Workflows and tips for creating nice cartography with QGIS

by Karsten Vennemann

TERRA GIS
TERRESTRIAL ENVIRONMENT REGIONAL ANALYSIS

In this talk I will wrap 3 things together

- A cool travel adventure
- Notes on the inital process of starting/making a poster map
- Examples and tricks with QGIS cartography

It starts with an adventure...

Bicycle trip

Copabana, Bolivia to Mendoza Argentina

Geospatial Data

The story

Our travel adventure that lead to this poster map

2021 I asked my son Kai if he wanted to go on a bicycle trip in South America

Lake Titicaca, Bolivia to northern Argentina ?

Due to Corona / Covid restictions
our plans for the Fall of 2021 fell apart

...then in Spring 2022 the land borders
Bolivia – Argentina re-opened !

Start in Copacabana

middle of May 2022

Nice cartography with QGIS

De Copacabana, Bolivia a Mendoza, Argentina en Bicicleta

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Tiahuanaco

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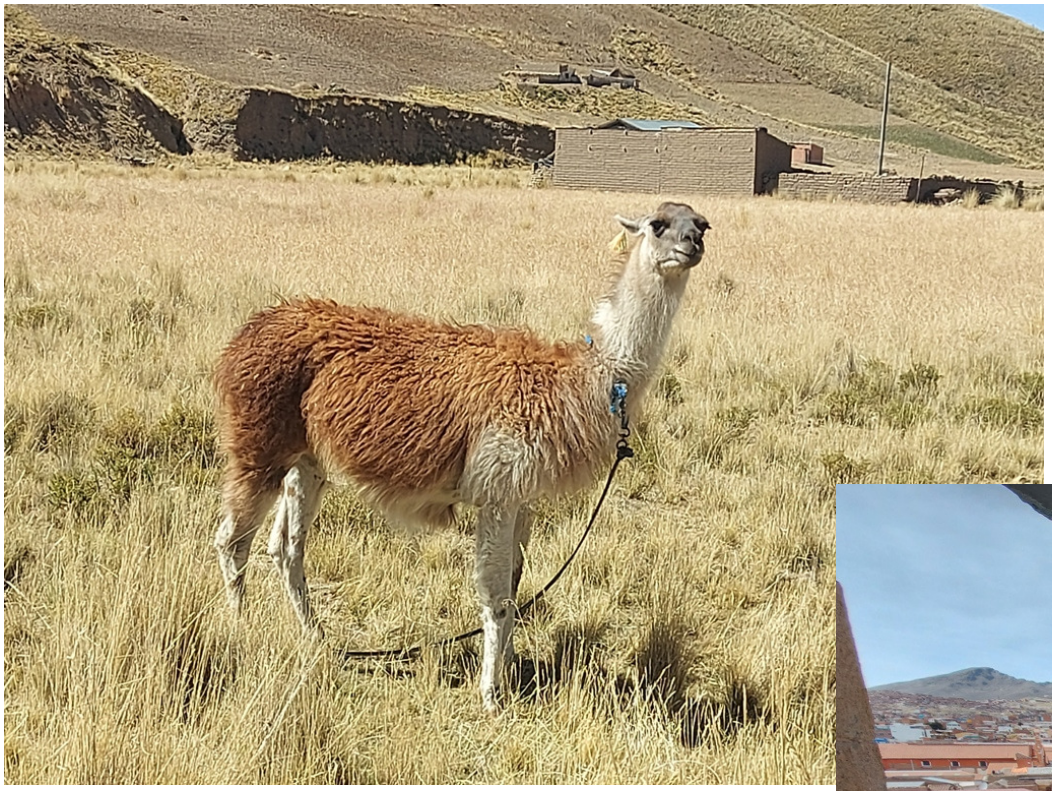
Saved by Argentinian Angels when my bike pedal fell off on the Bolivian Altiplano



Altiplano

Lama Land

Potosí

3894m

View of Cerro Rico

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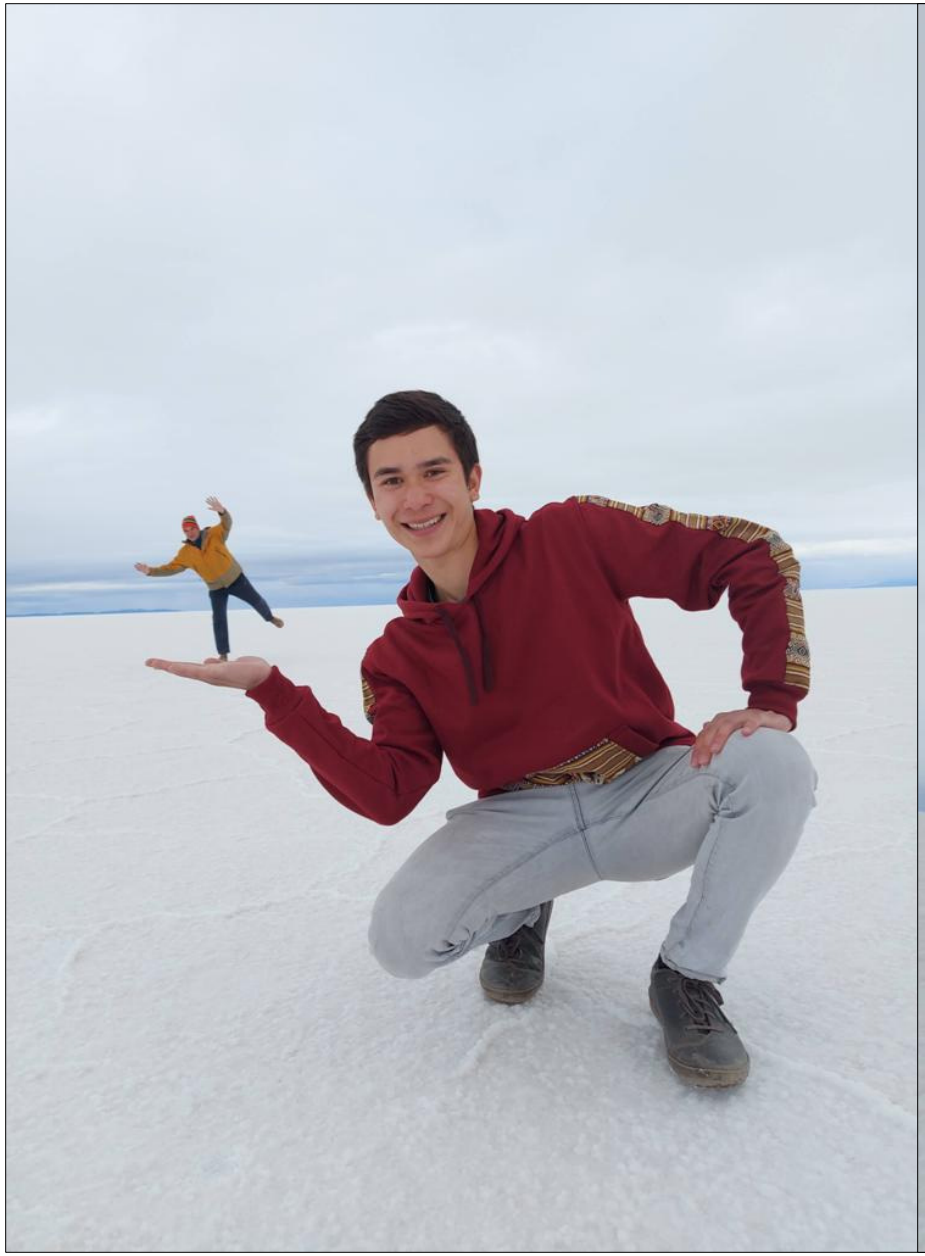
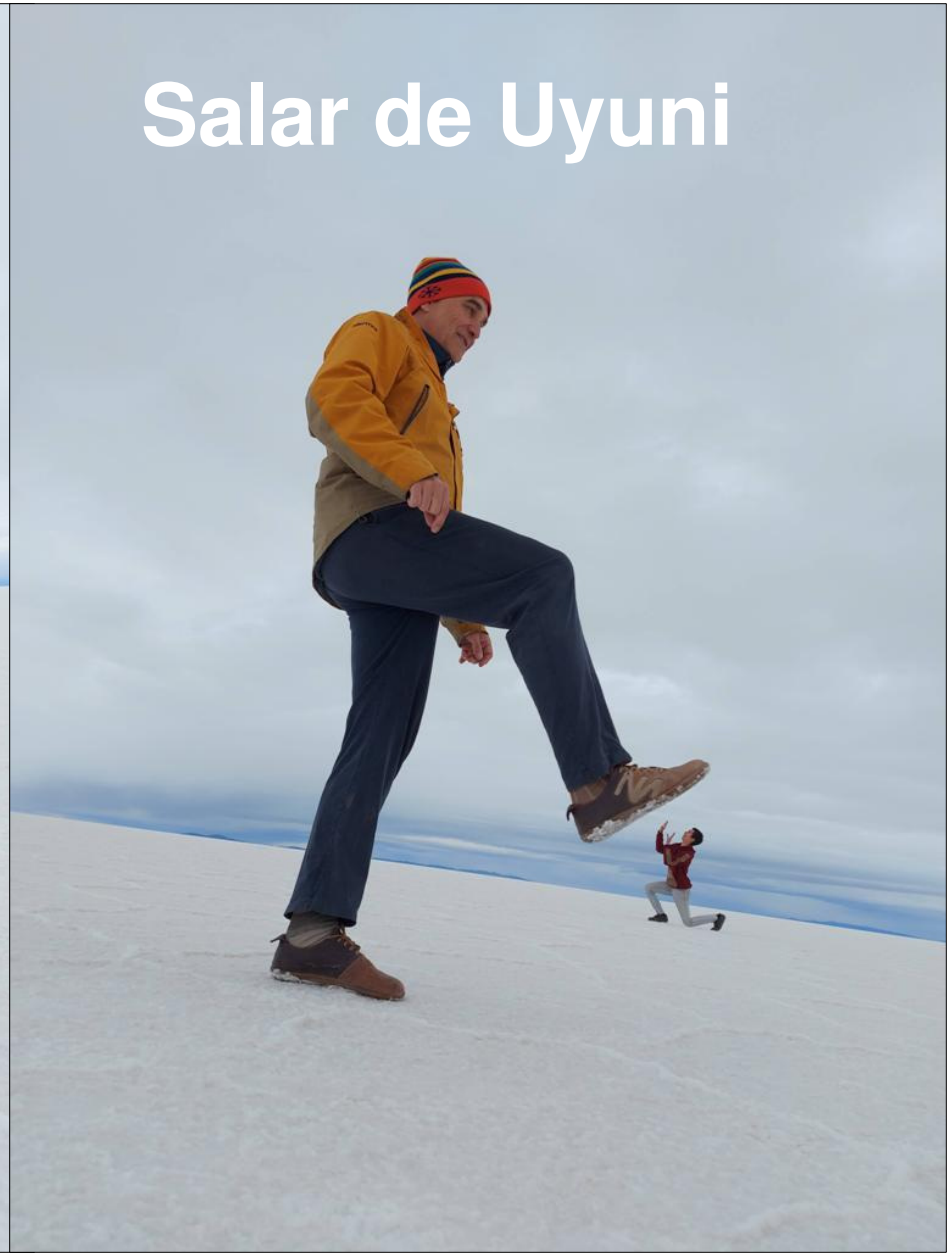
Minero Kai





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Tilcara
Argentina

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Mountain pass

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The Map with QGIS

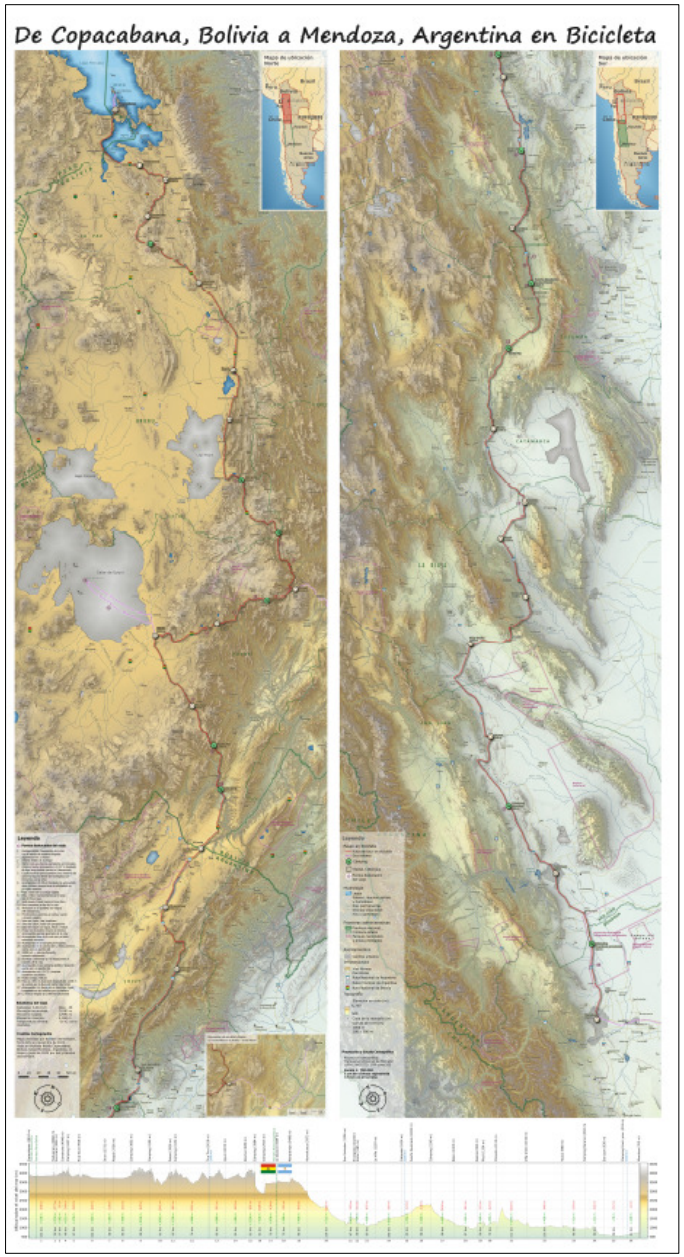
Print size 36 * 67 inches
300 dpi PDF or PNG ~ 250 MB
Scale 1 : 750,000
UTM Zone 20 S / WGS 72
Project directory on hard disk: 102 GB

Tour statistics

Cycling days	36
Coldest morning	-11 °C
Route length	3,061 km
Max. Elevation	4,630 m
Down accum.	22,993 m
Up accum.	20,383 m

Map Project & Cartography work stats

Start	October 2022
End	Nov 6 2025
Estimated work hours	350



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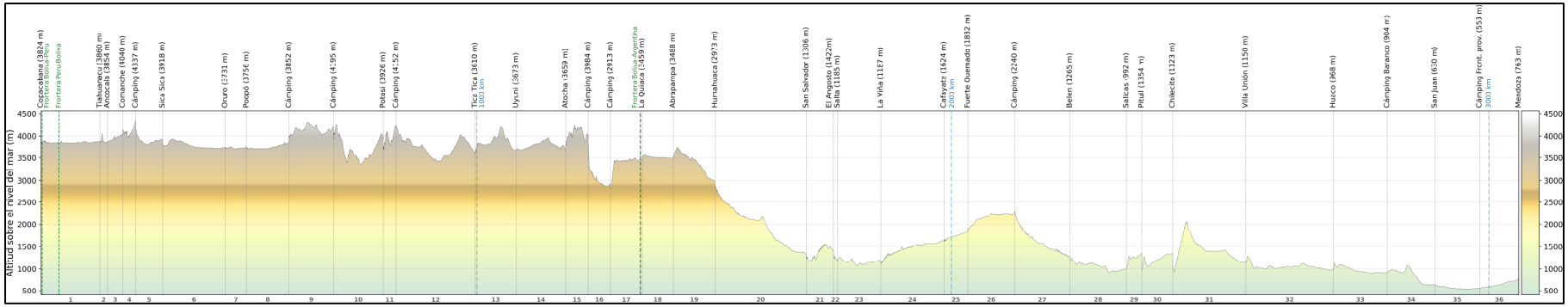
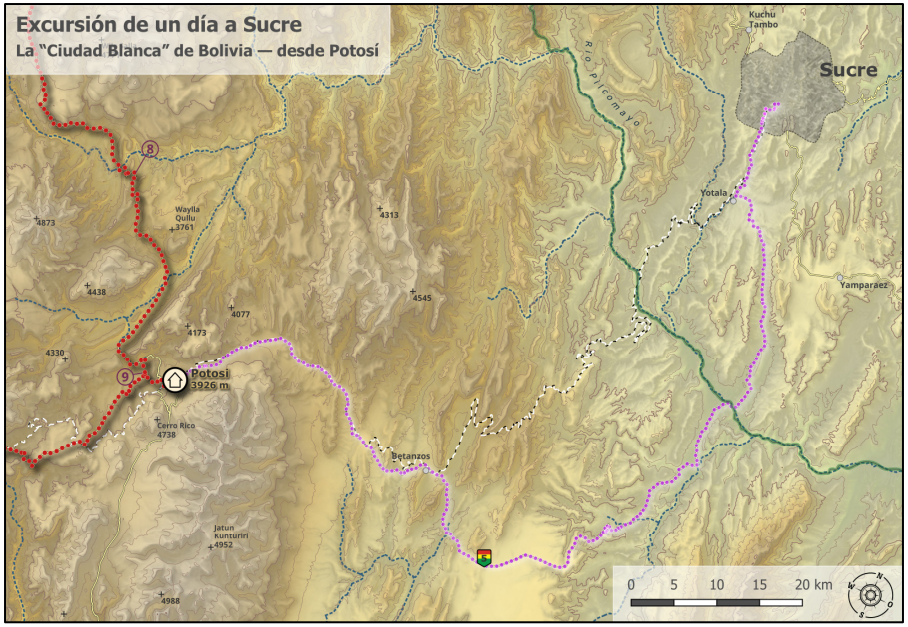
Route elevation Profile



Locator maps

Excursion to Sucre inset map



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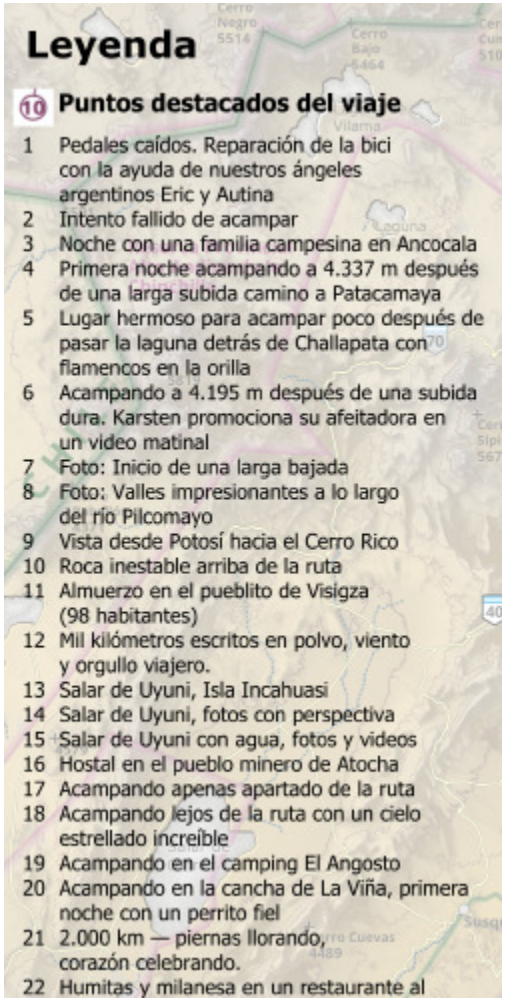
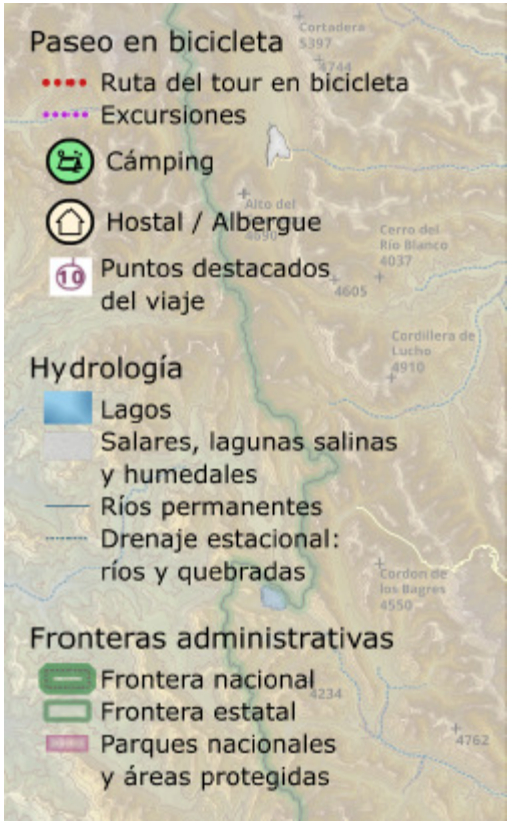
Legends


Leyenda
Puntos destacados del viaje
1 Pedales caídos. Reparación de la bici con la ayuda de nuestros ángeles argentinos Eric y Autina
2 Intento fallido de acampar
3 Noche con una familia campesina en Ancocala
4 Primera noche acampando a 4.337 m después de una larga subida camino a Patacamaya
5 Lugar hermoso para acampar poco después de pasar la laguna detrás de Challapata con flamencos en la orilla
6 Acampando a 4.195 m después de una subida dura. Karsten promociona su afeitadora en un video matinal
7 Foto: Inicio de una larga bajada
8 Foto: Valles impresionantes a lo largo del río Pilcomayo
9 Vista desde Potosí hacia el Cerro Rico
10 Roca inestable arriba de la ruta
11 Almuerzo en el pueblito de Visigza (98 habitantes)
12 Mil kilómetros escritos en polvo, viento y orgullo viajero.
13 Salar de Uyuni, Isla Incahuasi
14 Salar de Uyuni, fotos con perspectiva
15 Salar de Uyuni con agua, fotos y videos
16 Hostal en el pueblo minero de Atocha
17 Acampando apenas apartado de la ruta
18 Acampando lejos de la ruta con un cielo estrellado increíble
19 Acampando en el camping El Angosto
20 Acampando en la cancha de La Viña, primera noche con un perrito fiel
21 2.000 km — piernas llorando, corazón celebrando.
22 Humitas y milanesa en un restaurante al


Paseo en bicicleta
Ruta del tour en bicicleta
Excursiones
Cámping
Hostal / Albergue
Puntos destacados del viaje
Hydrología
Lagos
Salares, lagunas salinas y humedales
Ríos permanentes
Drenaje estacional: ríos y quebradas
Fronteras administrativas
Frontera nacional
Frontera estatal
Parques nacionales y áreas protegidas


Asentamientos
Centros urbanos
Infrastructura
Vías férreas
Carreteras
Ruta Nacional de Argentina
Ruta Provincal de Argentina
Ruta Nacional de Bolivia
Topografía
Elevación en color (m)
6,700
500
Cima de la montaña (m)
Curvas de nivel (m)
1000 m
200 o 500 m

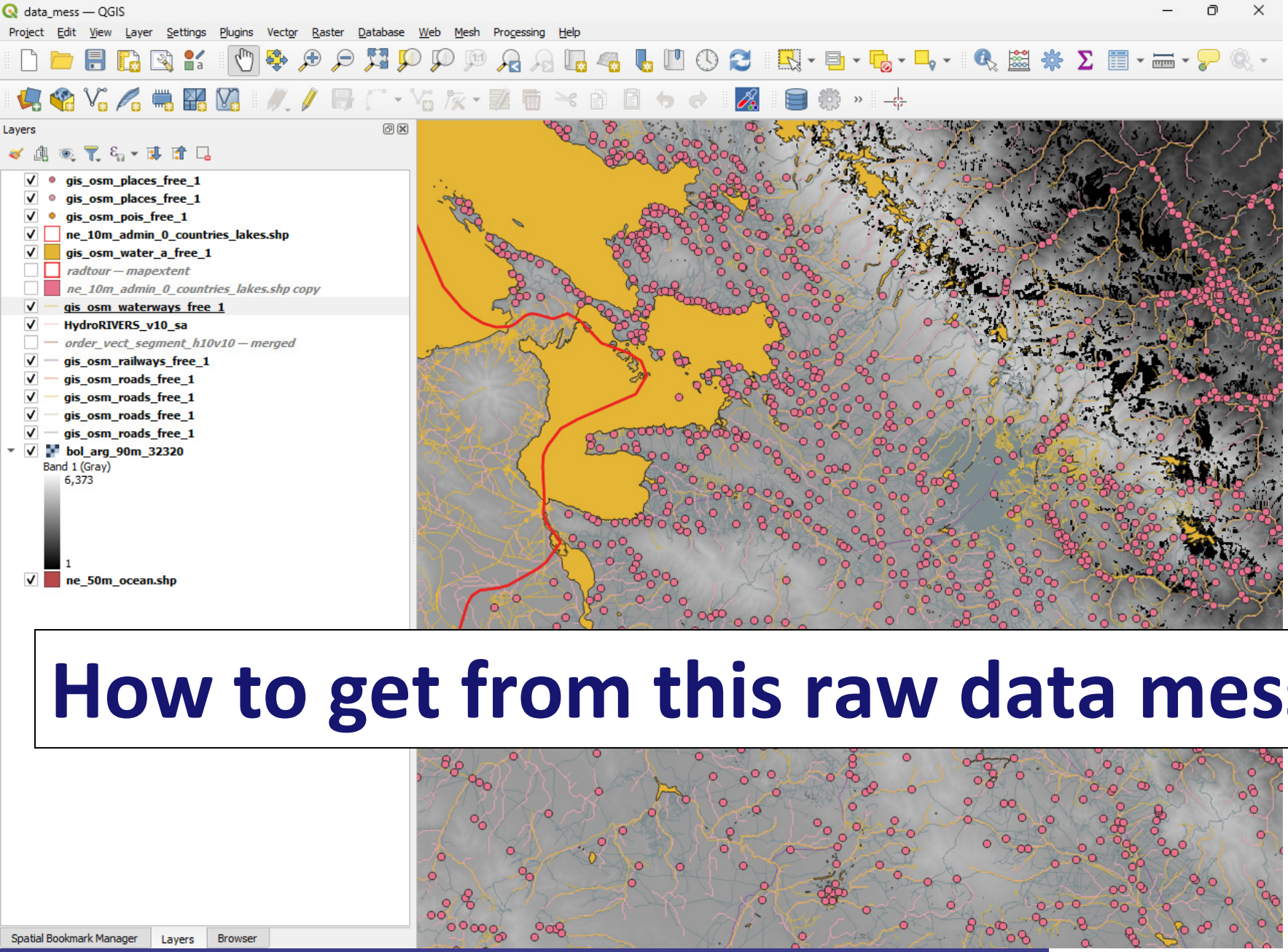
Project Planning

From idea to map

- Size, detail -> scale and extent ?
- Data selection, aquisition/collection and processing
- Data suitablity / issues
  e.g. gaps in DEM, detail of rivers, missing river order,
  different attribute data among countries (road order)...

How to decide - thoughts

- Settle on scale - detailed enough to show detail of topography
- Still printable poster size (max. width 36 inch)
- After digitizing route, decision to use 2 „colum layout“ N and S parts (due to route length N-S orientation)
  Still rotation from N needed to fit the route



How to get from this raw data mess

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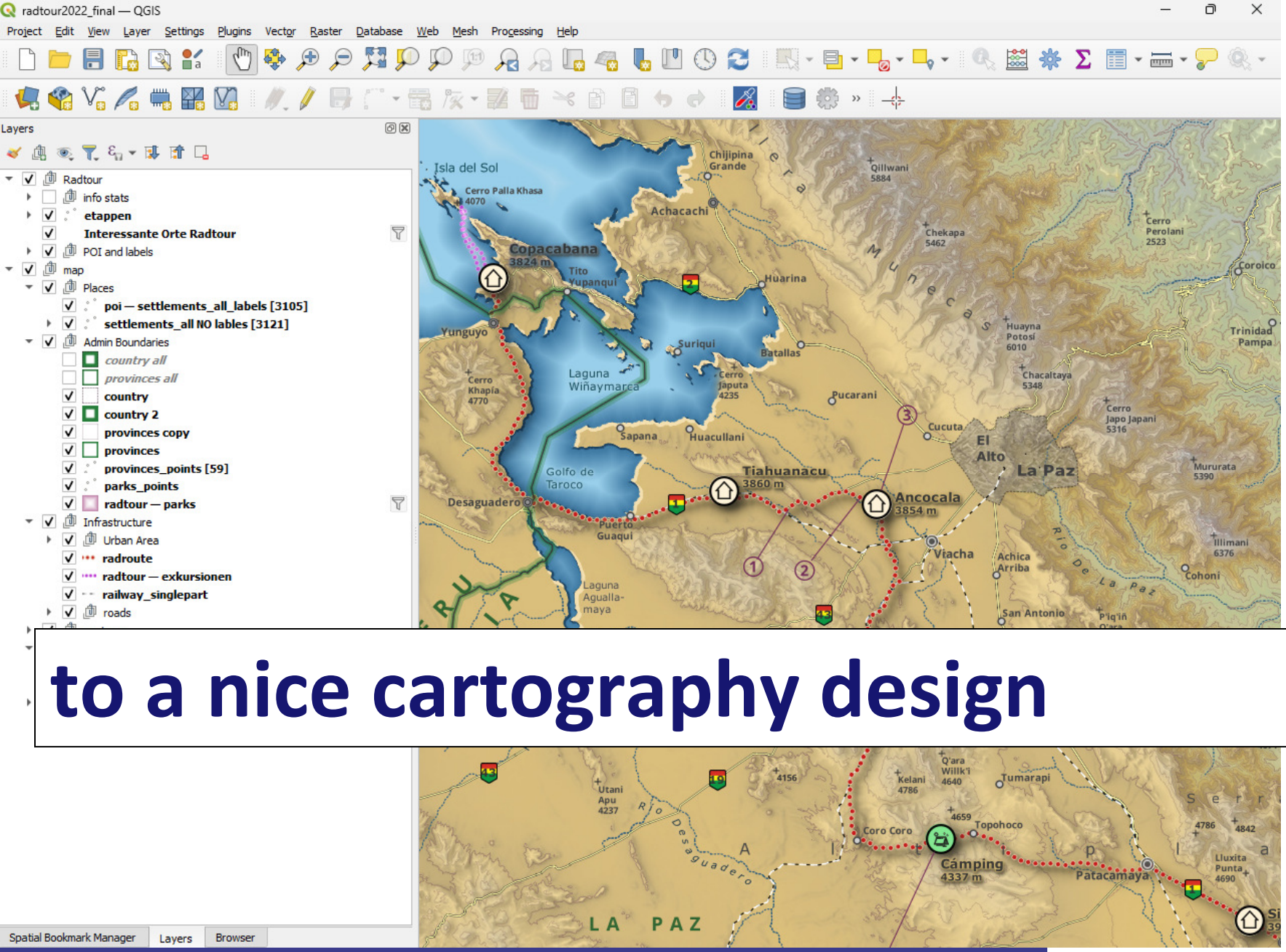

to a nice cartography design

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Data selection / collection

- OpenStreetMap data: rivers, lakes, streets, places (mountain peaks, settlements, urban areas, poi)
- Hydrology (OSM) but later used other sources for rivers
- GADM admin. borders
- DEM Aster satellite 30m -> 90 m
- World protected areas database

- Self-collected data – digitized route and stage lengths Converted route to points, every 90 m sampled elevation (generated statictics and route profile)

The Good, the Bad and the Ugly

The Bad

Initially collected enormous heaps of data that I later deemded useless
e.g. huge downloads of Baythymetry data (later outside map extent)

Several river network data with missing river order levels or wrong resolution - too detailed or too rough

Roads with inconsistent road order between countries
(Peru, Bolivia, Argentina)

The Ugly – Fails

Neded to place all labels 3 times due to software issues
(related to rotation of map and rendering in layout view)

Using data driven label placement in QGIS fixed the labeling issue

Cartography - Labels

Extensive use of data driven label placement
Combined with rule based symbolization

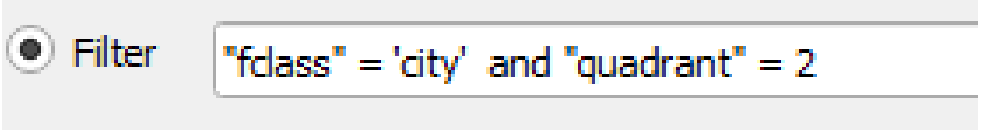
Mountain peaks

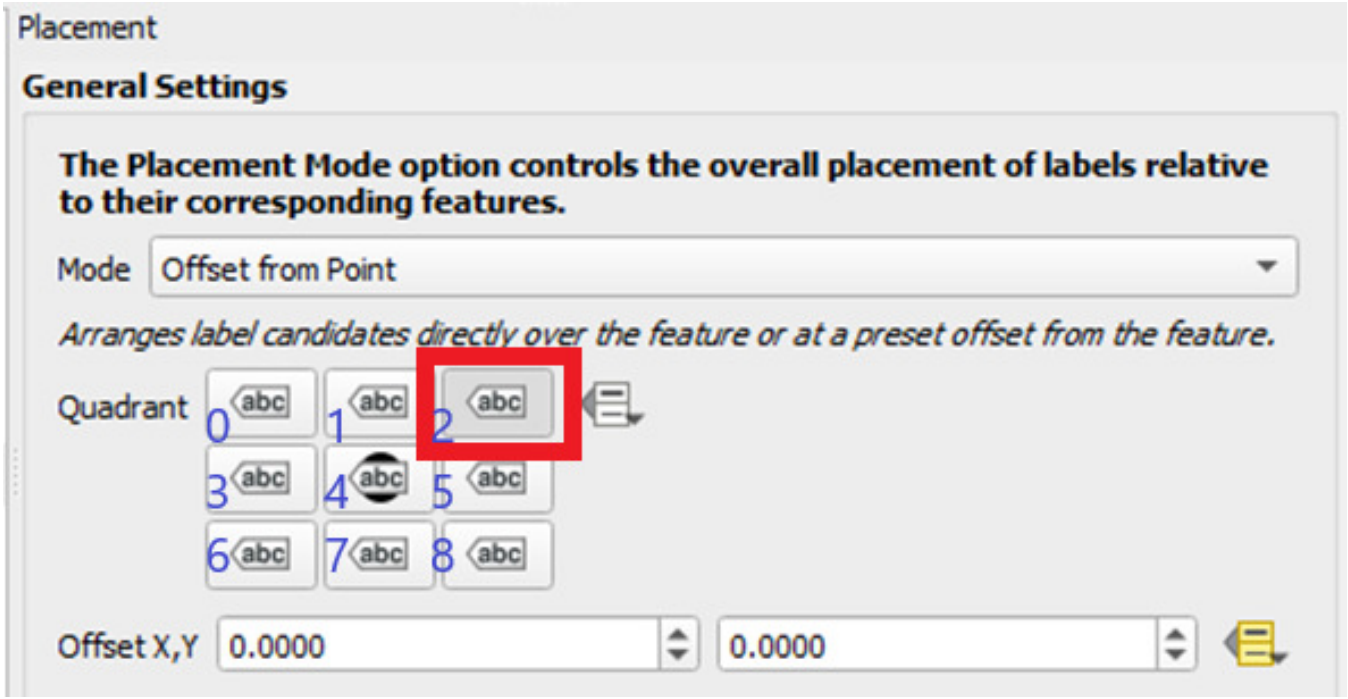
- added 2 integer fields show and showname
- added 1/0 values to show/not show for each
- show = 1 draws elevation in m
- showname = 1 draws mountain name

Cartography

Settlements

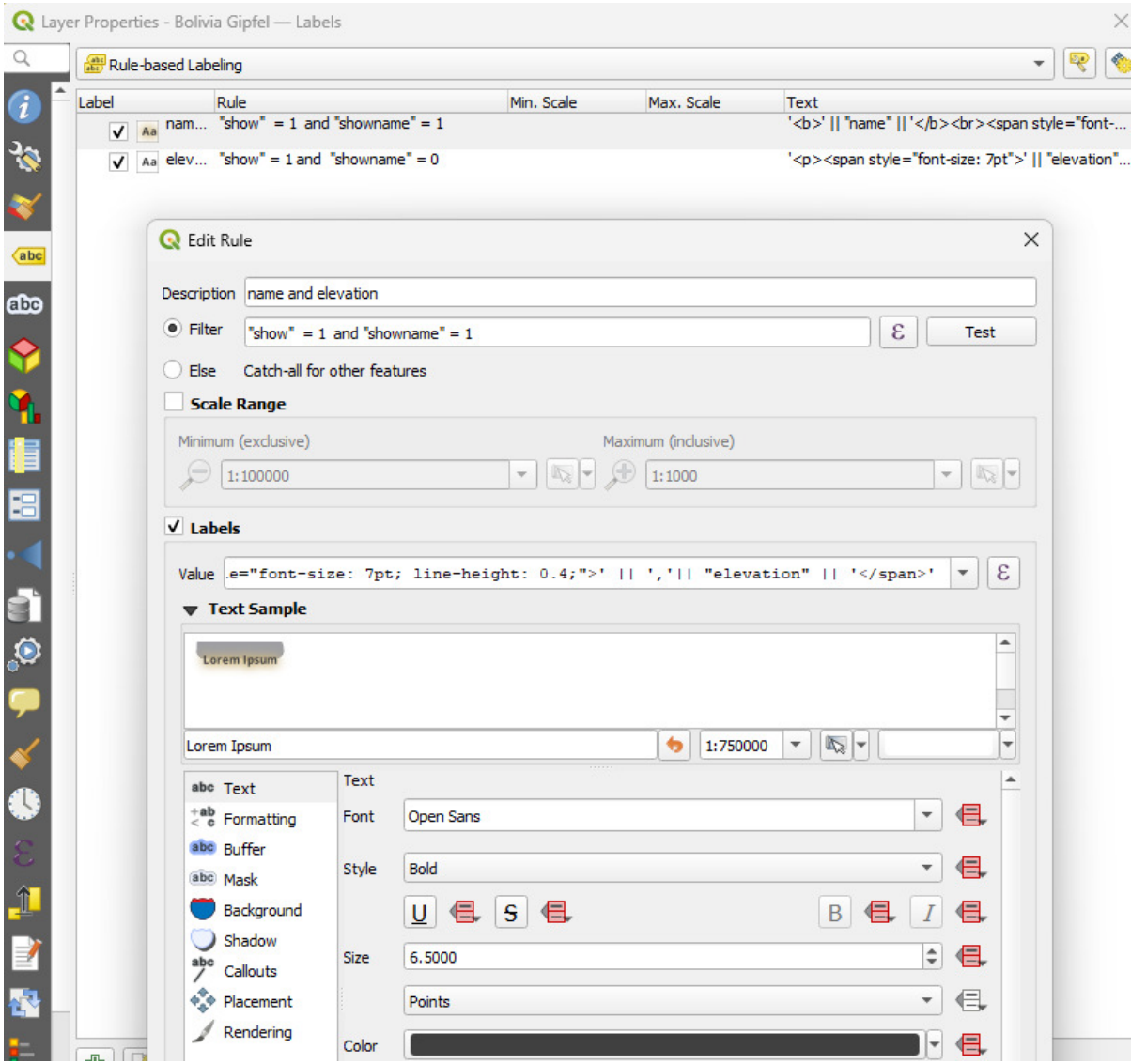
Label placement based on quadrant from column





Cartography - Settlements

Rule based, data driven labels

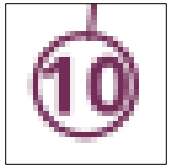


Cartography – Custom Icons

Argentinan Highways, like the famous Routa 40

Argentinan Provincial Roads

Created Bolivian one using Bolivian Flag

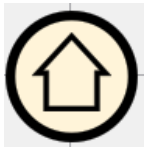


Our very on special *Points of Interests* on our travel route, like *1000 km*

point layer with callout label

Cycle Route

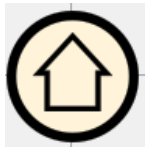
Camping / Tent



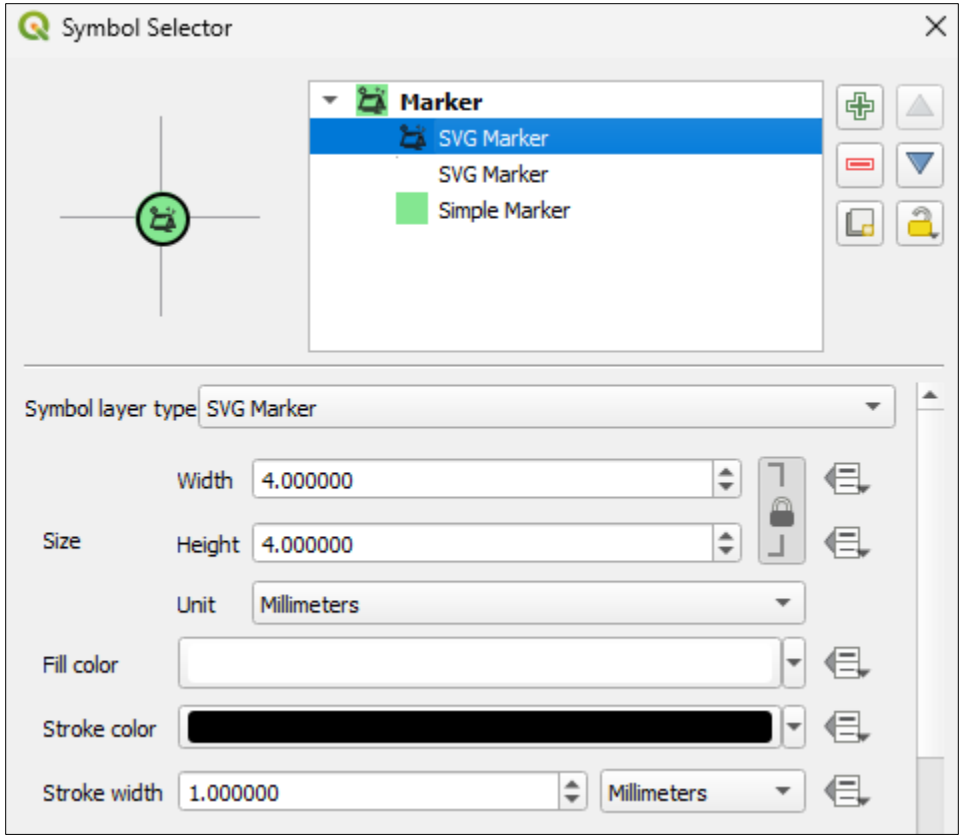
Hostal/ Albergue

Cartography

Camping / Tent



Hostal/ Alotamiento

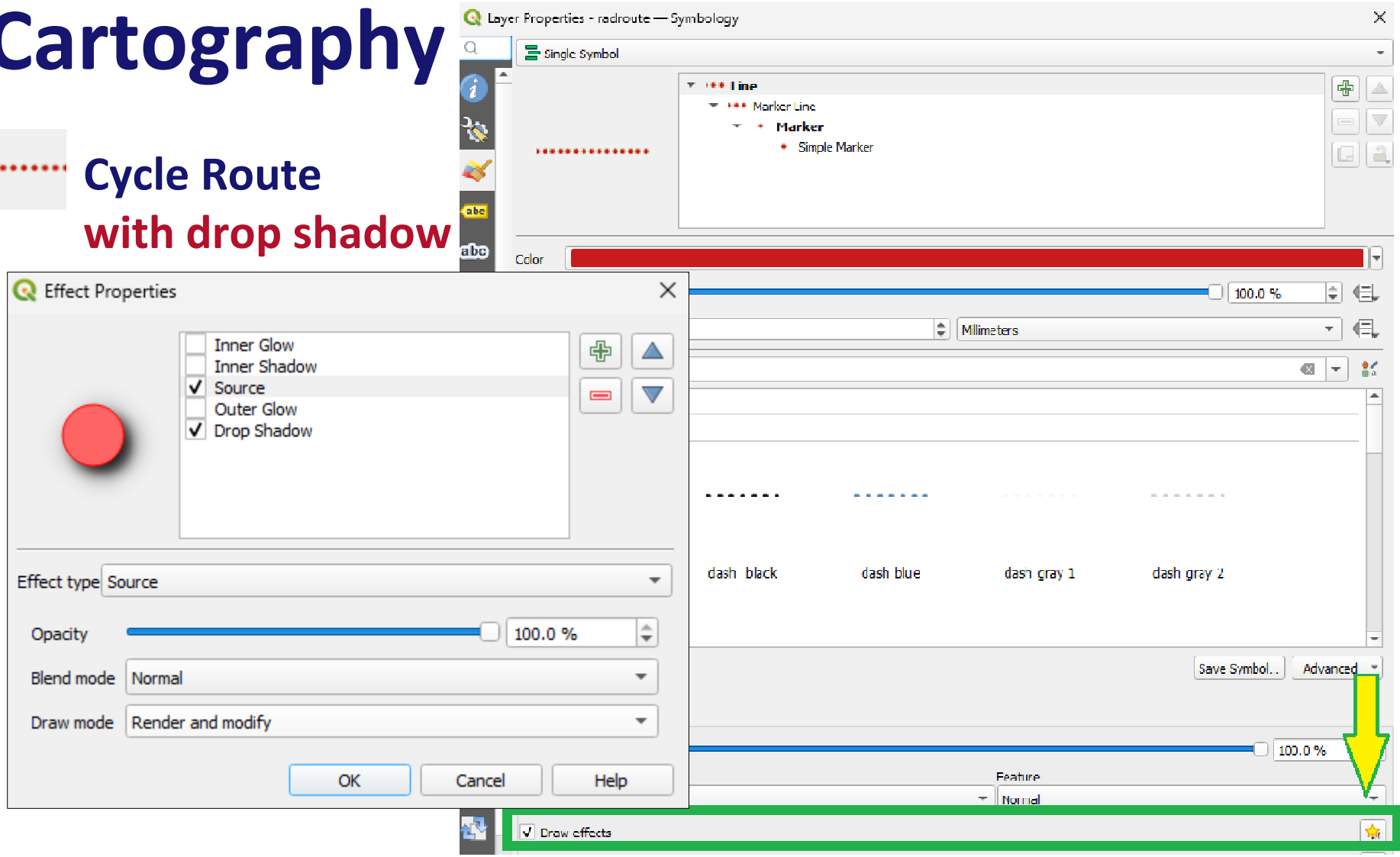


3 icons stacked

- svg tent image
- svg circle image
- green fill

Cartography

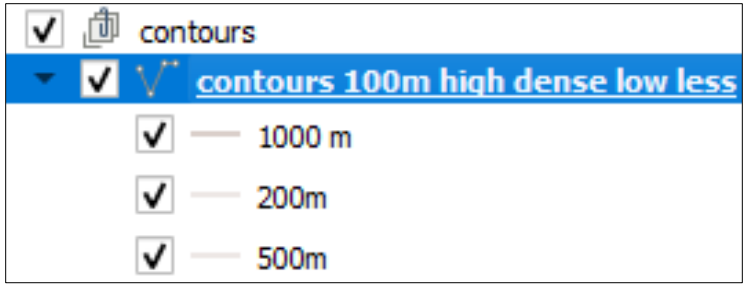
Cycle Route
with drop shadow



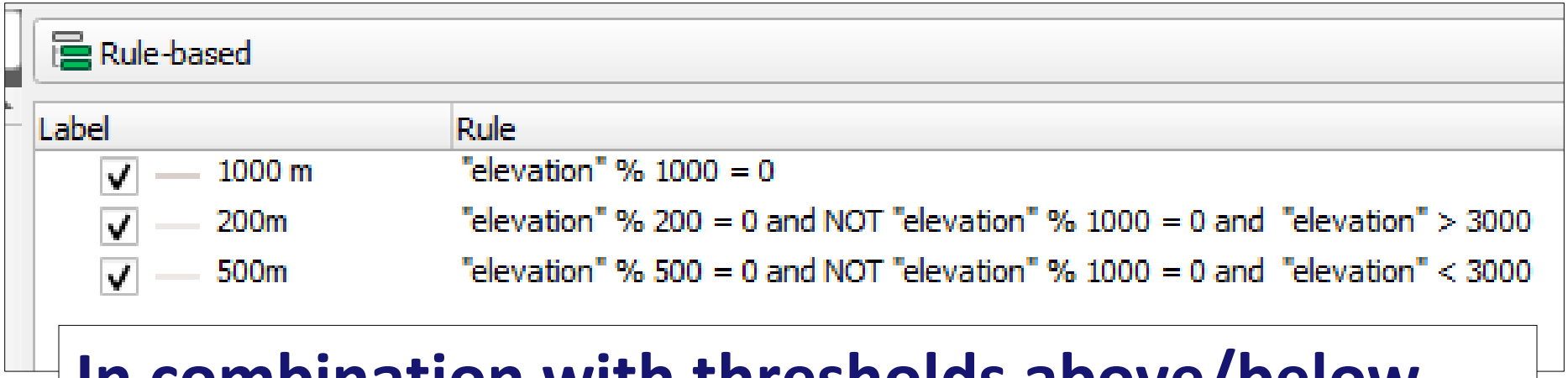
Cartography

Using attributes to show only desired features

Contour lines (elevation) – control line density

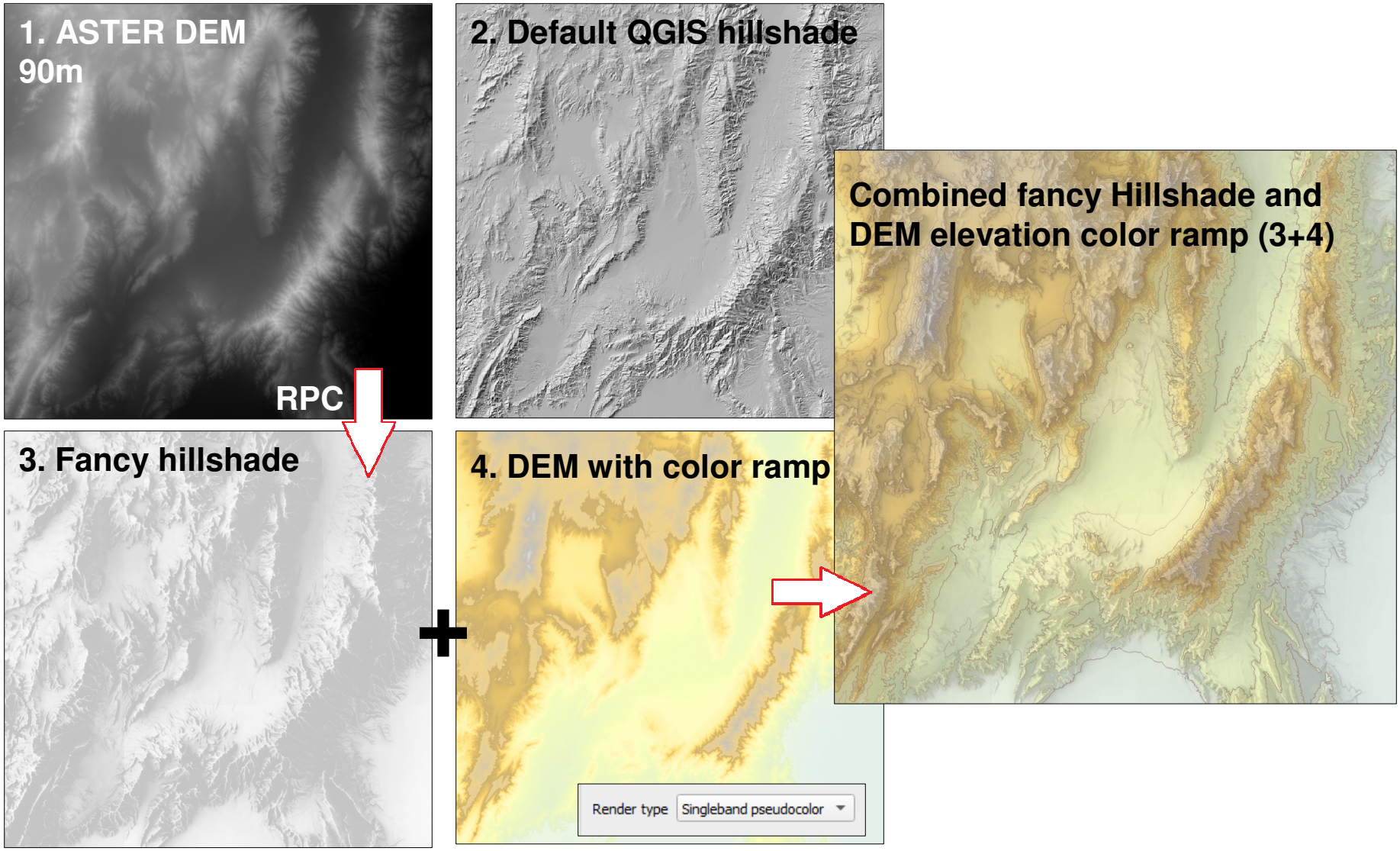


Using the modulo operator (%) returns the remainder after division



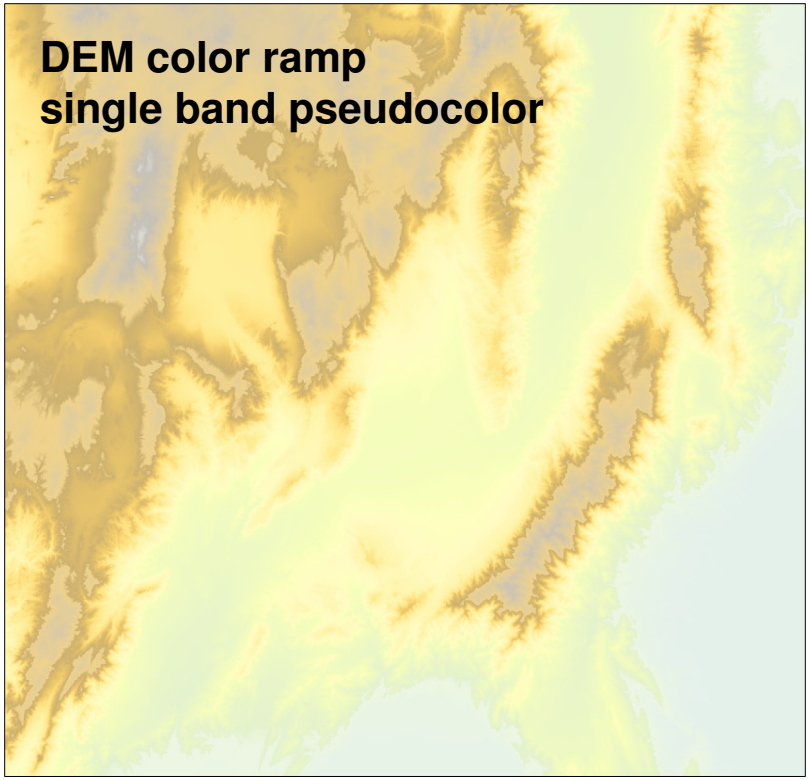
In combination with thresholds above/below shows 200m contours only above 3000 m elev.

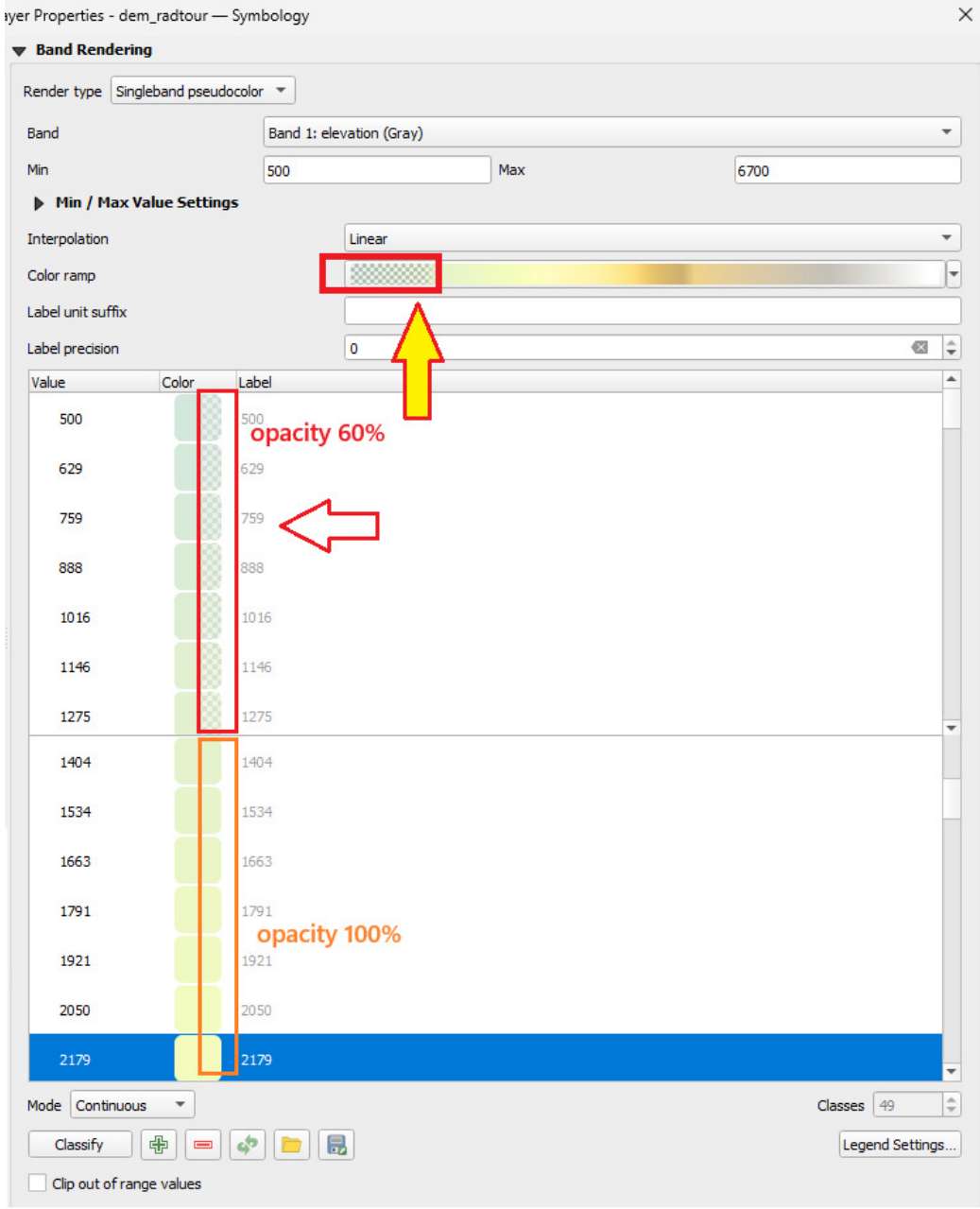
Map – Elevation based Background



DEM color with color ramp use sliding transparencies

e.g. high transparency in low elevations





Map Background: Fancy Hillshades

Raster Chunk processing (Linux/Mac) + Skylum (windows)

Python script

raster_chunk_processing.py

```
def ParallelRCP(in_dem_path, out_dem_path, chunk_
                options, num_threads=1, verbose=F
    '''
    Breaks a raster into smaller chunks for easie
    determines the file parameters, prepares the
    the start/end indices for each chunk, and sto
    a Chunk() object. This object is then passed
    call to ProcessSuperArray() to perform the ac

    in_dem_path:    Full path to input raster.
    ou                                          ster
    ch                                          chur
    ov                                          mens
                                                hbor
                                                houl
                                                thoc
                                                blur
    me                                          sing
    op                                          pair
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    nu                                          proc

    ve                                          formation (including mdenoise

    Re                                          tire raster.
    '
```
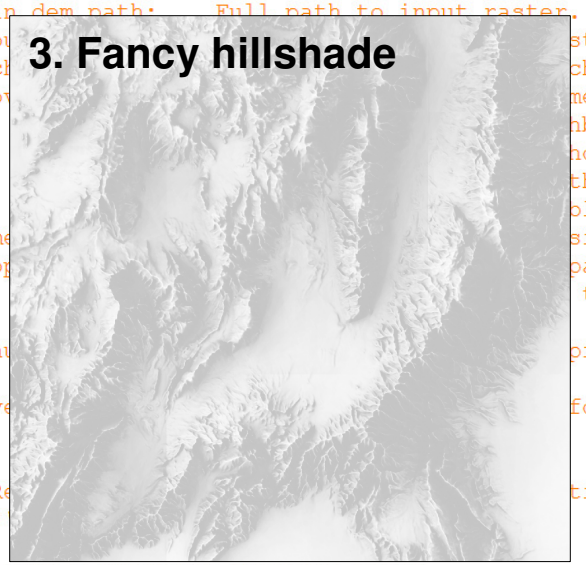



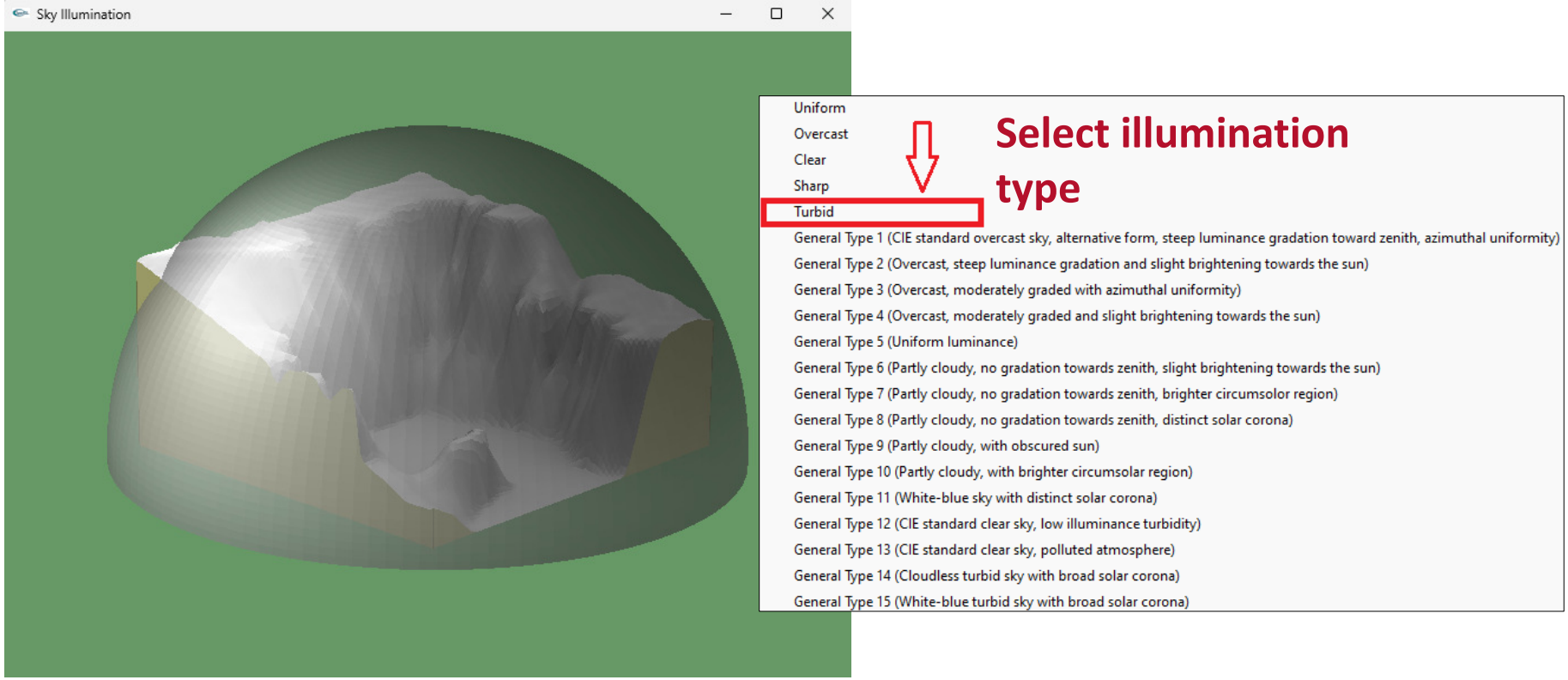
Raster Chunk Processing (RPC)

Applies any one of several raster processing methods to arbitrarily-large rasters by automatically breaking up The raster into smaller chunks

- **DEM smothers (blur_mean, blur_gauss, blur_toews, and mdenoise)**
- **Skymodel Hillshade**
- **Topographic Position Index (TPI)**

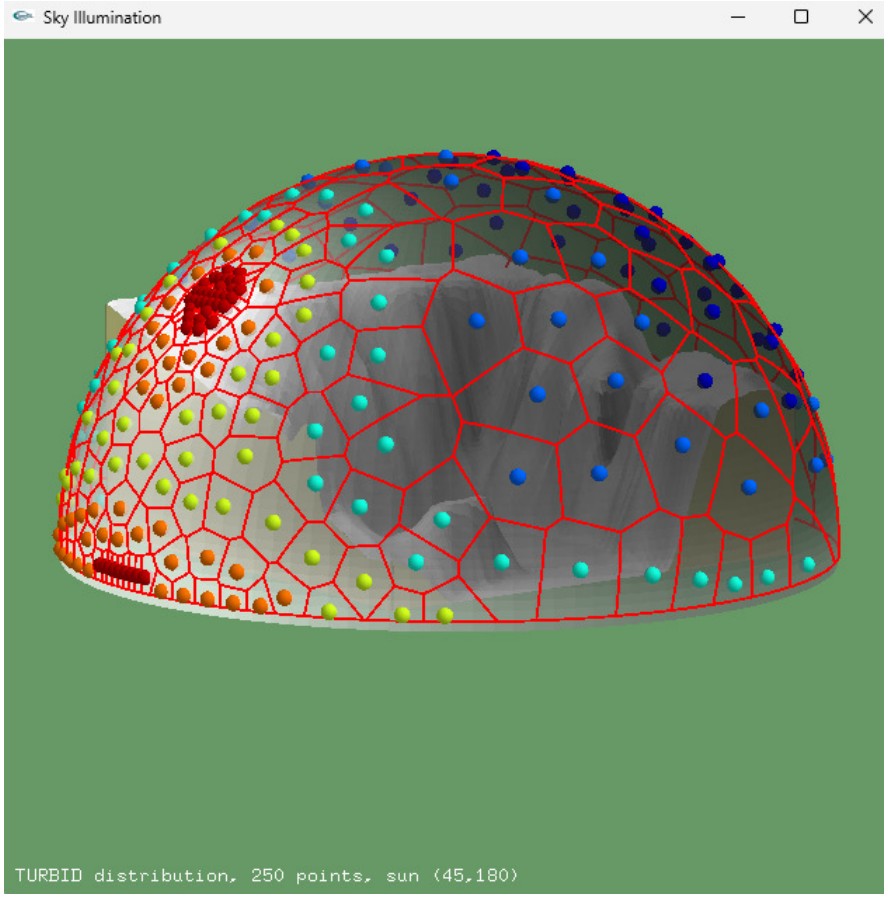
Fancy Hillshades with

Raster Chunk processing (Linux/Mac) + Skylum (windows)



Raster Chunk processing + Skylum

Visualize illumination sources and strength for each



export csv file for use in the python script

```
256,45,0.000521674
257,40,0.000605504
251,41,0.000691218
260,44,0.000952494
252,47,0.00103446
250,44,0.00097316
255,42,0.00049443
254,40,0.000741369
258,47,0.000989942
259,42,0.000670189
254,44,0.000515116
257,41,0.000464016
260,45,0.000717986
251,45,0.000667106
257,42,0.000484959
253,42,0.000486651
256,47,0.000715902
254,47,0.000786995
252,44,0.000490698
256,44,0.000509415
258,44,0.000481719
251,42,0.000676398
```

Creating the Hillshade

in RCP using the illumiation csv file exported from Skylum

DEM Raster processing & creating hillshade

1. Reproject and deflate with gdalwarp

```
Potosi - Sucre
gdalwarp -srcnodata -32767 -dstnodata -99 -of GTiff -t_srs EPSG:32320 -co COMPRESS=DEFLATE -co PREDICTOR=2
/home/karsten/data/radtour/dem/s20_w066_larc_v3.tif /home/karsten/data/radtour/dem/s20_w066_32320.tif
```

2. Denoise

```
python3 raster_chunk_processing.py -m mdenoise -s 1500 -o 20 -p 12 -n 10 -t 0.6 -v 20 --verbose
/home/karsten/data/radtour/dem/s20_w066_32320_sml.tif /home/karsten/data/radtour/dem/s20_w066_32320_sml_dn.tif
```

3. Run Skymodel

```
python3 raster_chunk_processing.py -m skymodel -s 1000 -o 200 -p 12 -l lum_turbid.csv --verbose
/home/karsten/data/radtour/dem/s20_w066_32320.tif /home/karsten/data/radtour/dem/s20_w066_32320_sm3.tif
```

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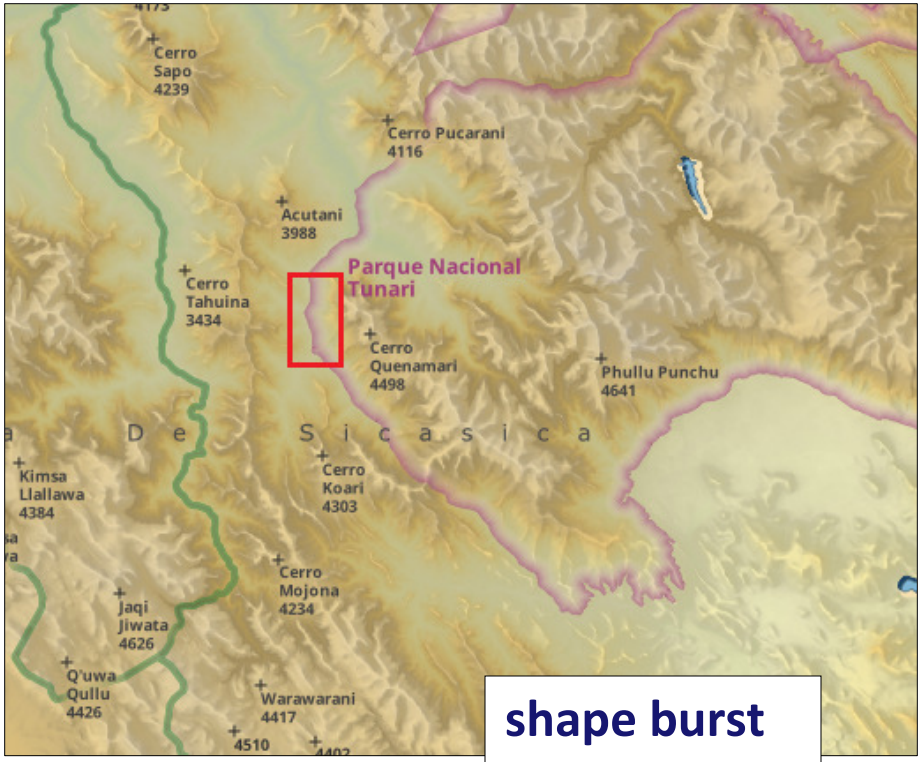
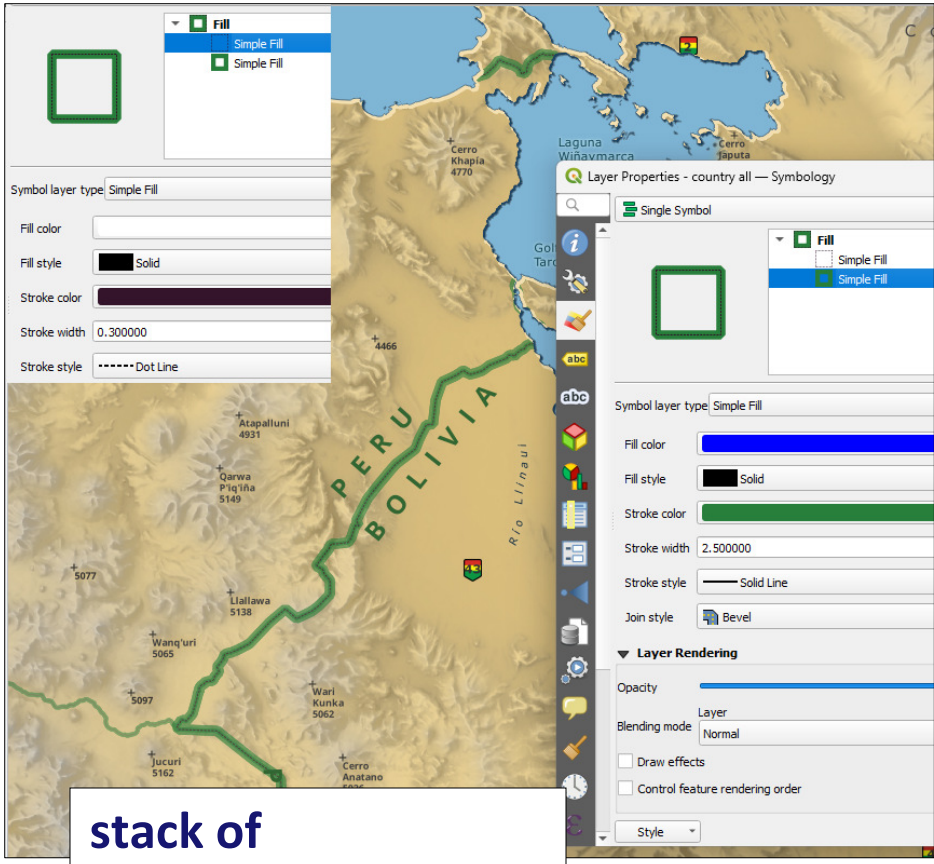
Outlines/Fills: Protected areas and Borders

Protected Areas



shape burst fill

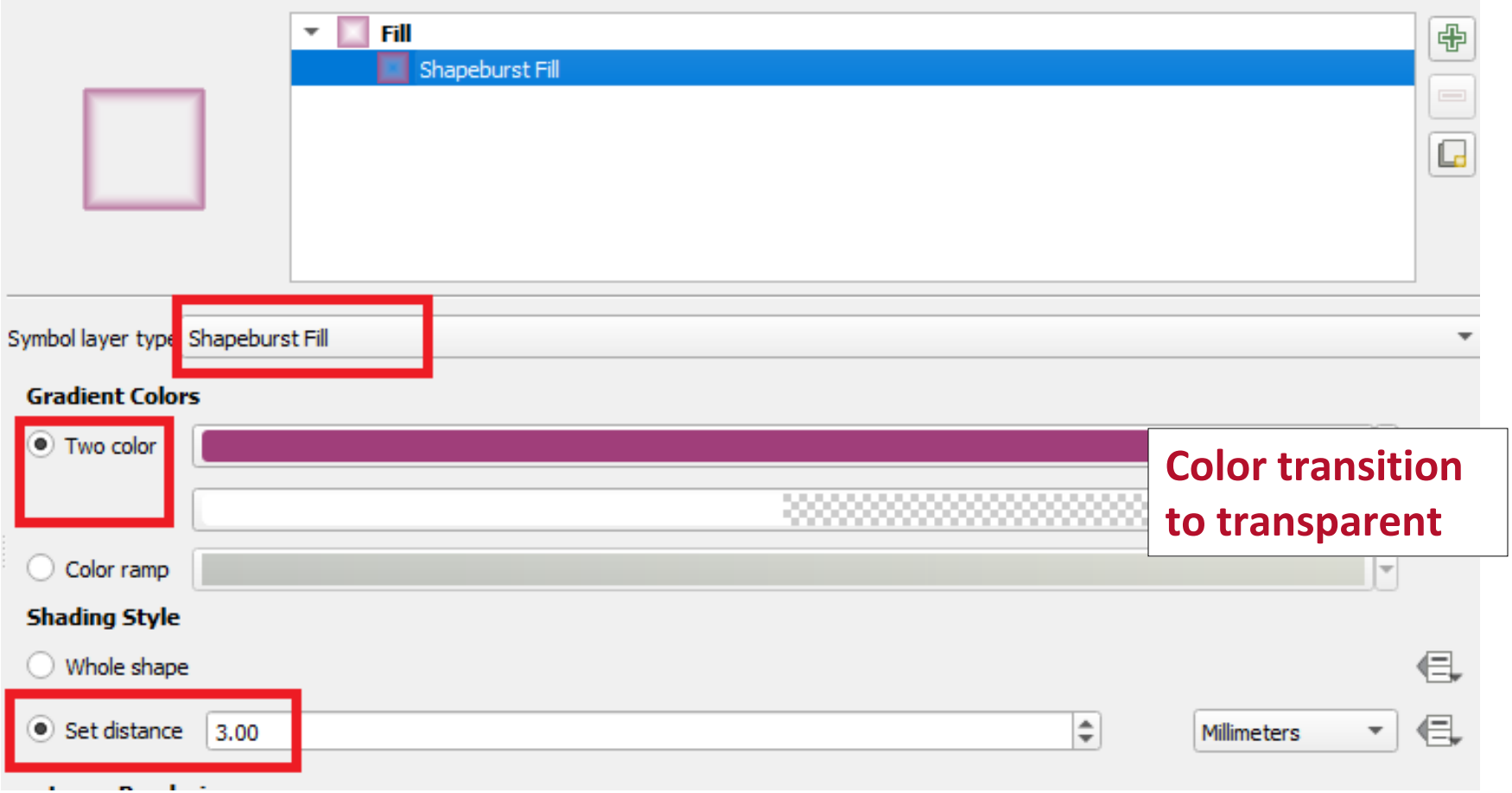
Country and Provincial Borders



stack of
2 simple fills
+ transparency 15%

Shape burst Fills - Borders

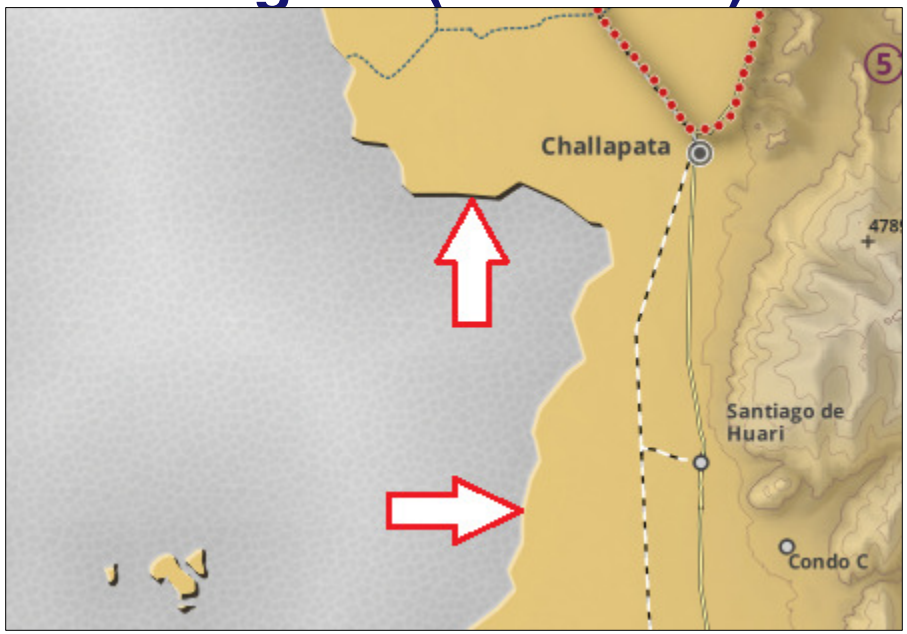
Protected Areas



Lakes and Salar/Lagunas

Lake

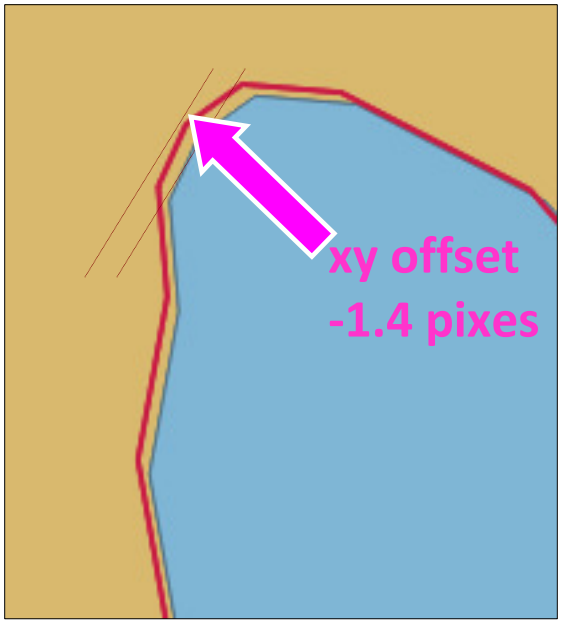
Salar/Laguna (Salt Lake)

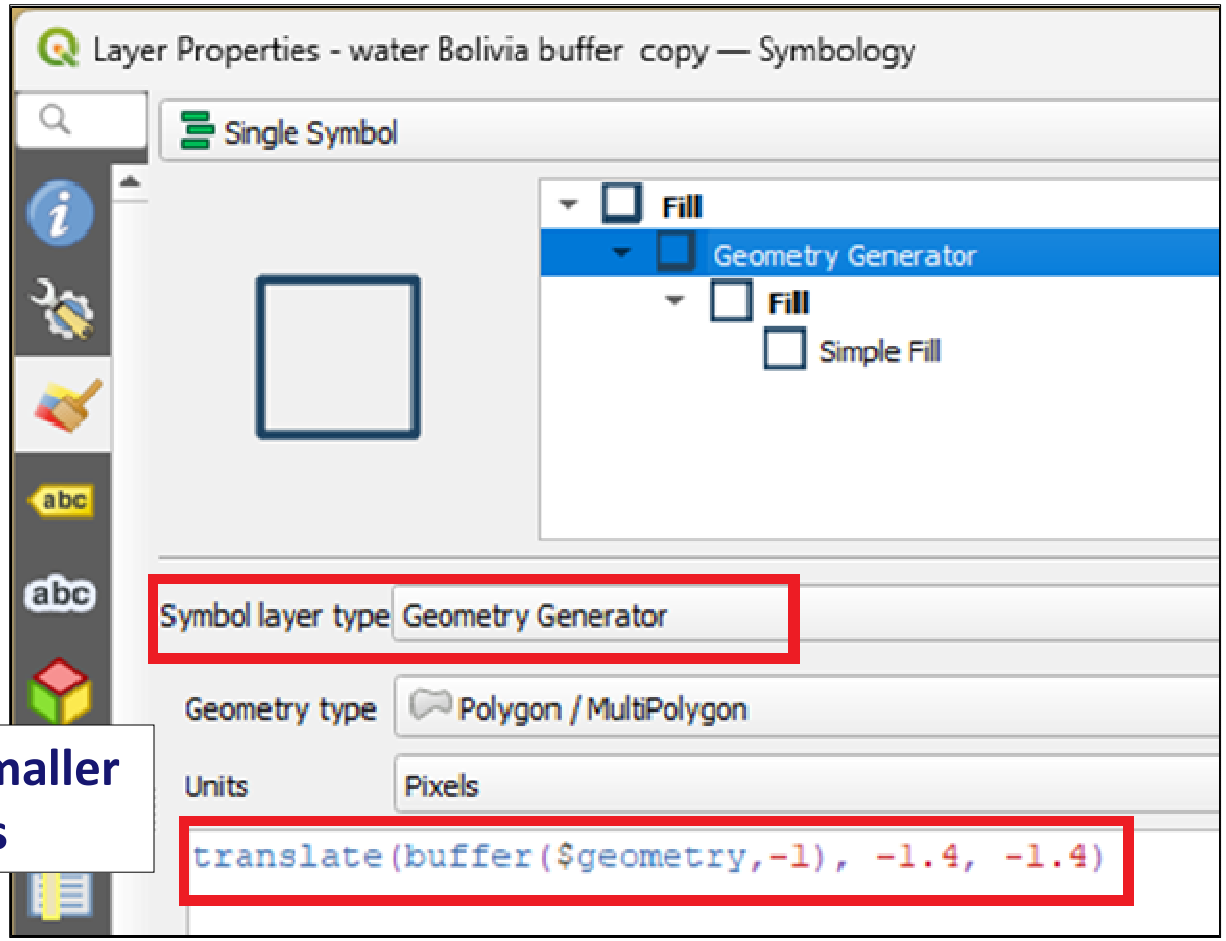


- **Optimized area fills (shapeburst fill or raster fill)**
- **Raised / beveled land edges (x/y offset lines)**

Raised / beveled land edges for display

Lake example

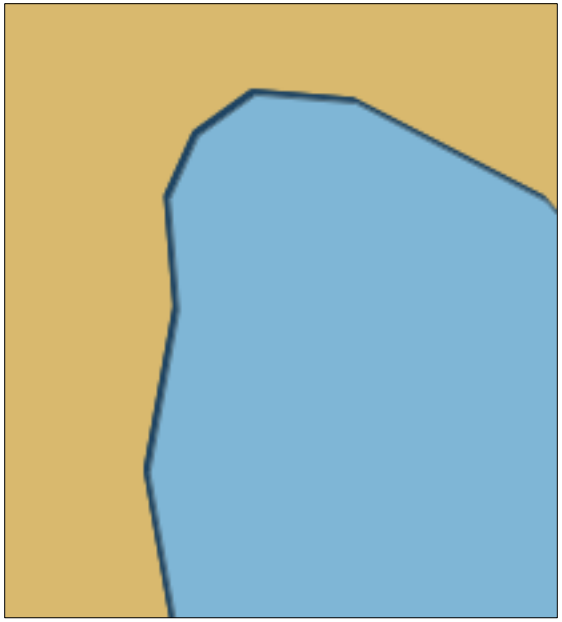


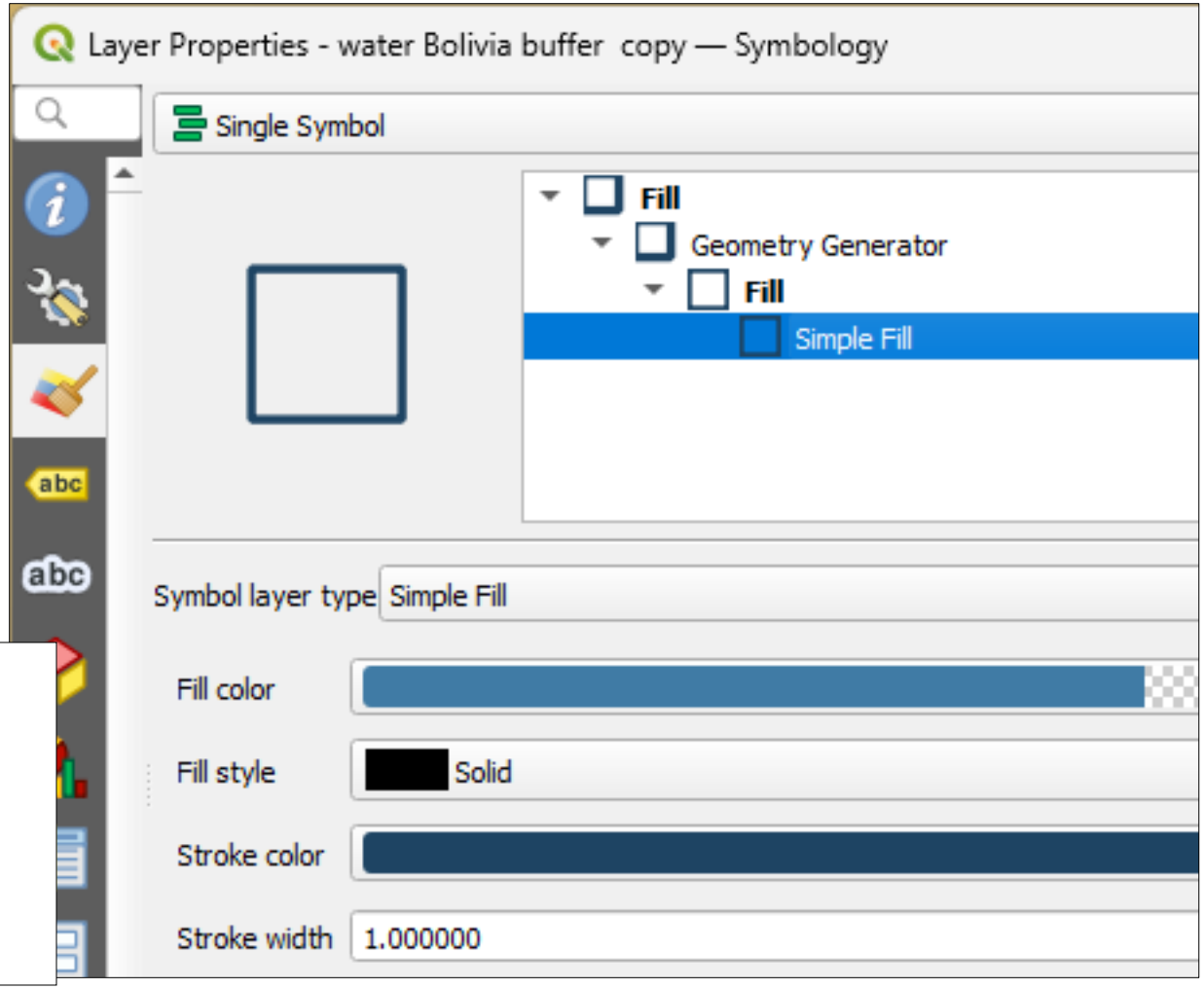


buffer: make 1 pixel smaller
translate: offset x,y pixels

Raised / beveled land edges for display

Lake example

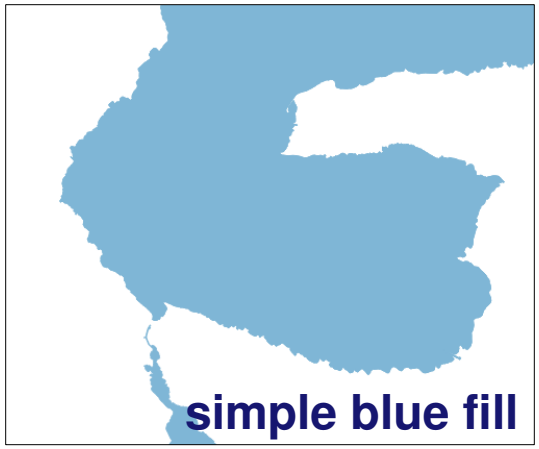


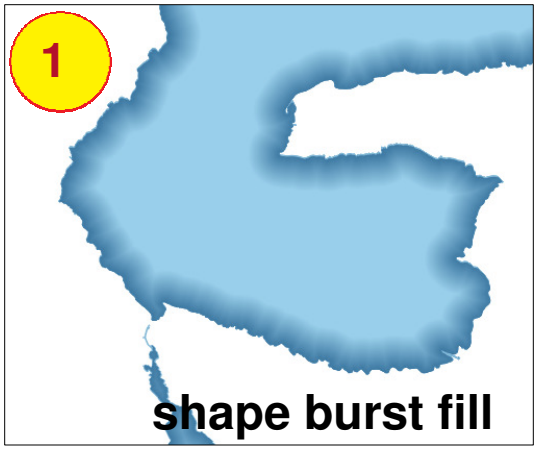


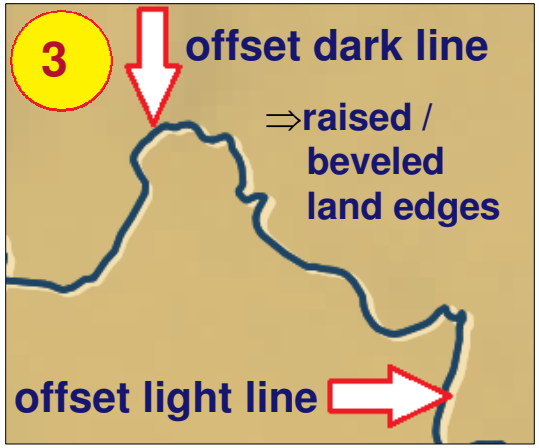
- make line thicker
- move layer below filled lake layer
- repeat for second layer for low edge

Lakes representation - 4 layers

Lake example

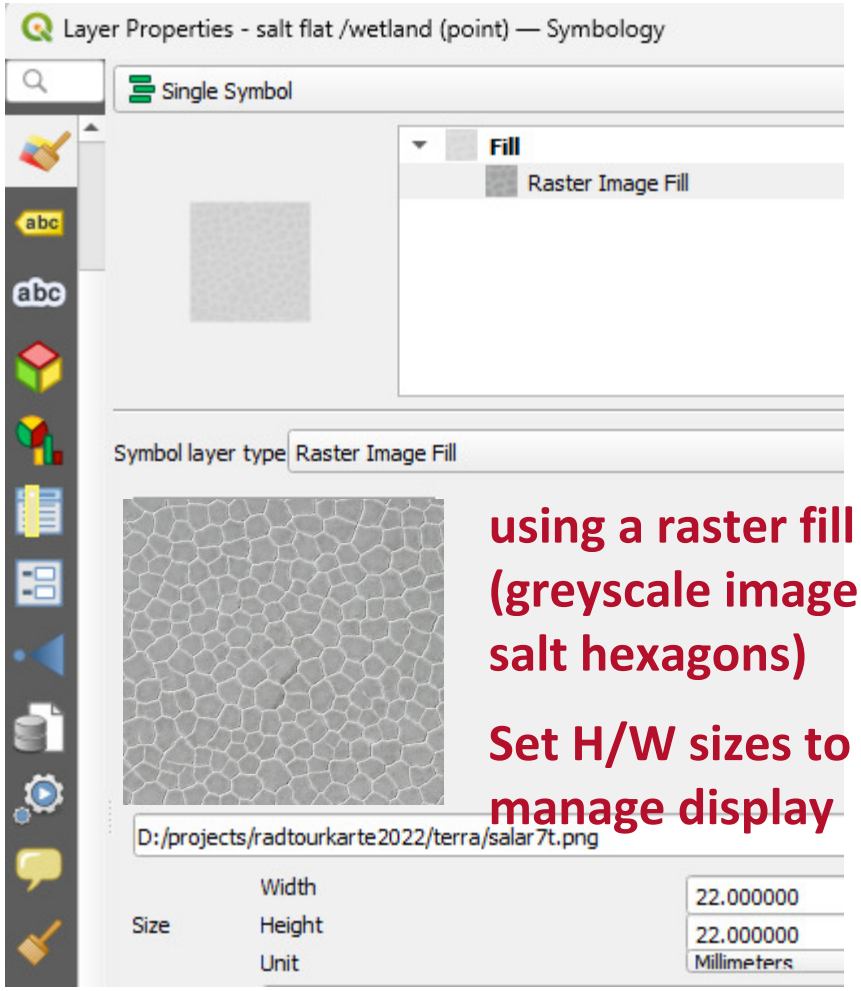






Raster fills: Salar/Laguna + Urban Area

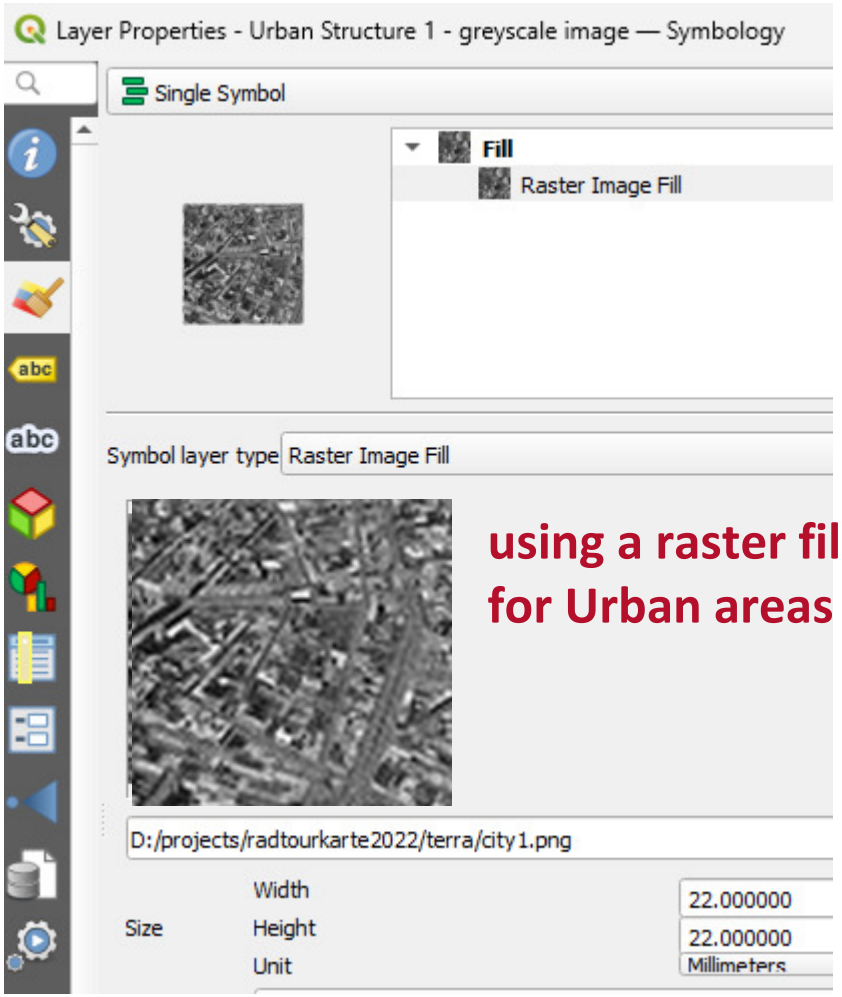
Salar/Laguna (Salt Lake)



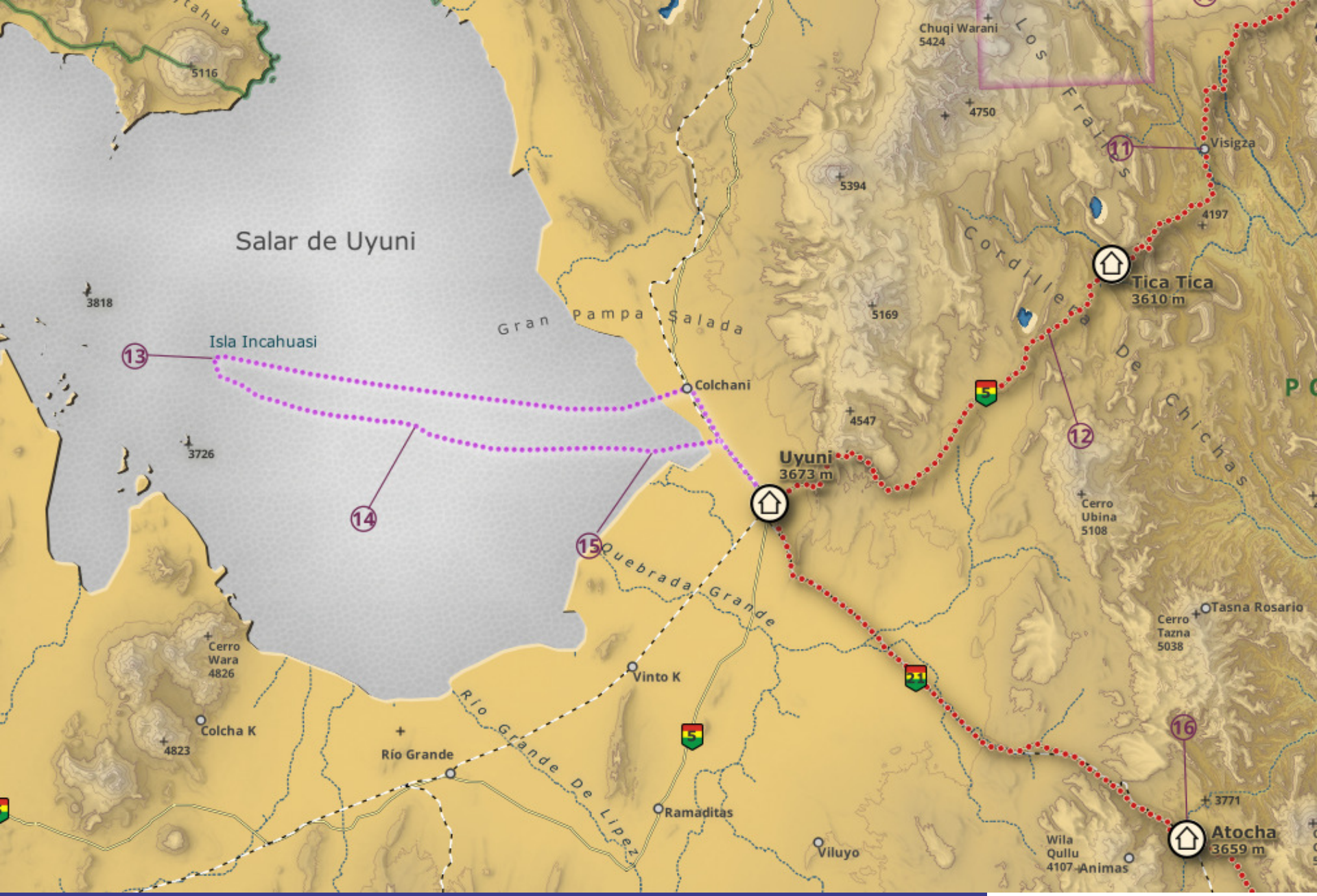
using a raster fill (greyscale image of salt hexagons)

Set H/W sizes to manage display

Urban Area



using a raster fill for Urban areas



Nice cartography with QGIS

De Copacabana, Bolivia a Mendoza, Argentina en Bicicleta

TERRA GIS
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TERRESTRIAL ENVIRONMENT REGIONAL ANALYSIS

Hillshade

GIS Jake- Cartography, programming, and a love Of the mountains

Introducing raster chunk processing

https://gisjake.blogspot.com/2018/10/introducing-rasterchunkprocessingpy-aka.html

The Wandering Cartographer Shaded Relief using Skymodels

Courtesy of Raster Chunk Processing

https://wanderingcartographer.wordpress.com/2020/05/08/shaded-relief-using-skymodels-courtesy-of-raster-chunk-processing/

General sky models for illuminating terrains

Patrick J. Kennelly & A. James Stewart

https://www.tandfonline.com/doi/abs/10.1080/13658816.2013.848985

Contact

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Bicycle trip blog

https://lapaztobuenosaires.blogspot.com/

Equipment