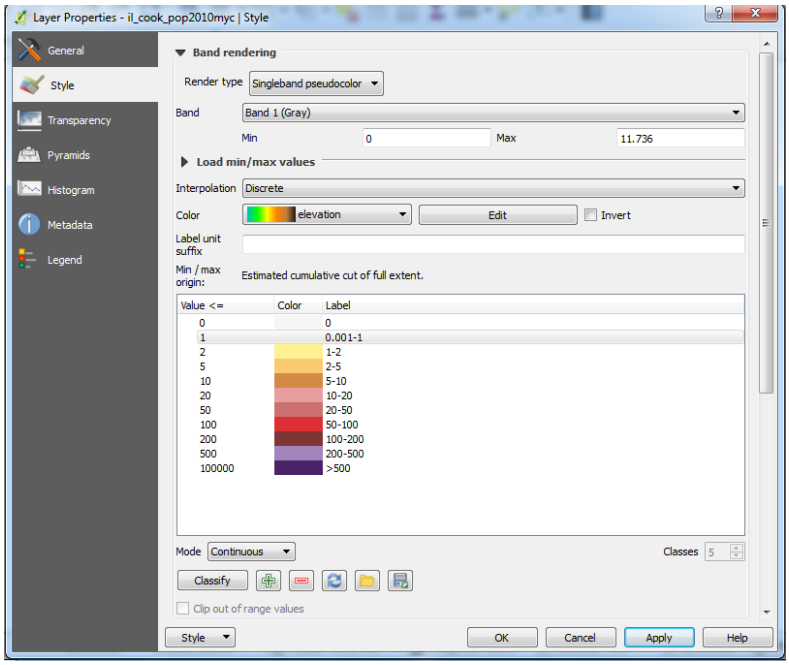


Fig.14. Raster layer properties dialog for population distribution

6. Working with population grids in QGIS

Symbolizing Layer using user define color map

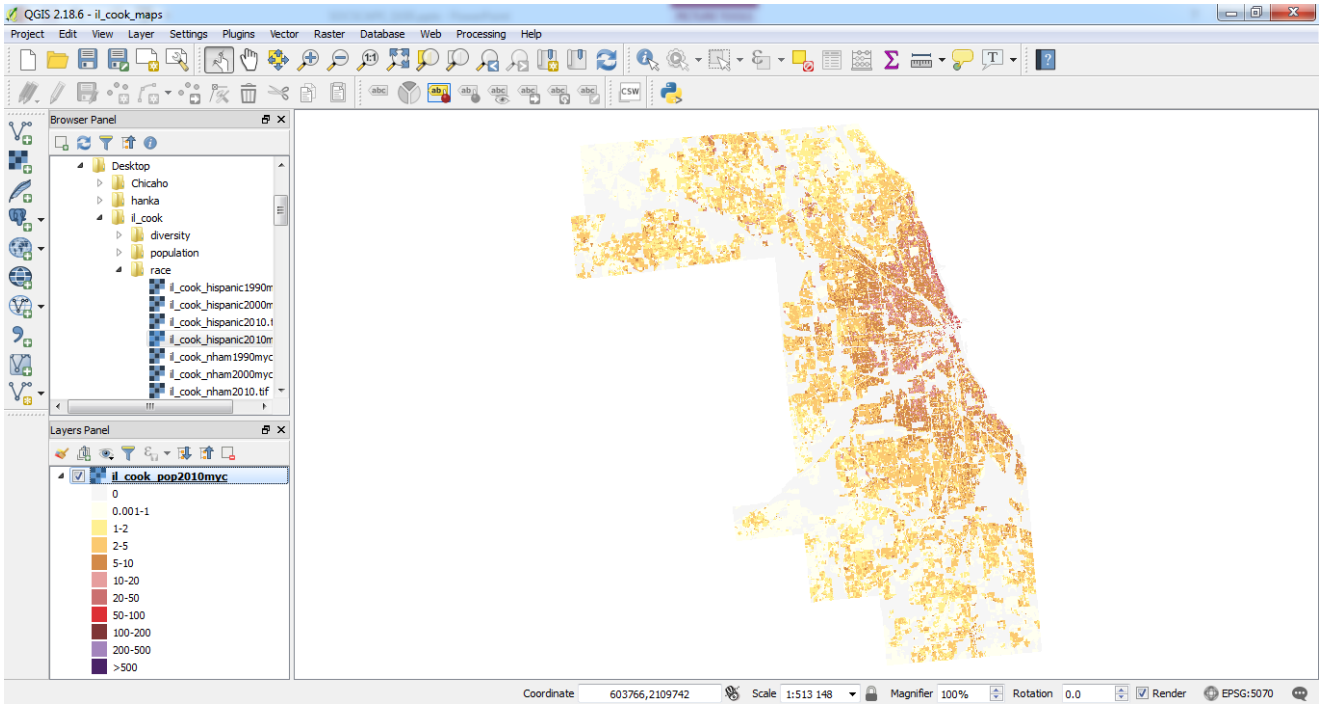


Fig.15. Population distribution of Cook county, IL area in 2010 loaded to QGIS (with user define color)

Save map as image

Map displayed in Map window in QGIS can be saved as image (PNG, JPG) using ***Projects – Save as image*** from main menu.

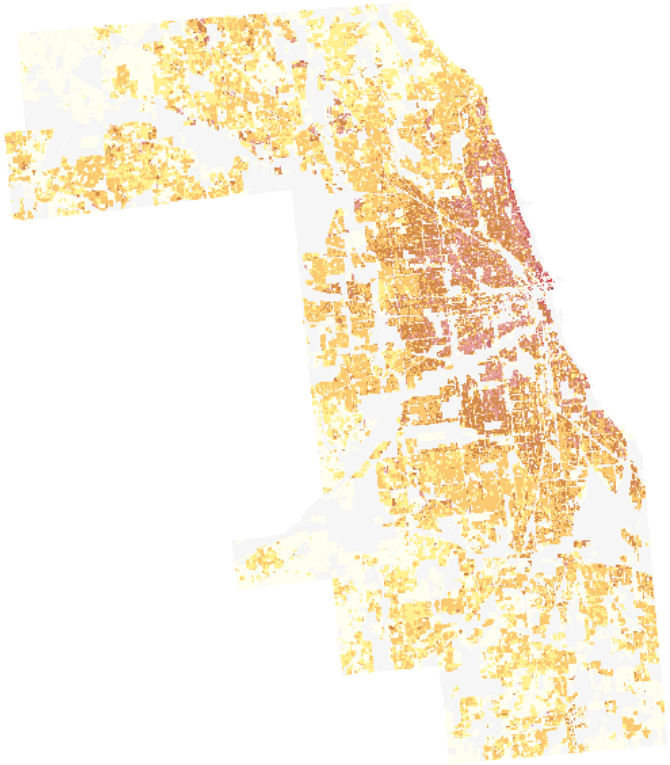


Fig.16. Population distribution of Cook county, IL area in 2010

7. Calculate population density

Calculate population density per km² for Cook county, IL

- Select ***Raster Calculator*** in the ***Raster*** menu.
- Construct calculation expressions:

il_cook_pop2010myc@1/0.0009

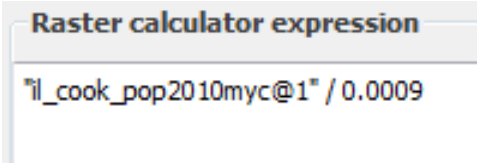


Fig.17. Raster calculator expression

*Double click fields list to add raster to Raster calculation expression field. on the name of raster (**il_cook_pop2010myc@1**) in the Raster band*

- Choose output directory ... and type output name: ***il_cook_pop2010myc_km2.tif***
- Check Add result to project (the result of calculation will be add to QGIS)
- Clik OK.

The resultant map will be saved in selected directory and add to Layer Panel in QGIS. Population density map is shown in grey colors.

7. Calculate population density

Symbolizing Layer using user define color map

Following an instruction "***Symbolizing Layer using color map from text file***" from the section ***Getting started with QGIS*** set color to set color to ***il_cook_pop2010myc_km2.tif*** *map. Colors are saved in* ***population_km2_color.txt***

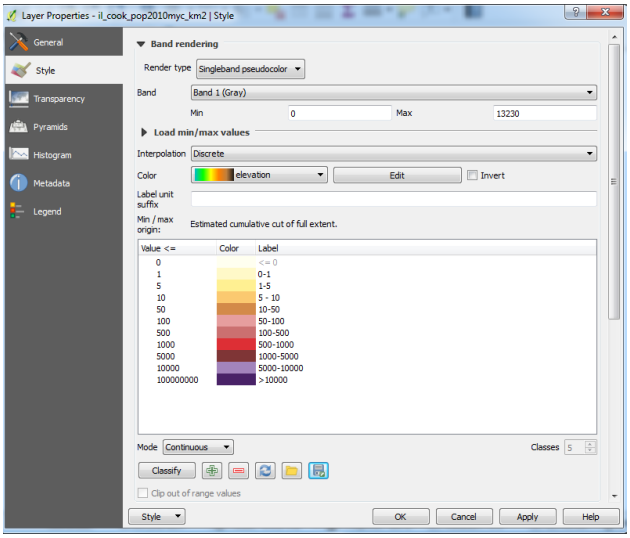


Fig.18. Raster layer properties dialog for population density

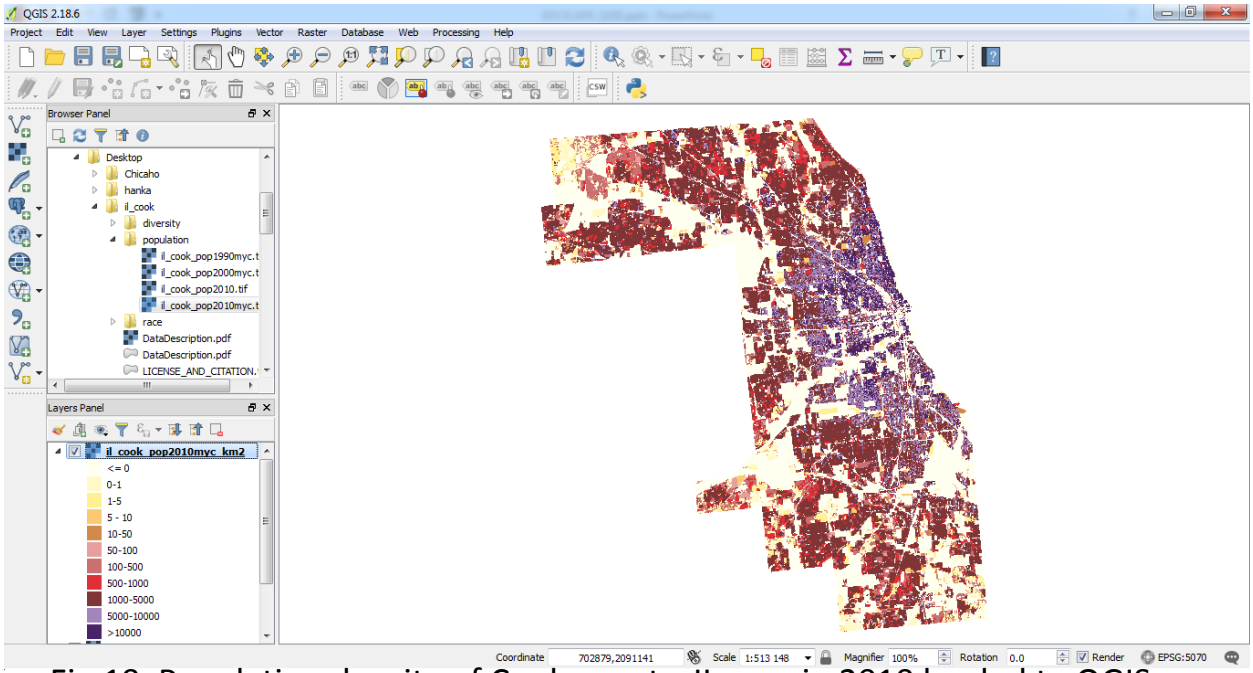


Fig.19. Population density of Cook county, IL area in 2010 loaded to QGIS (with user define color)

8. Calculate racial percentage maps

Calculate percentage map for Hispanic in 2010 for Cook county, IL

Load population grid to QGIS

- from main menu choose ***Layer – Add Layer - Add Raster Layer*** *or* choose the icon  in the left panel of QGIS window.

- select ***il_cook_pop2010myc.tif*** from ***il_cook/population*** directory and open it.

Load race grid to QGIS

- from main menu choose ***Layer – Add Layer – Add Raster Layer*** *or* choose the icon  in the left panel of QGIS window.

- select ***il_cook_hispanic2010myc.tif*** from ***il_cook/race*** directory and open it.

Calculate percentage of Hispanic

Percentage is calculated using **Raster calculator** from **Raster** menu. The general expression will be:

(race grid/population grid)*100

where race is a race/ethnicity grids and population grids is a total population grids.

- Select ***Raster Calculator*** in the ***Raster*** menu.
- Construct calculation expressions:

("il_cook_hispanic2010myc@1" / "il_cook_pop2010myc@1")*100

Double click fields list to add raster to Raster calculation expression field.
on the name of raster ***(il_cook_hispanic2010@1,*** **il_cook_pop2010myc@1)**
in the Raster band

- Save new map as **il_cook_perc_hispanic2010myc.tif**

8. Calculate racial percentage maps

Raster calculator allows to percentage maps based on race and population grids.

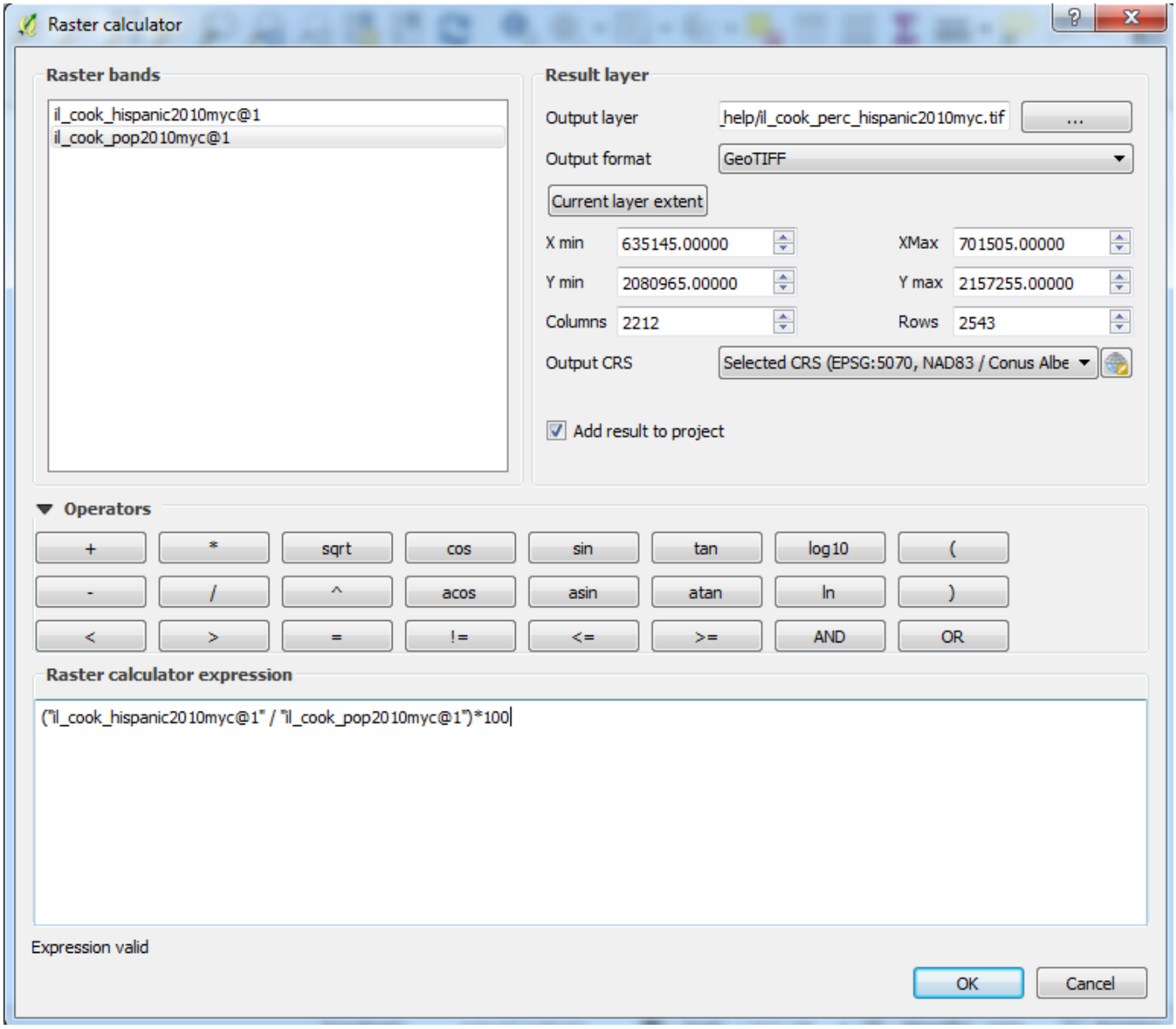
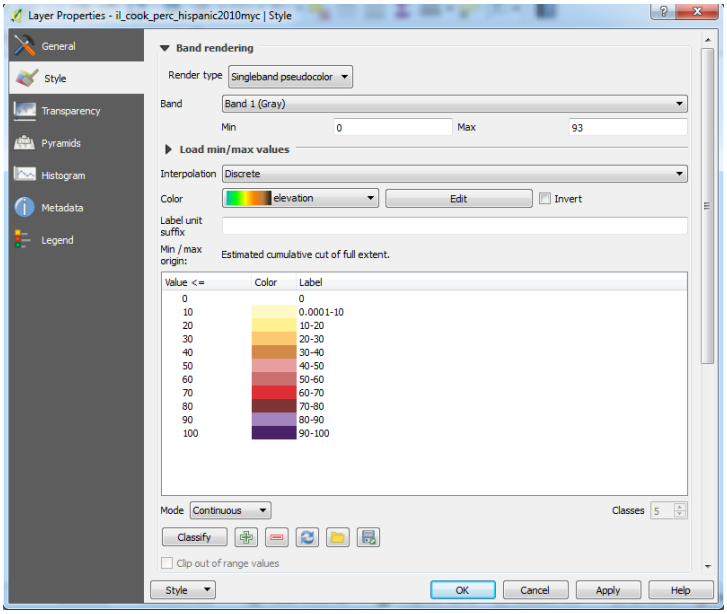


Fig.20. Calculating percentage maps using Raster Calculator

8. Calculate racial percentage maps

Symbolizing Layer using user define color map



Following an instruction "***Symbolizing Layer using color map from text file***" from the section ***Getting started with QGIS*** set color to ***il_cook_perc_hispanic2010myc.tif*** *map. Colors are saved in* ***percentage_color.txt***

Fig.21. Raster layer properties dialog for percentage map

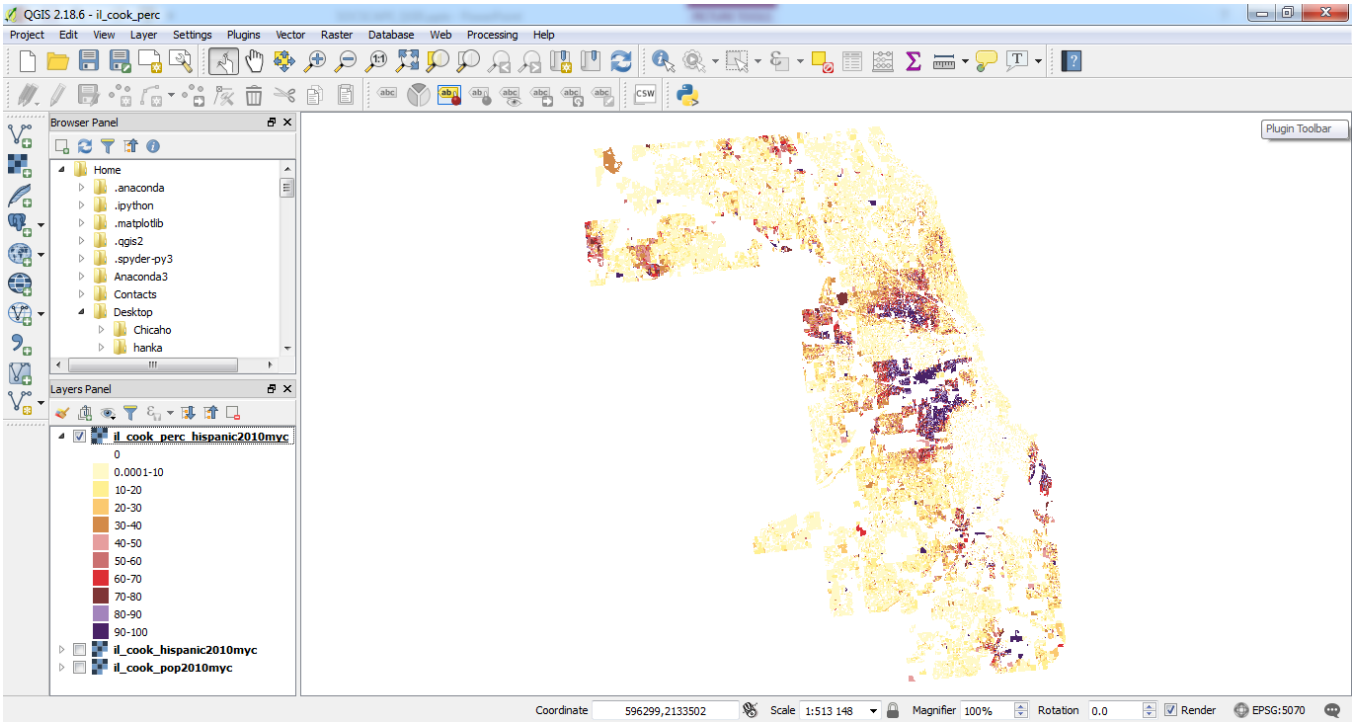


Fig.22. Percentage of Hispanic in Cook county, IL in 2010 (with user defined colors)

8. Calculate racial percentage maps

Save map as image

Map displayed in Map window in QGIS can be saved as image (PNG, JPG) using ***Projects – Save as image*** from main menu.

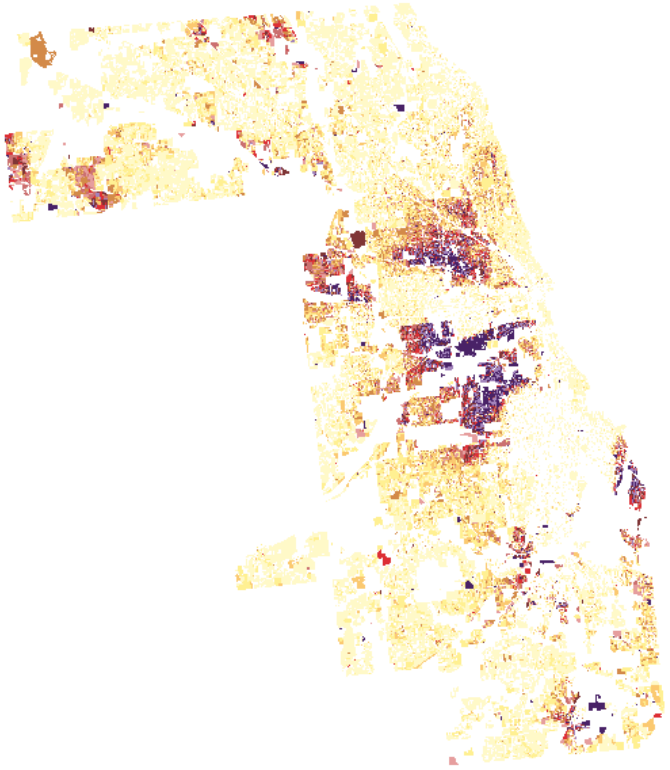


Fig.23. Percentage of Hispanic in Cook county, IL in 2010

9. Working with change maps in QGIS

SocScape data website (http://sil.uc.edu/cms/index.php?id=socscape-data) made available racial diversity change maps. **Change map** is available as shapefile format for 351 metropolitan areas and is limited to 2010-urban areas of main city in MSA.

Racial diversity change map (or change map) show temporal change in racial diversity in a single map. Change map is created in the basis of a high resolution (30m) two-dimensional classification of grid cells into 14 categories based on racial diversity level and dominant race. We use racial diversity map for 1990, 2000, 2010 years. This map is available as shapefile for 1990-2000, 2000-2010 and 1990-2010 comparison.

Change map show unchagned areas in original colors assigned to each of 14 diversity/dominant race classes. Changed areas are shown in stripes with the color of narrower stripes indicating the classes in first time point (i.e 1990 for 1990-2000 comparison) and broader stripes indicating the class in second point time (i.e 2000 for 1990-2000 comparison).

Racial diversity change maps are downloaded as a zip archive for selected metropolitan area. Each zip archive contain **DataDescription.pdf** file with detailed description of data.

Each archive contains 5 directories:

- **chicago_il_change_map_1990_2000** – contains shapefile with racial diversity change map for 1990-2000 and *.qml legend file – legend file for QGIS.
- **chicago_il_change_map_2000_2010** – contains shapefile with racial diversity change map for 2000-2010 and *.qml legend file – legend file for QGIS.
- **chicago_il_change_map_1990_2010** – contains shapefile with racial diversity change map for 1990-2010 and *.qml legend file – legend file for QGIS.
- **Legend files –** contains 8 files: *.lyr file is a symbology to use with ArcGIS and *.sld is a file to use with older version of QGIS
- **Transition matrix** – contains transition matrix csv files. See DataDescription.pdf for more information.

Each shapefile 2 attribute columns: value – is a number of category (1-196), label – is a description of change, i.e. WL-WM means, that white low diversity area change into white medium diversity.

All data are provided in Albers Conical Equal Area projection (EPSG: 5070).

Download change map for selected metropolitan area.

- Go into SocScape data website (http://sil.uc.edu/cms/index.php?id=socscape-data)
- From the left dropdown menu select the last position on the list - ***metropolitan areas (change)*** and next from the right menu select ***name of MSA.*** Selected metropolitan area will be shown below the dropdown menu. Click on **"Download"** button to download a zip archive. Here is presented an example for Chicago, IL metropolitan area

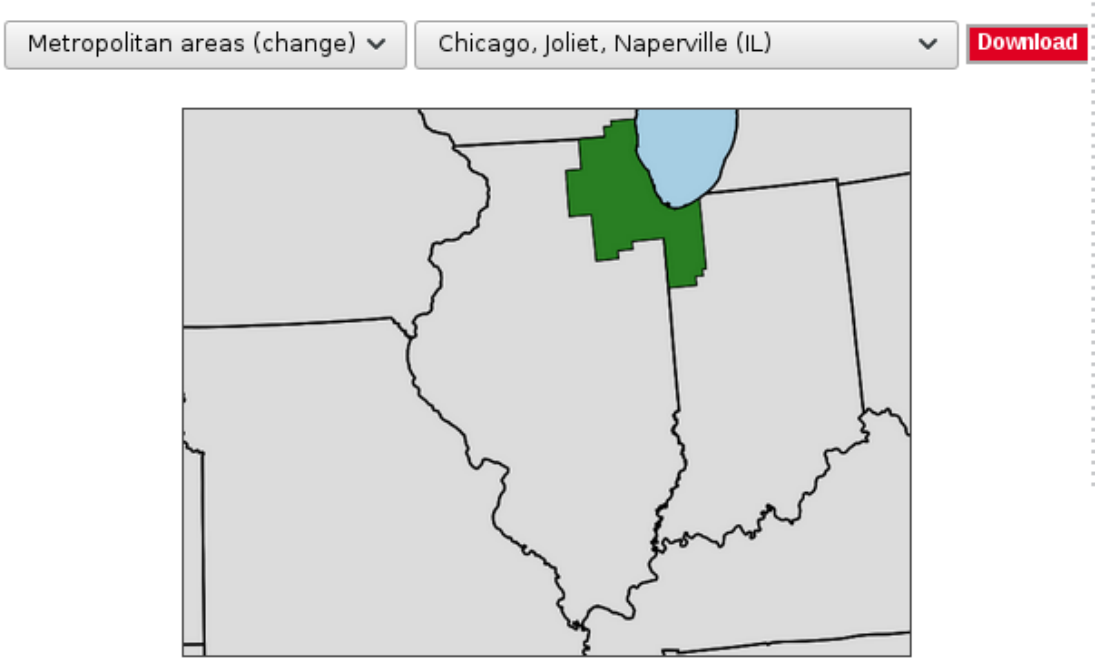


Fig. 24. Download change map for Chicago metropolitan area

Name of each zip archive contains the prefix "msa_change", the name of metropolitan area and 2-letters state code. In this example there will be downoladed zip archive named **msa_change_chicago_il.zip**
Each archive contains data for analysis of racial diversity change and description file with detailed information about dataset.

9. Working with change maps in QGIS

Open change map in QGIS

Change map is available as vector in shapefile format.

Load vector data to QGIS

- from main menu choose ***Layer – Add vector Add Vector Layer*** *or* choose the icon  in the left panel of QGIS window.

- select ***chicago_il_change_map_1990_2000 from the direcotry with the same name as vector file*** and open it.

Change map will be displayed with correct color legend.
*(chicago_il_change_map_1990_2000 directory contains shapefile data and *.qml file with color legend to display map correctly).*

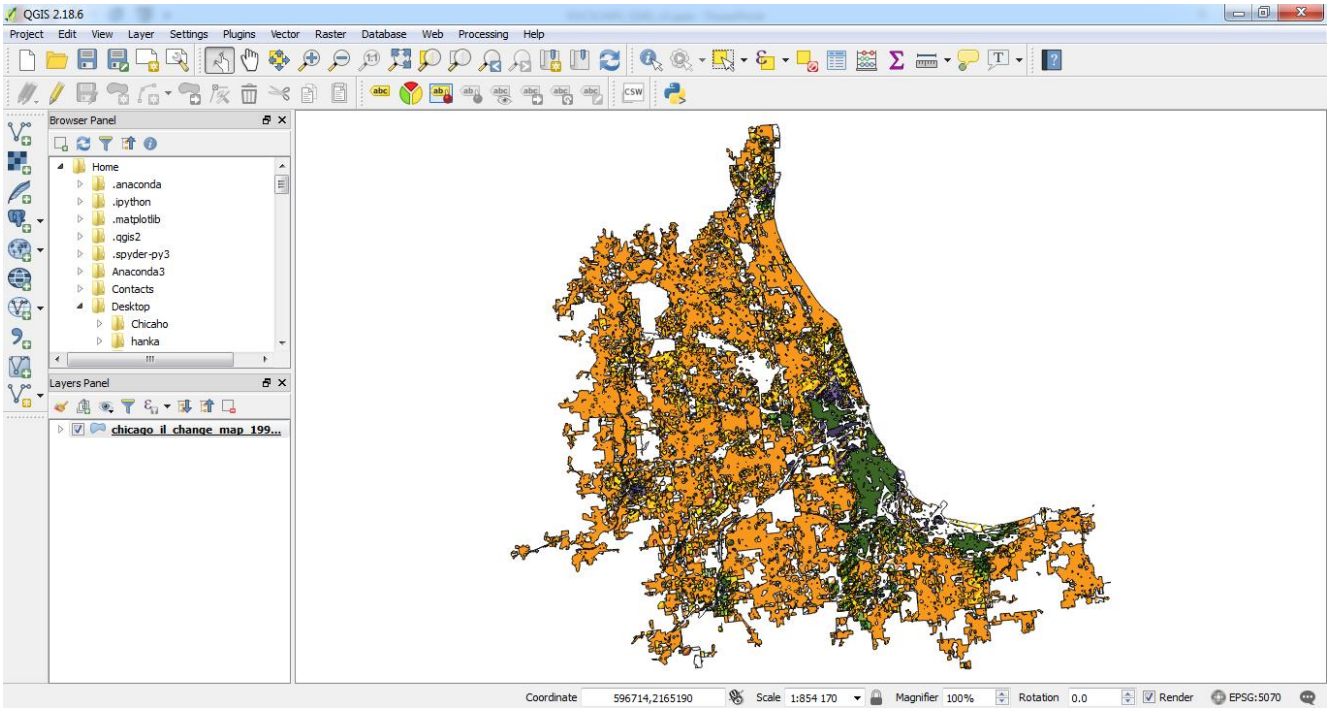


Fig.25. Change map 1990-2000 for Chicago, IL

9. Working with change maps in QGIS

Navigate to area of interests

Using pan and zooming icon choose area of interests.

Pan a map

Zoom in/Zoom out

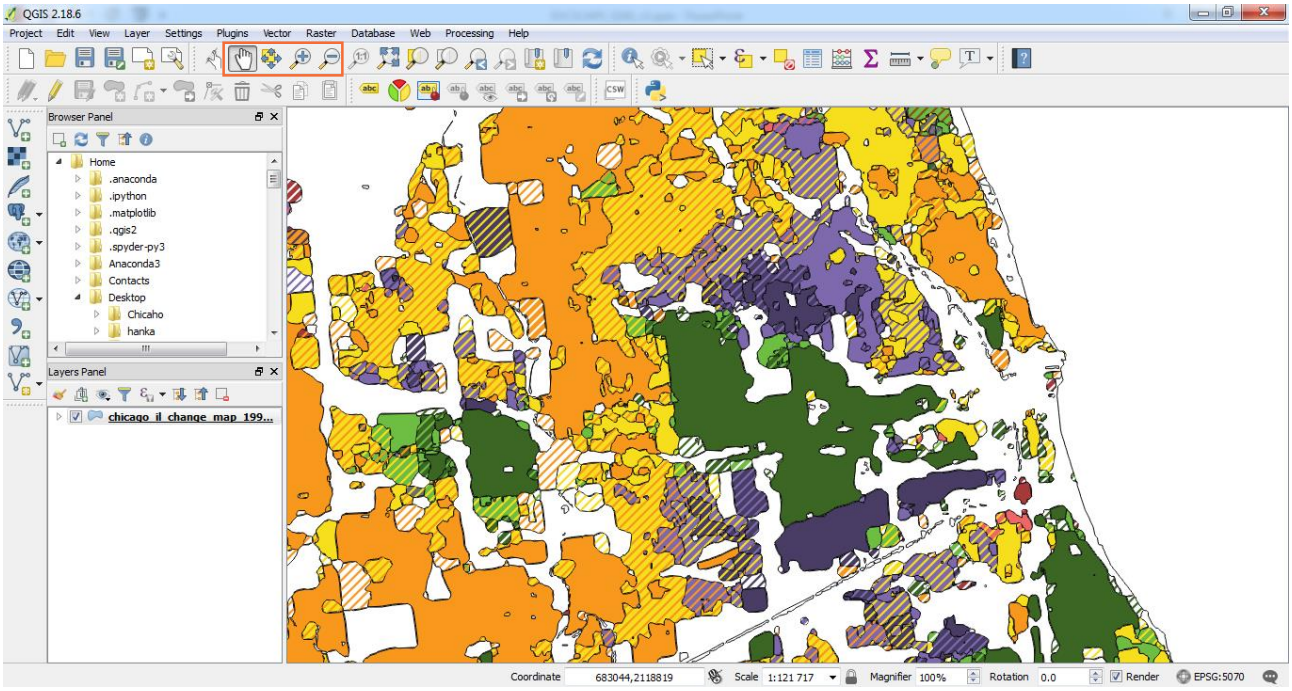


Fig.26. Change map 1990-2000 for the part of Chicago, IL

Save map as image

Map displayed in Map window in QGIS can be saved as image (PNG, JPG) using ***Projects – Save as image*** from main menu.

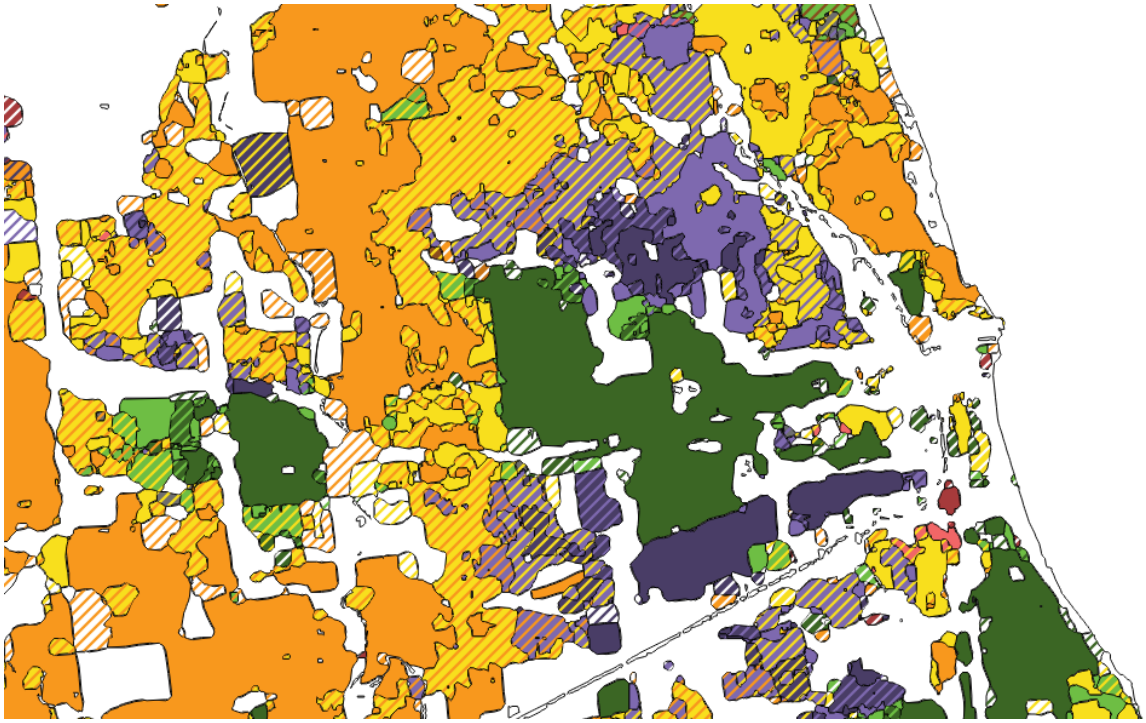


Fig.27. Change map 1990-2000 for the part of Chicago, IL

10. Compose map using Print Composer tool

Print Composer provides layout to create nice maps that can be printed or saved as PDF-file, an image (i.e PNG) or an SVG-file. It allows you to add elements such as the QGIS map canvas, text labels, images, legends, scale bars and more.

Before you start to work with the Print Composer, first raster or vector layers need to be loaded to QGIS and appropriate styl need to be set. After everything is symbolized to your liking, choose ***Project – New Print Composer*** from main menu to launch Print Composer.

You will be prompted to choose a title for the new Composer.

More information about using Print Composer is in QGIS documentation.
http://docs.qgis.org/2.18/en/docs/user_manual/print_composer/index.html

Please read for more details:
http://docs.qgis.org/2.18/en/docs/user_manual/print_composer/overview_composer.html

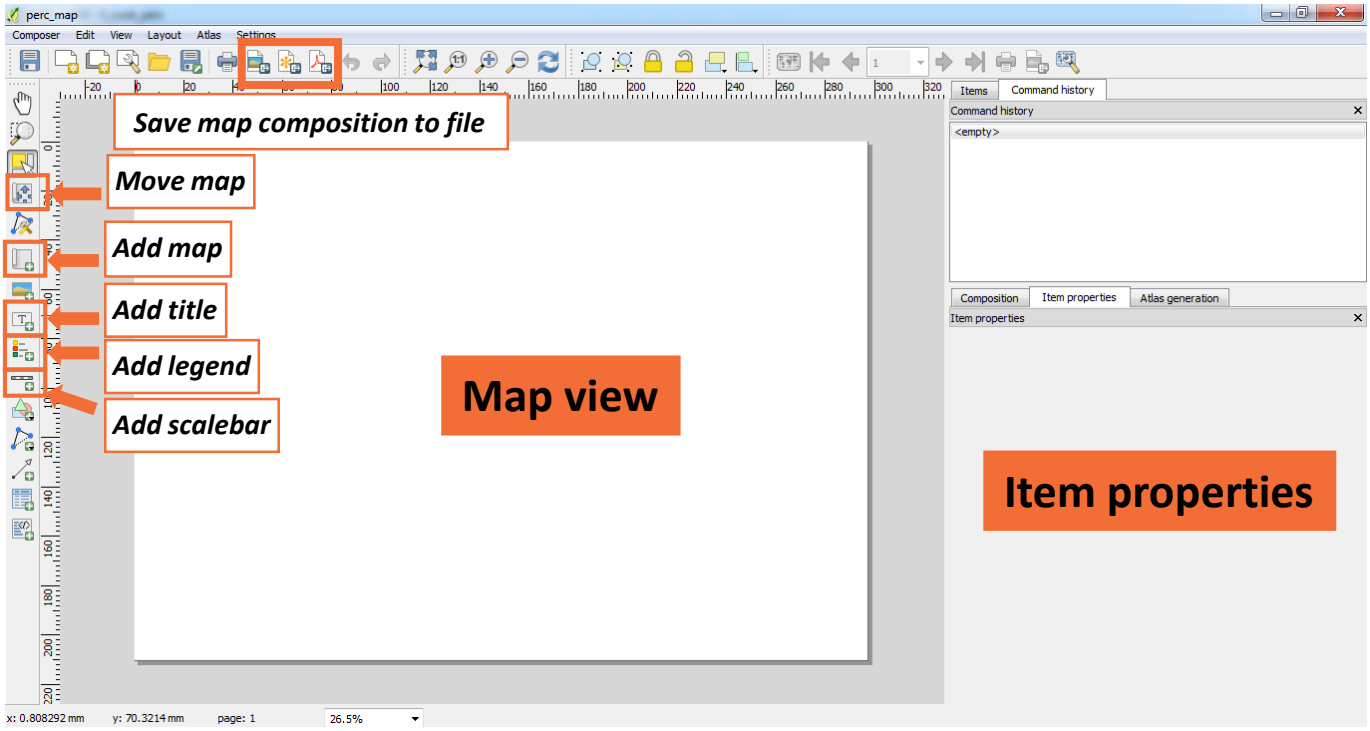


Fig.28. Print Composer in QGIS

10. Compose map using Print Composer tool

Example of using Print Composer will be presented based on percentage map of Hispanic (calculated in the 8. section of this tutorial)

- Load percentage map to QGIS
- Set appropriate colors for percentage map.
- Choose ***Project – New Print Composer*** from main menu to launch Print Composer.
- You will be prompted to choose a title for the new Composer.
- Type ***perc_map*** as a title

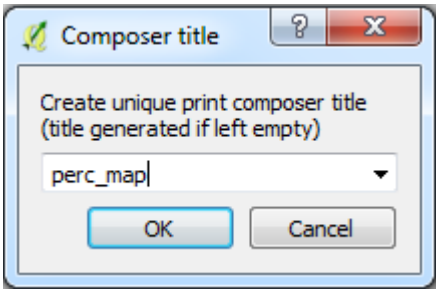


Fig.29. Type composer name

Add new map to Print Composer

On the left side, select the  toolbar button and draw a rectangle on the canvas holding down the left mouse button. Inside the drawn rectangle the QGIS map view to the canvas.

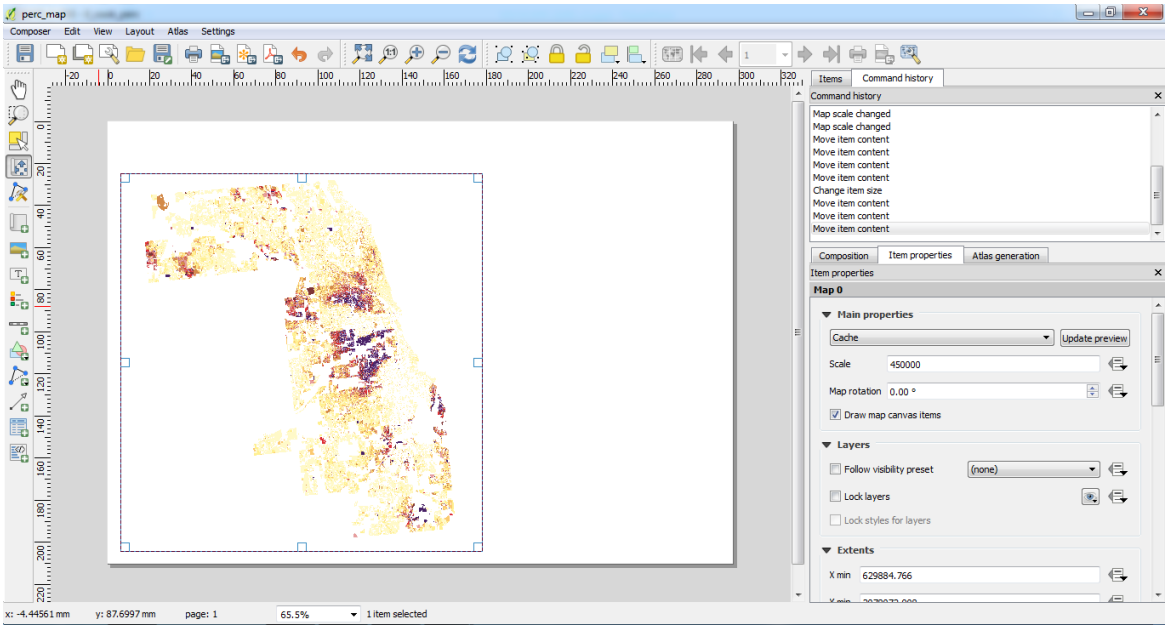


Fig.30. Add layer to Print Composer

10. Compose map using Print Composer tool

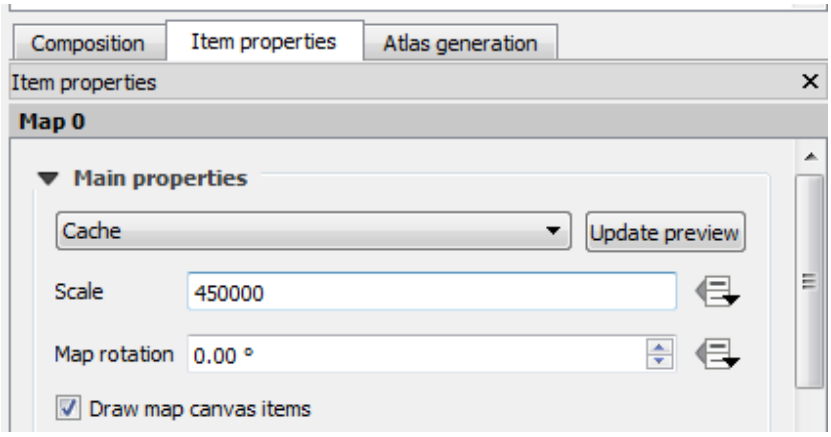


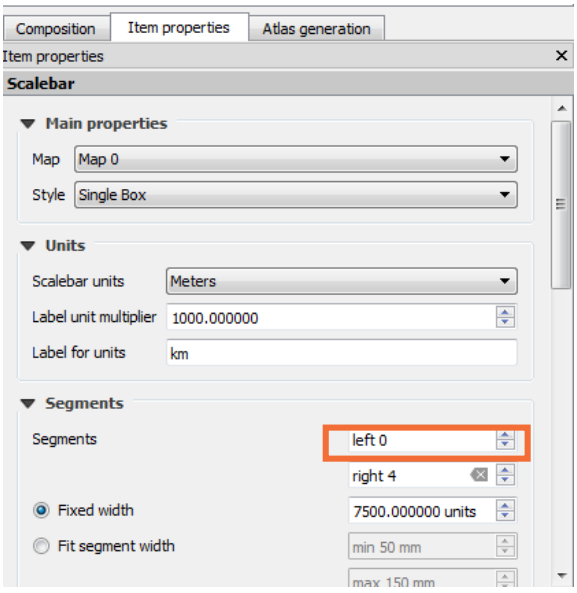
Fig.31. Set scale for map added to Print Composer

Add scale bar

Select the toolbar button and click with the left mouse button on the Print Composer canvas. A scale bar will be added to the canvas.

Add map title

Select the toolbar button and click with the left mouse button on the Print Composer canvas. A title will be added to the canvas.



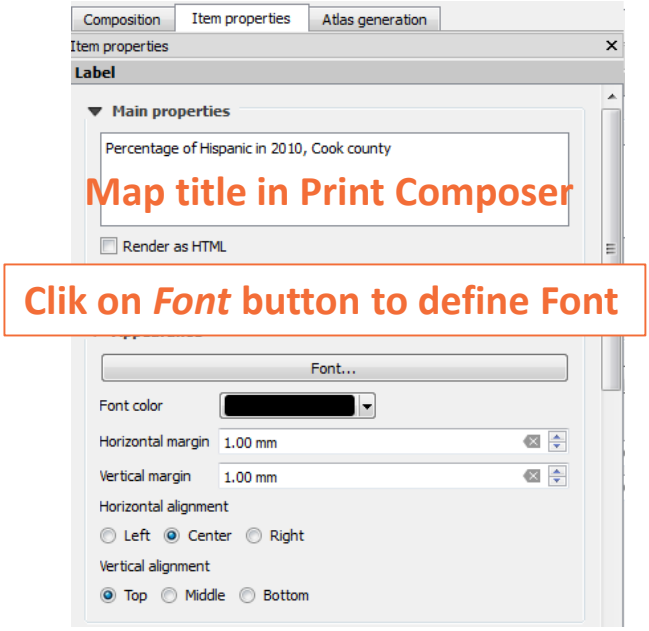


Fig.32. Item properties: Scale bar and title

10. Compose map using Print Composer tool

Add legend

Select the  toolbar button and click with the left mouse button on the Print Composer canvas. A legend will be added to the canvas. Default are added legend for all layers which are loaded to QGIS

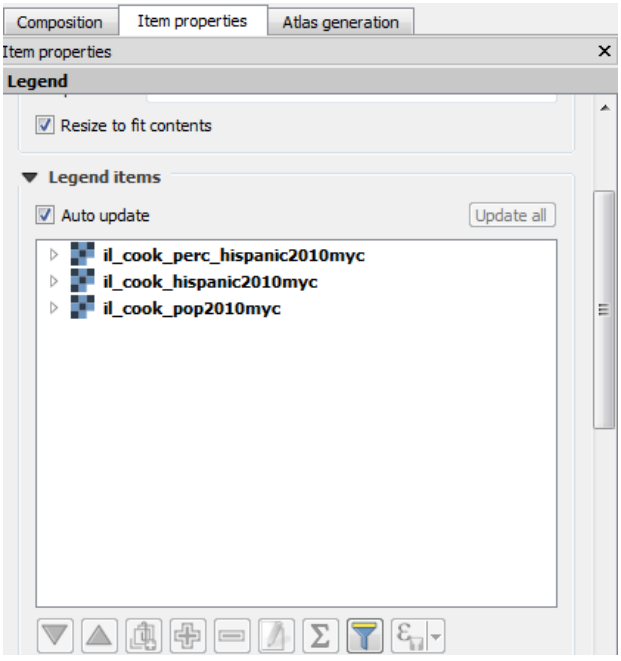


Fig.33. Legend properties dialog in Print Composer

Uncheck ***Auto update*** option in Item properties for Legend.

Using  icon (in item properties window for Legend) remove il_cook_hispanic2010myc and il_cook_pop2010myc layer.

Using  icon (in item properties window for Legend) type new name for layer (This name will be displayed in Legend)

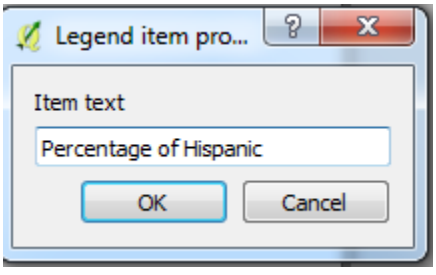


Fig.34. New layer name to be displayed in Legend

10. Compose map using Print Composer tool

Save map to file

Choose one of those icon  and save map to file.

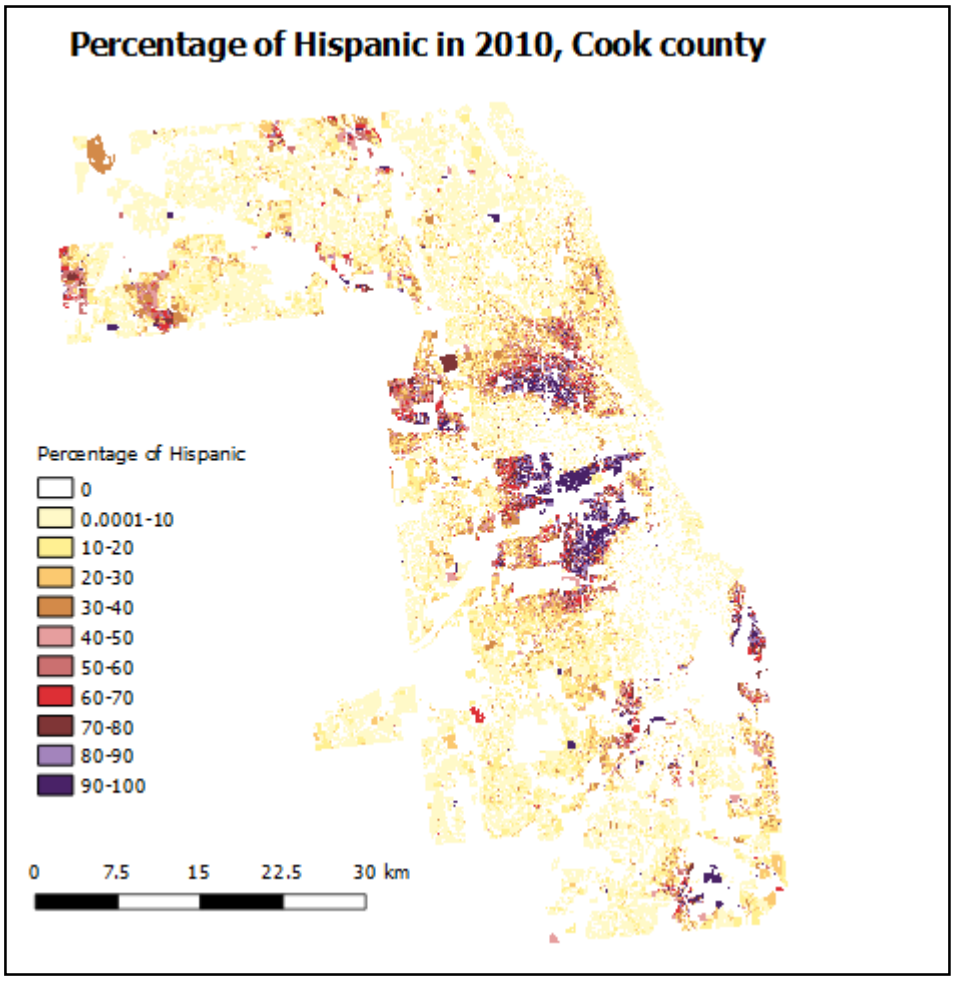


Fig.35. Map of percentage of Hispanic in 2010, Cook county, IL

Plugins

Plugins provide many new features and functions to QGIS. One of example is OpenLayers Plugin, which provides Google, Bing and Open Street map to be displayed in QGIS.

Plugins are available in ***Manage and install plugins from Plugins menu.***

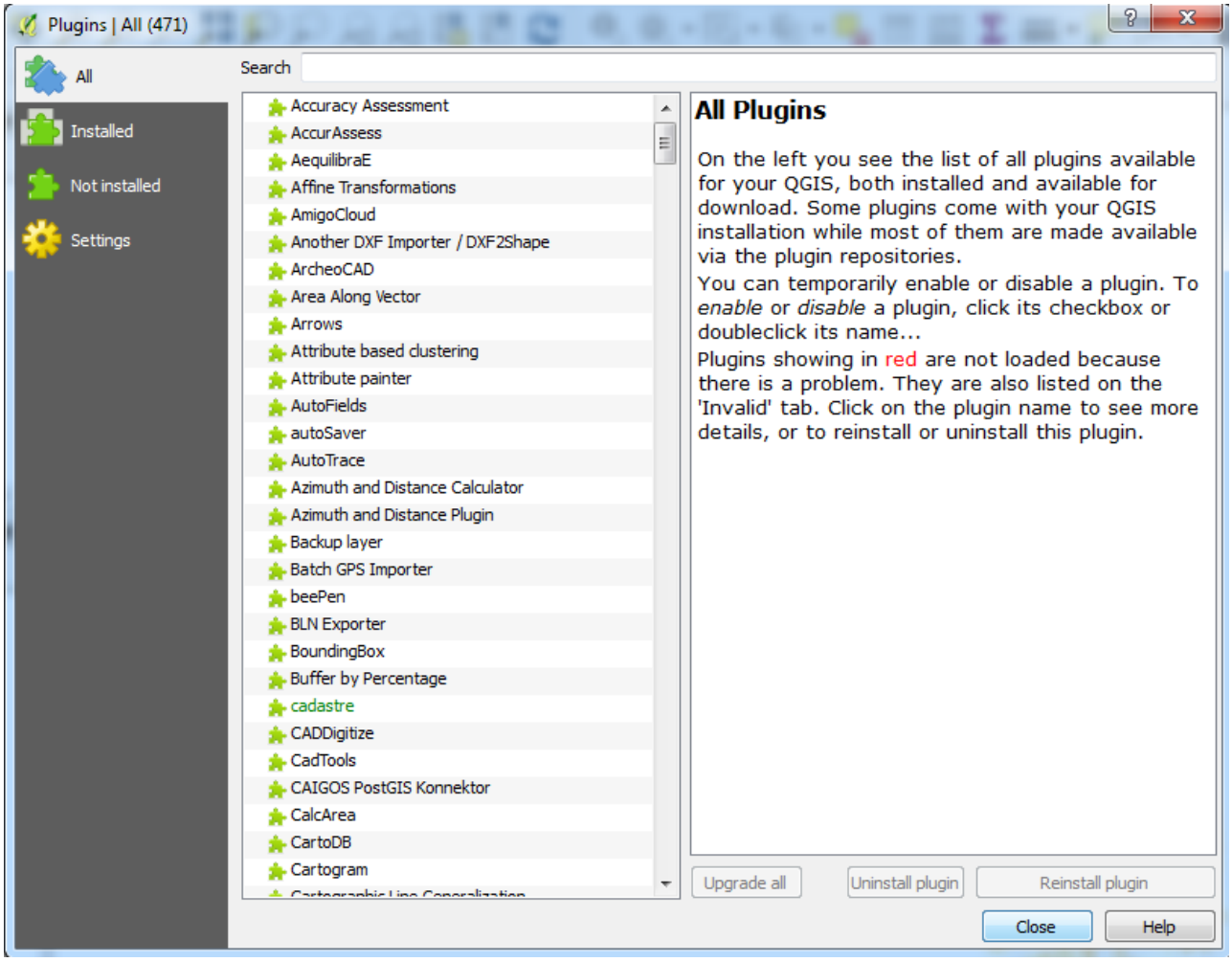


Fig.36. The All menu (Plugins dialog)

Install OpenLayers Plugin

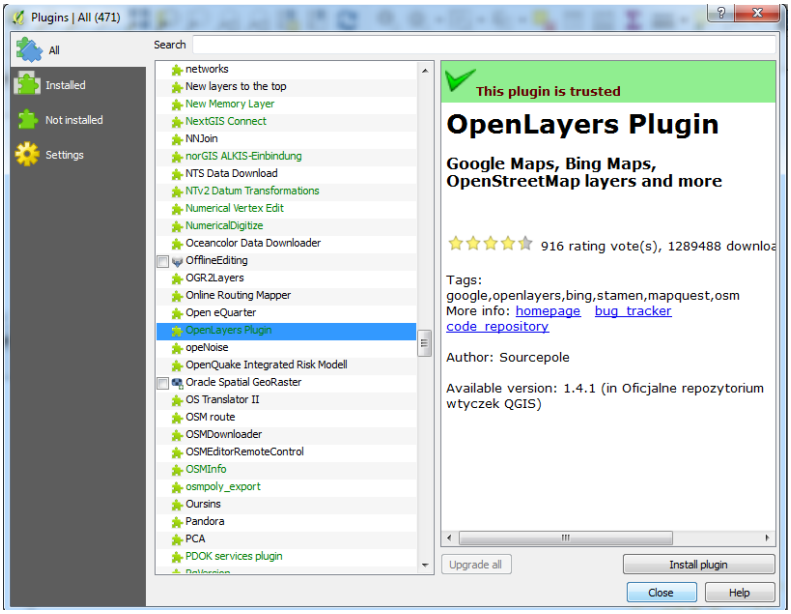


Fig.37. Installation of OpenLayers Plugin.

- Select ***All*** in Plugin menu and choose **OpenLayers Plugin** from the available list.
- OpenLayers Plugin will be highlighted, then click on Install Plugin button on the bottom right part of the dialog window.
- OpenLayer Plugin will be installed.

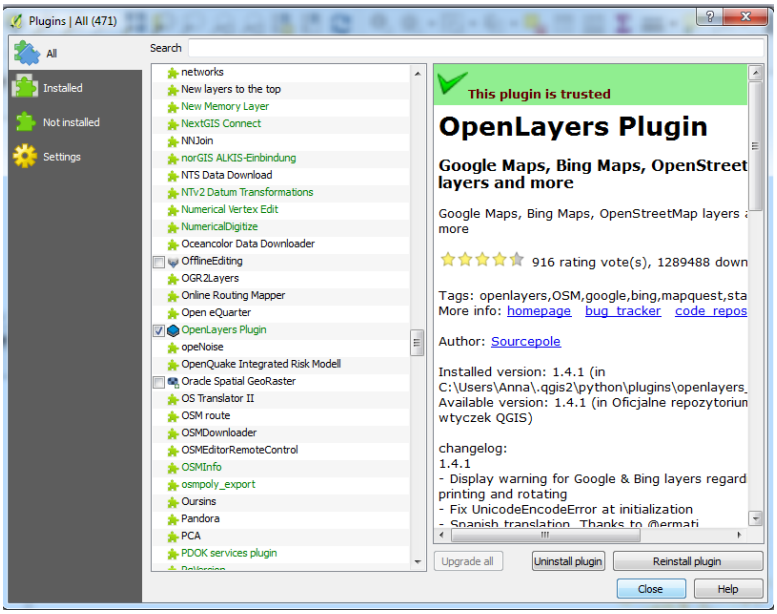


Fig.38. Installation of OpenLayers Plugin.

- Check OpenLayer Plugin to activate it.

11. Exploring demographic grids in QGIS

Working with OpenLayers Plugin

Choose ***Web – OpenLayers plugin*** menu and select one of the available basemap. There are available Bing Maps, Google Maps, OpenStreetMap and more. You can choose between ”Street ” map, ”Satelitte image ” map or ”Hybrid”.

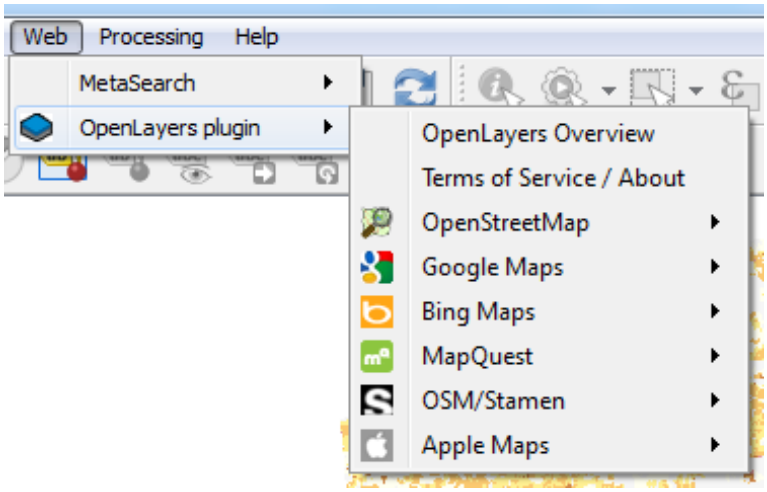


Fig.39. OpenLayers Plugin menu.

11. Exploring demographic grids in QGIS

Exploring racial diversity map in QGIS

- From main menu choose ***Layer – Add Layer – Add Raster Layer*** *or* choose the icon  in the left panel of QGIS window. Select ***il_cook_div2010myc.tif*** from ***il_cook/diversity*** directory and open it.
- Choose ***Web – OpenLayers plugin – Bing Maps – Bing Road***. Bing Road will be added to QGIS.

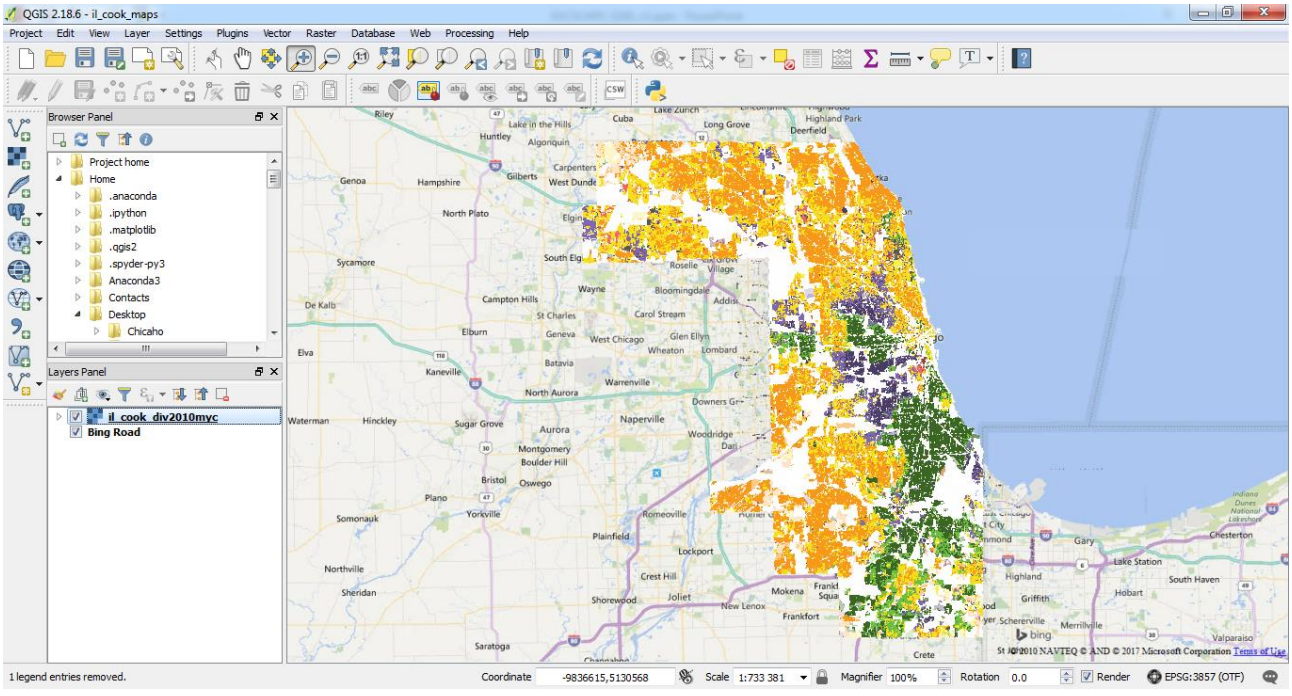


Fig.40. Bing road maps and racial diversity map in QGIS.

- Using pan  and zooming  icon choose area of interests.

11. Exploring demographic grids in QGIS

Exploring racial diversity map in QGIS

- Open Layer Properties window and go to Transparency (To open Layer Properties double click on the layer name in the map legend, or right click on the layer name and choose ***Properties*** from the context menu.
- Set Global transparency for about 50%.
- Click on OK.

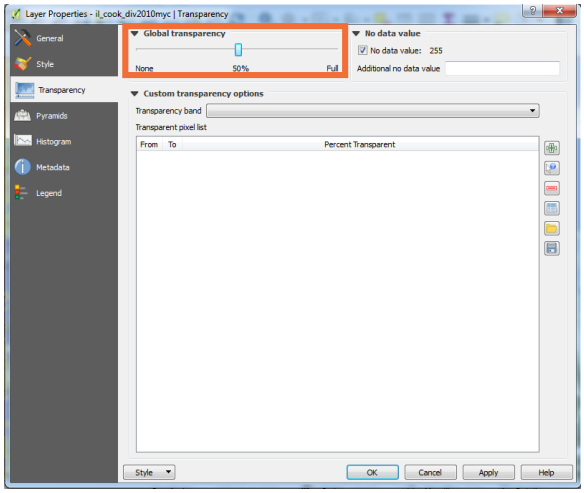


Fig.41. Transparency settings.

Transparency will be set for racial diversity map and the name of the streets will be seen.

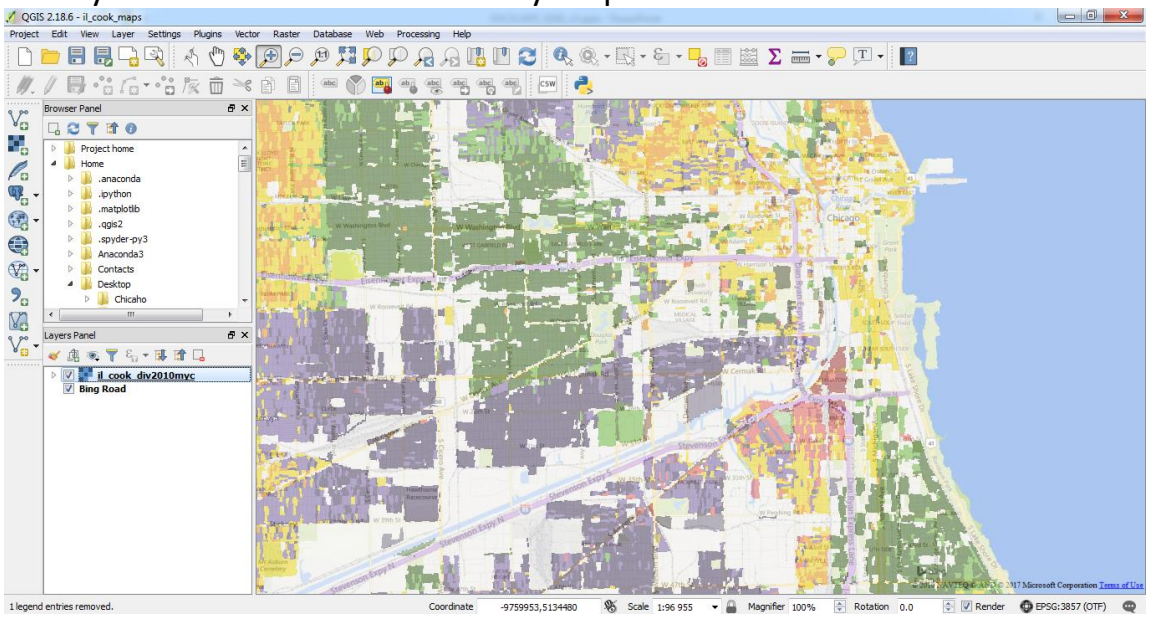


Fig.42. Racial diversity for the part of the Chicago overlat into Bing Road Map.