

Step-by-step tutorial

Vista Saga Plugin 1.6.1 for QGIS 4

Vila Serena: from data to diagnosis, through the seven modules

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1. Before you start

This tutorial is a **guided exercise**: from start to finish, you will carry out a complete territorial diagnosis of a fictitious town, **Vila Serena**, using the seven modules of the Vista Saga Plugin. Each step says what to click, what to fill in and **which result you should get**. If your number matches the one in the text, you did it right.

The user manual explains every field and concept. This tutorial goes the other way round: it starts from a real question and shows how the modules link up to answer it.

The Vila Serena question

Vila Serena is a town of 400 hectares (2 km × 2 km), crossed by a river from north to south, with hills to the east. Between 2000 and 2020 its urban area tripled. The town council wants to know:

1. **What are** the Downtown and Riverside districts **made of** today? (Signature)
2. **What changed** between 2000 and 2020, and at the expense of what? (Monitoring)
3. **Which associations** of land use and soil exist, and where is the city built on floodplain soil? (Map combination)
4. **Where can the town grow** with the least conflict? (Evaluation)
5. **Which school serves each part** of the town, given the size of the schools and the river? (Voronoi)
6. **How to show** the growth as an animation at the public hearing? (Map sequencer)

The Format converter comes first, because it prepares one of the maps and because it is the bridge to Vista SAGA.

What you need

Item	Details
QGIS	Version 4.x (Windows or Linux), interface in English (the plugin follows the QGIS language).
Vista Saga Plugin	Version 1.6.0 installed (Plugins > Manage and Install Plugins > Install from ZIP).
Tutorial data	**dados_tutorial_vila_serena_en.zip** (synthetic data, free to use; class and district names in English). Unzip it to a folder whose path has no accents, for example C:\VilaSerena\dados.
Time	About 2 hours in total; each lesson takes 10 to 20 minutes and can be done on its own.

What is in the data folder

File names are in Portuguese (the plugin was born in Brazil): **uso_solo** = land use, **solos** = soils, **declividade** = slope, **atrito** = friction, **bairros** = districts, **escolas** = schools, **MATRICULAS** = enrolment.

File	Content
uso_solo_2000.tif, uso_solo_2010.tif, uso_solo_2020.tif	Land use on three dates: 1 Urban area, 2 Native vegetation, 3 Farming, 4 Pasture, 5 Water.
solos.tif	1 Argisol, 2 Latosol, 3 Fluvic neosol (floodplain soil, prone to flooding).

File	Content
declividade.tif	1 Flat (0-3%), 2 Gently rolling (3-8%), 3 Rolling (8-20%), 4 Strongly rolling (> 20%).
atrito.tif	Friction rating for Voronoi: urban area 1, pasture and farming 2, vegetation 4, water 10.
bairros.gpkg	6 districts (fields CODIGO and NOME).
escolas.gpkg	6 schools (fields NOME and MATRICULAS).
aptidao_expansao.geosaga.json	Ready-made Evaluation project (weights and scores of lesson 5).

All rasters share the **same grid**: 200 × 200 cells of 10 m, in the CRS **SIRGAS 2000 / UTM 25S (EPSG:31985)**. This is no accident: several modules compare maps cell by cell and require the same grid.

> **The data are synthetic**
>
> Vila Serena does not exist. The maps were generated by a script with a fixed seed (docs/tutorial/gerar_dados.py, in the repository), so everyone gets exactly the same numbers. The weights and scores used in the lessons are teaching choices, not method recommendations.

> **Reports stay in Portuguese**
>
> Whatever the interface language, the CSV and TXT reports, file suffixes (_transicoes, _combinacoes, _centros…) and column names are always written in Portuguese. This tutorial translates the columns it uses.

2. Preparing the project

1. Open QGIS 4 and create a new project (**Project > New**).
2. Set the project CRS: **Project > Properties > CRS**, search for **31985** and choose **SIRGAS 2000 / UTM zone 25S**. Click **OK**.
3. Drag the files of the **dados** folder into the Layers panel: the three **uso_solo**, **solos**, **declividade**, **atrito**, **bairros.gpkg** and **escolas.gpkg**.
4. Rename the layers so they read like the screenshots (right-click > Rename Layer): **Land use 2000**, **Land use 2010**, **Land use 2020**, **Soils**, **Slope**, **Friction**, **Districts**, **Schools**.
5. Check the legend of the categorical rasters: QGIS should show the **class names** (Urban area, Native vegetation…), because they are stored in the GeoTIFFs.
6. Save the project in the tutorial folder (**Project > Save As…**, for example vila_serena.qgz).
7. Create a **resultados** (results) folder next to the **dados** folder: all lesson results go there.

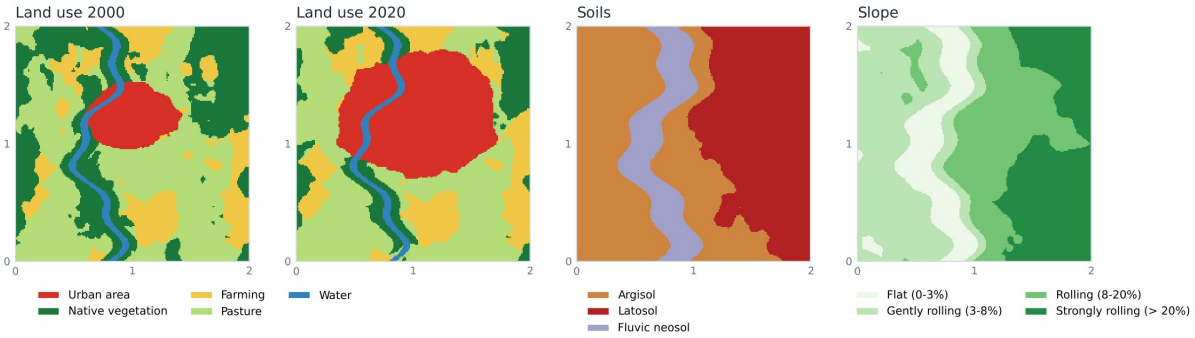


Figure 1 - The maps of Vila Serena: land use in 2000 and 2020, soils and slope

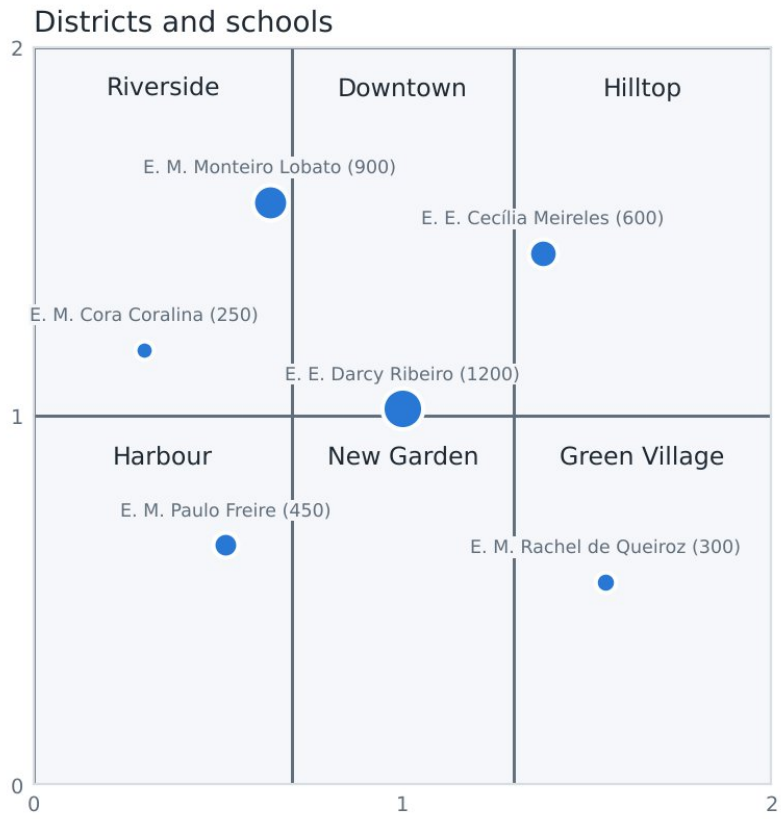


Figure 2 - Districts and schools (enrolment in brackets)

Why the CRS matters so much

The plugin **never reprojects without telling you** and **never guesses the CRS** from coordinates. Maps in different CRSs are refused with a clear message. In real work, standardize the CRS (projected, in metres) before you start: it is the step that saves the most rework.

3. Lesson 1 - Format converter: preparing and exchanging data

Goal: turn the districts (vector) into a raster on the same grid as the other maps, to use it as the reference in Signature; and export land use to RS2, the Vista SAGA format.

1.1 Districts: from vector to GeoTIFF

1. Open **Vista Saga Plugin > Format converter**.
2. In **Convert**, choose **Vector → GeoTIFF (rasterization)**.
3. In **Project vector layer**, choose **Districts** and click **Select**.
4. In **Field to rasterize**, choose **CODIGO**; in **Pixel size**, **10**.
5. In **Output file**, enter resultados\bairros.tif. Click **Run**.

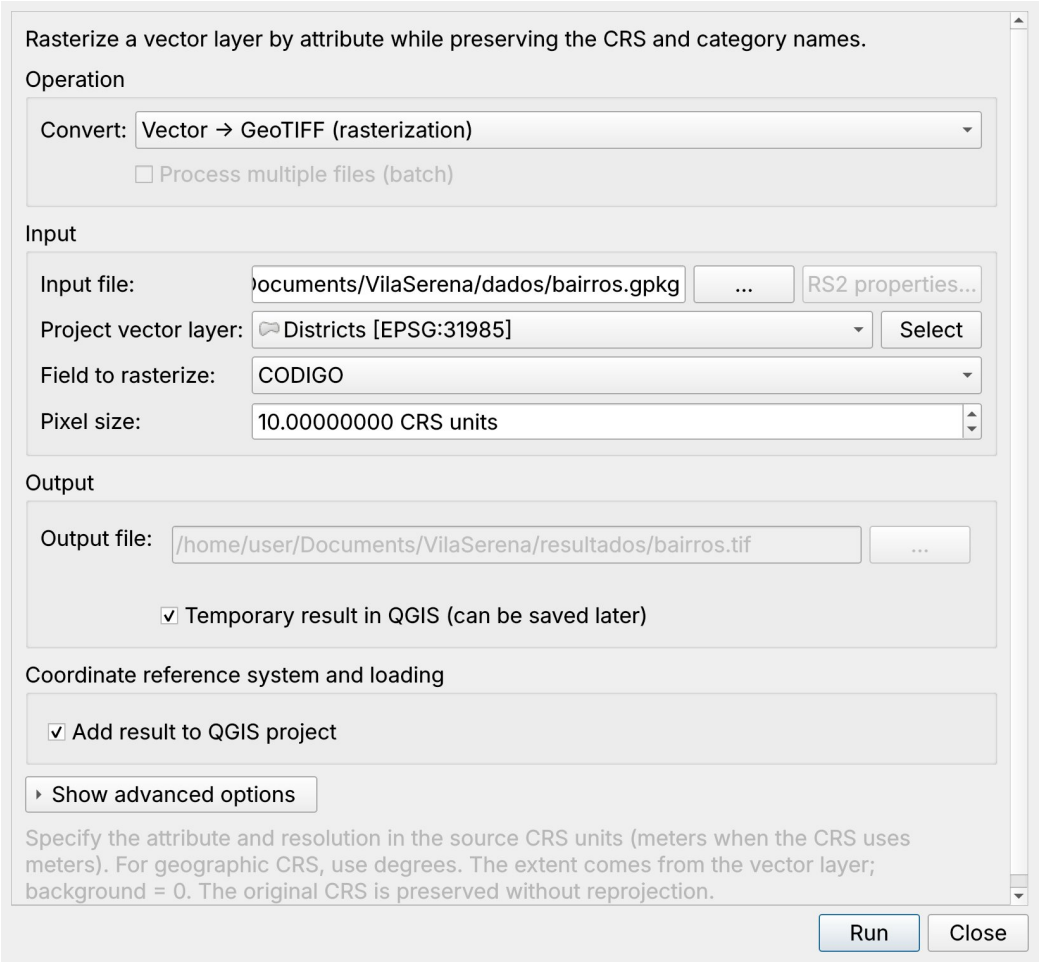


Figure 3 - Format converter: bairros.gpkg to GeoTIFF

Expected result: bairros.tif with **200 × 200 cells of 10 m**, exactly the grid of the other maps, because the districts cover the whole study area. The raster loads with a style (.qml) that shows only the real classes.

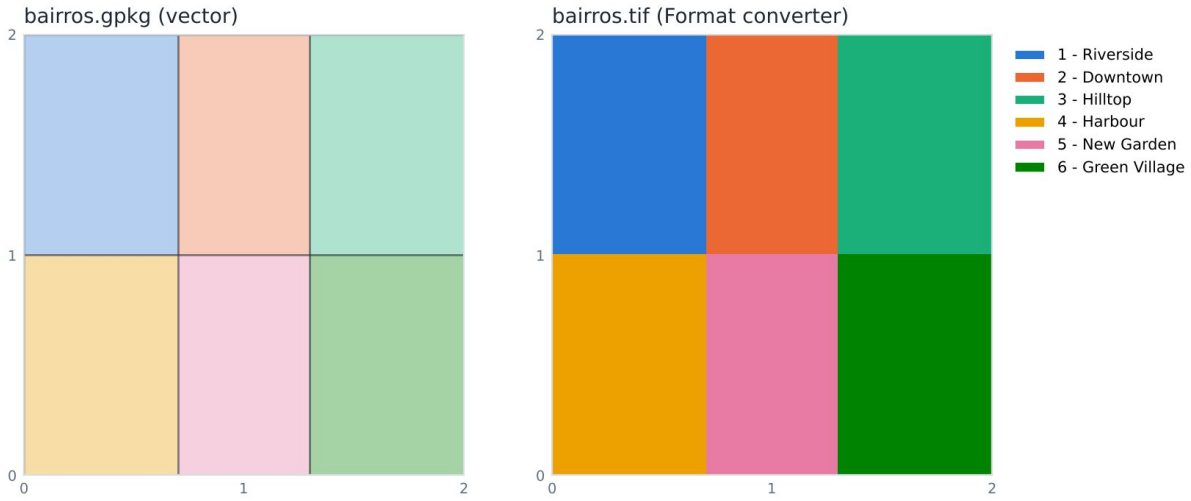


Figure 4 - The same map before (vector) and after (raster) the conversion

1.2 Naming the raster classes

The new GeoTIFF stores the **codes** (1 to 6), and QGIS shows "Classe 1", "Classe 2"… Signature uses the names of the layer style in QGIS, so name the classes now:

1. Double-click the **bairros** raster layer and open **Symbology**.
2. In the **Label** column, type: 1 Riverside, 2 Downtown, 3 Hilltop, 4 Harbour, 5 New Garden, 6 Green Village.
3. Click **OK**. To keep the names with the file: **Style > Save as Default**.

> **A tip only the tutorial tells you**
>
> The code → name table is in bairros.gpkg itself (fields CODIGO and NOME). Open the attribute table next to Symbology and copy the names; with maps of dozens of classes, this avoids mistakes.

1.3 Land use 2020: from GeoTIFF to RS2 (and back)

1. In the converter, choose **GeoTIFF → RS2 (Vista SAGA format)**.
2. In **Input file**, enter dados\uso_solo_2020.tif; in **Output file**, resultados\uso_solo_2020.rs2. Click **Run**.
3. To check, go back: **RS2 → GeoTIFF (categorical raster)**, input uso_solo_2020.rs2, output uso_solo_2020_de_volta.tif. Check the CRS: the plugin reads it from the .rs2.json file written in the previous step (**EPSG:31985**).

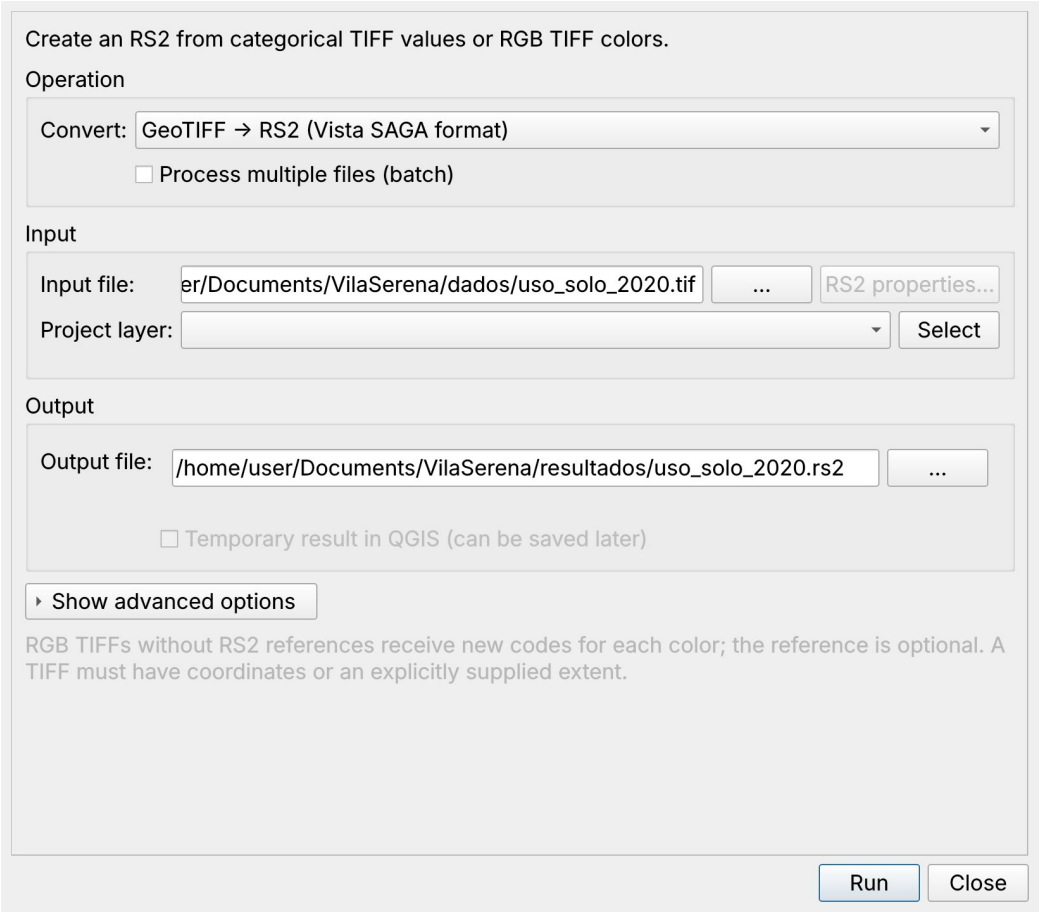


Figure 5 - Format converter: GeoTIFF to RS2

Expected result: an RS2 file of 139,998 bytes, plus the sidecar file **uso_solo_2020.rs2.rs2.json**, which stores the CRS, the legend and the code mapping. The GeoTIFF that comes back is **identical cell by cell** to the original, with the same names and colours.

> **Warning**
>
> RS2 **does not store the CRS**. When you move an RS2 to another folder or person, take the .rs2.json along; without it, the plugin will ask you to confirm the CRS.

4. Lesson 2 - Signature: what are Downtown and Riverside made of?

Goal: measure, inside the Downtown and Riverside districts, how much each class of land use, soil and slope occupies.

1. Open **Vista Saga Plugin > Signature**, **Raster** tab.
2. In **1. Maps**, add the **bairros** raster **first** (it will be the reference), then **Land use 2020**, **Soils** and **Slope** (Layer in QGIS + **Add selected layer**).
3. In **2. Selection on the reference**, tick **1 - Riverside** and **2 - Downtown**.
4. In **3. Options**, keep **Per-feature result** on (one block per district, besides the union).
5. In **4. Result**, type the title "Downtown and Riverside" and choose resultados\assinatura.csv (the TXT is written next to it). Click **Run**.

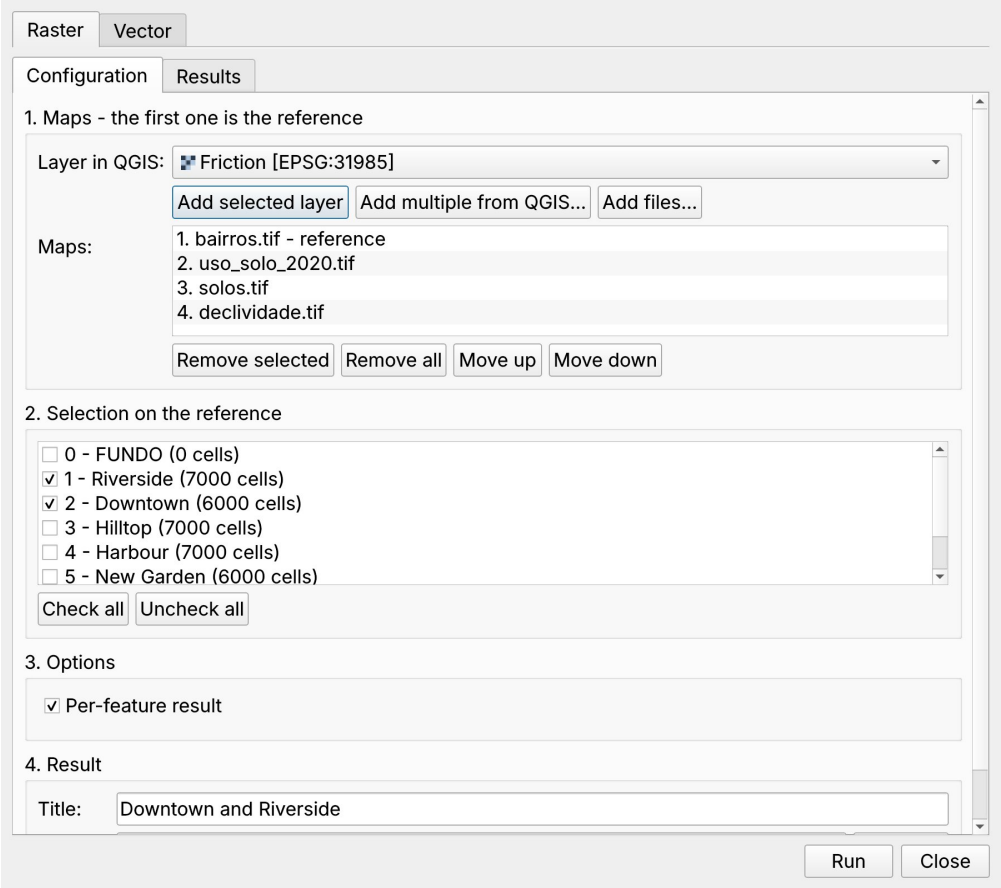


Figure 6 - Signature: districts as the reference, Downtown and Riverside ticked

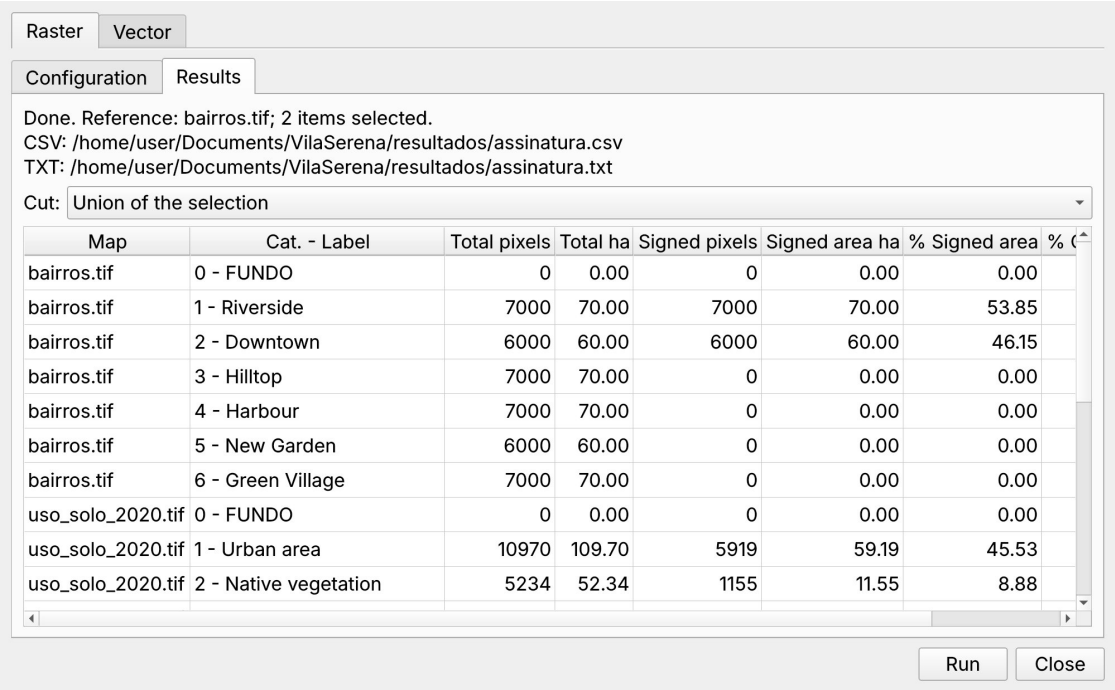


Figure 7 - Signature, Results tab: the table of the union of the selection

Expected result

The union of the two districts covers **130.00 ha** (Riverside 70.00 ha + Downtown 60.00 ha). For land use in 2020:

Class	Signed area (ha)	% signed area	% category
Urban area	59.19	45.53	53.96
Native vegetation	11.55	8.88	22.07
Farming	19.84	15.26	26.41
Pasture	32.95	25.35	21.96
Water	6.47	4.98	50.55

How to read it

- **% signed area** answers "what is the place made of": 45.53% of the two districts is urban. This column adds up to 100% in each map.
- **% category** answers "how much of the class is here": 53.96% of all the urban area of Vila Serena lies in these two districts, and 50.55% of the water. This column does **not** add up to 100%.
- District by district, the contrast is sharp: Downtown is 70.75% urban; Riverside only 23.91%, with 46.36% pasture.
- In Downtown, 32.65% of the area is fluvic neosol, a floodplain soil: a clue that Map combination and Evaluation will confirm.

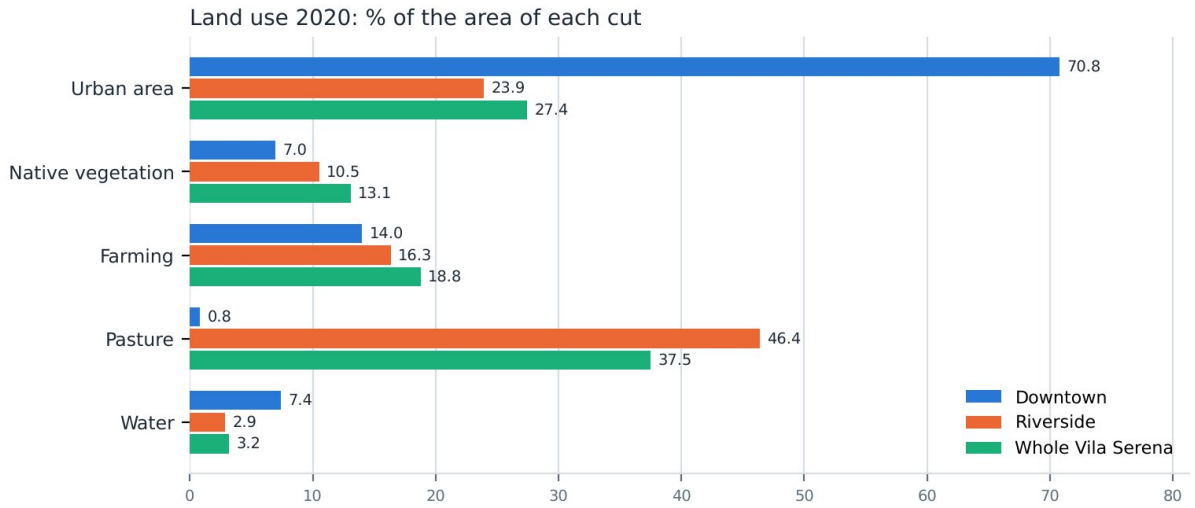


Figure 8 - Land use 2020 in each cut: Downtown, Riverside and the whole town

Tips only the tutorial tells you

- The table of the reference itself (districts) shows 100% for the ticked classes: it checks the exact size of the boundary. If it is not 100%, the selection is not what you think.
- Do not add up the per-district blocks to get the union: use the "Union of the selection" block.
- In the CSV, filter the RECORTE (cut) column (UNIAO or FEICAO) and build a pivot table by MAPA (map) and CLASSE (class).

Exercise: sign the **New Garden** district on your own, the town's growth frontier. What is its % of urban area? And of native vegetation?

5. Lesson 3 - Monitoring: what changed between 2000 and 2020?

1. Open **Vista Saga Plugin > Monitoring**, **Raster** tab.
2. In **Initial map**, choose **Land use 2000** and type **2000** in Period.
3. In **Final map**, choose **Land use 2020** and type **2020** in Period.
4. In **Study title**, "Land use 2000 - 2020"; in **Save to**, resultados\transicoes_2000_2020.tif.
5. Click **Run**.

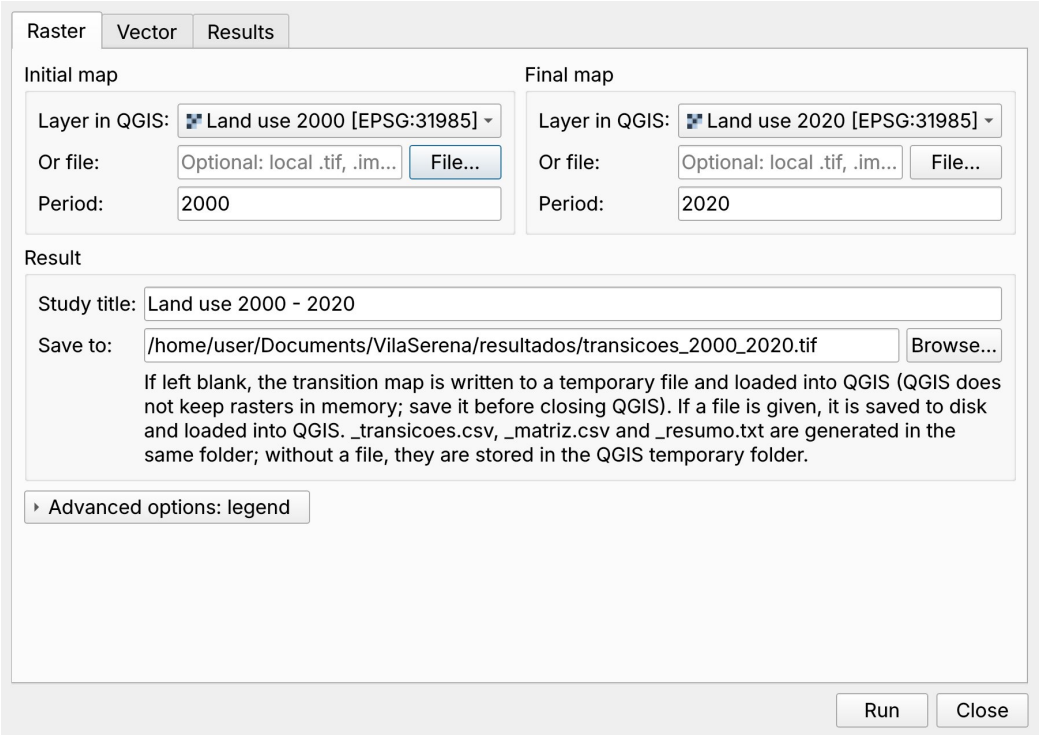


Figure 9 - Monitoring: the two periods and the result

Expected result

Of the 40,000 cells (400 ha), **69.11% persisted** in the same class (276.46 ha) and **30.89% changed** (123.54 ha). The largest changes:

Transition	Area (ha)	% of the area
Pasture → Urban area	46.98	11.74
Native vegetation → Pasture	29.56	7.39
Native vegetation → Urban area	21.85	5.46
Native vegetation → Farming	16.77	4.19
Farming → Urban area	8.38	2.10

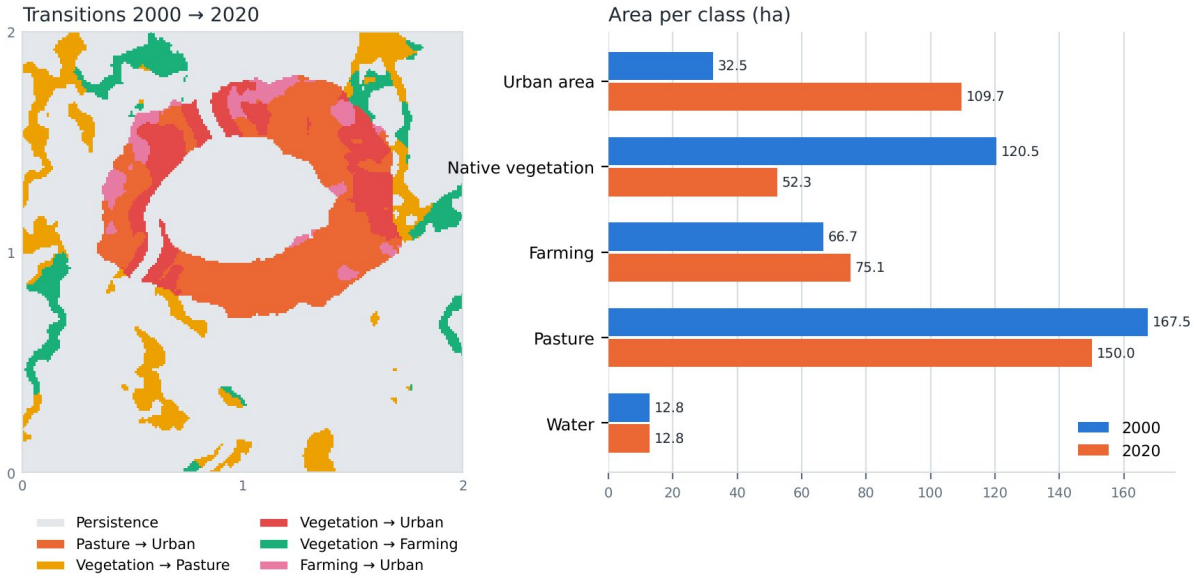


Figure 10 - The transition map (persistence in grey) and the area of each class on both dates

How to read it

- The urban area went from **32.49 ha to 109.70 ha** (3.4 times). Almost half of the growth came from pasture (46.98 ha) and a quarter from native vegetation (21.85 ha).
- Native vegetation fell from **120.52 ha to 52.34 ha** (-56.6%): it lost area to the city, to pasture and to farming.
- Water (12.80 ha) did not change: a good quality check. If the water "changed", distrust the maps.
- In the matrix (_matriz.csv), read **by row**: each row shows where each 2000 class went.

> **A tip only the tutorial tells you**
>
> Open _transicoes.csv in Excel or LibreOffice and sort by the AREA_HA column: the first five change rows tell the story of the period. SITUACAO tells persistence (Permanência) from change (Mudança); DEIXOU_DE_SER and TORNOU_SE are the "from" and "to" classes.

6. Lesson 4 - Map combination: city on floodplain soil?

1. Open **Vista Saga Plugin > Map combination**, **Raster** tab.
2. Add **Land use 2020** and then **Soils** (the order sets the order of the columns in the table).
3. In **Save to**, enter resultados\uso2020_x_solos.tif and click **Run**.

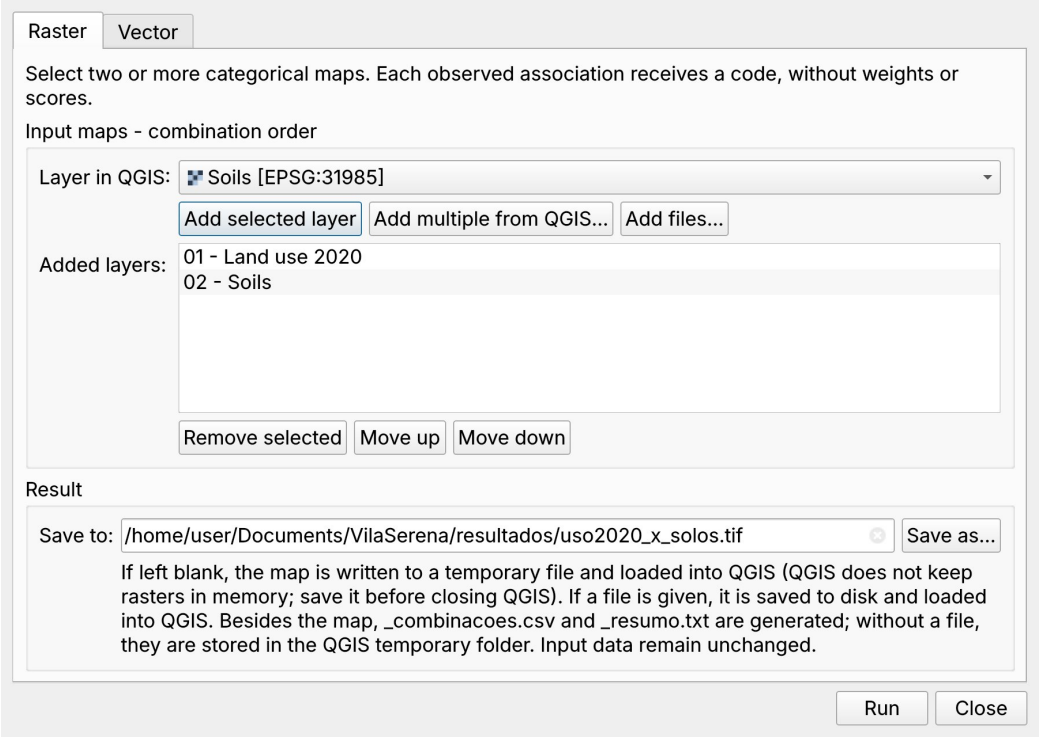


Figure 11 - Map combination: land use 2020 and soils

Expected result

13 combinations found, in 400 ha. The largest is **Pasture | Argisol** (98.07 ha, 24.52%). The one the council cares about is **Urban area | Fluvic neosol: 17.89 ha (4.47%)**: city built on floodplain soil, prone to flooding.

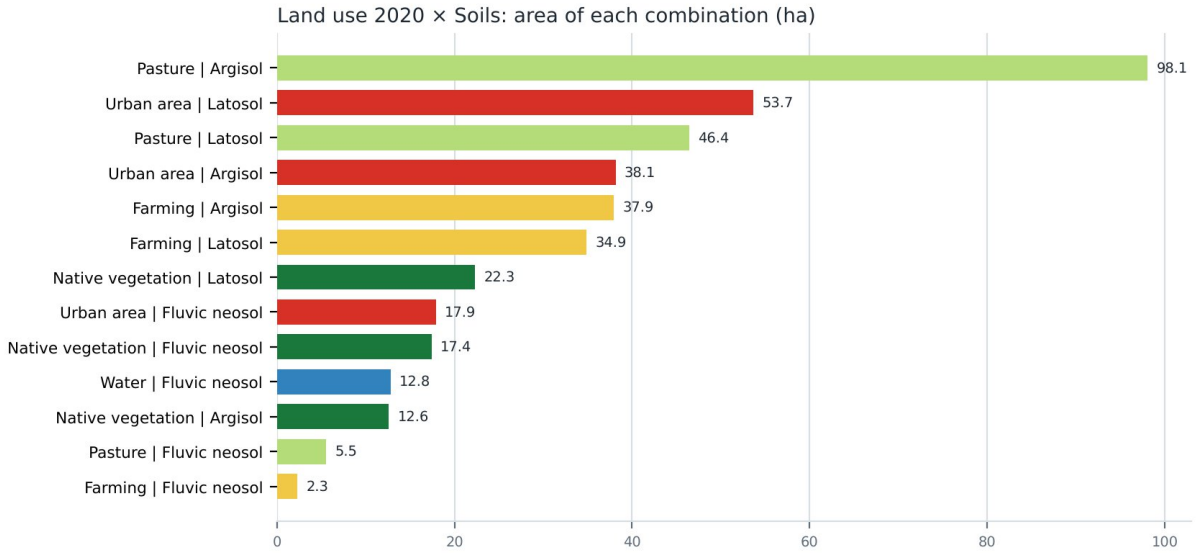


Figure 12 - Area of each combination of land use and soil

A tip only the tutorial tells you

In QGIS, use the **Identify Features** tool on the combined map: the cell value matches the ID_COMB of _combinacoes.csv. To highlight only urban areas on the floodplain, open Symbology and untick the other combinations.

7. Lesson 5 - Evaluation: where can the town grow?

Goal: produce a suitability-for-urban-growth map as the weighted average of three criteria. The weights and scores below are **for teaching**: in a real study they must be justified (literature, expert consultation, legislation).

Criterion (weight)	Scores (0 to 10)
Slope (40%)	Flat 10; Gently rolling 8; Rolling 4; Strongly rolling 1
Soils (25%)	Argisol 7; Latosol 9; Fluvic neosol 2 (floodplain, floodable)
Land use 2020 (35%)	Urban area 8; Native vegetation 1; Farming 6; Pasture 9; Water: Do not evaluate

Building it step by step

1. Open **Vista Saga Plugin > Evaluation**, **Raster** tab. Score scale: **0 to 10**.
2. Add **Slope**, **Soils** and **Land use 2020**. Weights start blank, on purpose.
3. Type the weights 40, 25 and 35 (the **Tab** key jumps from weight to weight). The line below the table should read "Weights: 100.00% - valid allocation".
4. Select each map and type the class scores. For **Water**, tick **Do not evaluate**.
5. Click **Validate**: no class may be left with the score "—".
6. In **Save to**, enter resultados\aptidao_expansao.tif, keep both reports ticked and click **Run**.

> **Shortcut**
>
> Instead of typing everything, click **Open project…** and choose dados\aptidao_expansao.geosaga.json: the three maps, the weights and the scores load at once. That is how you reuse an evaluation.

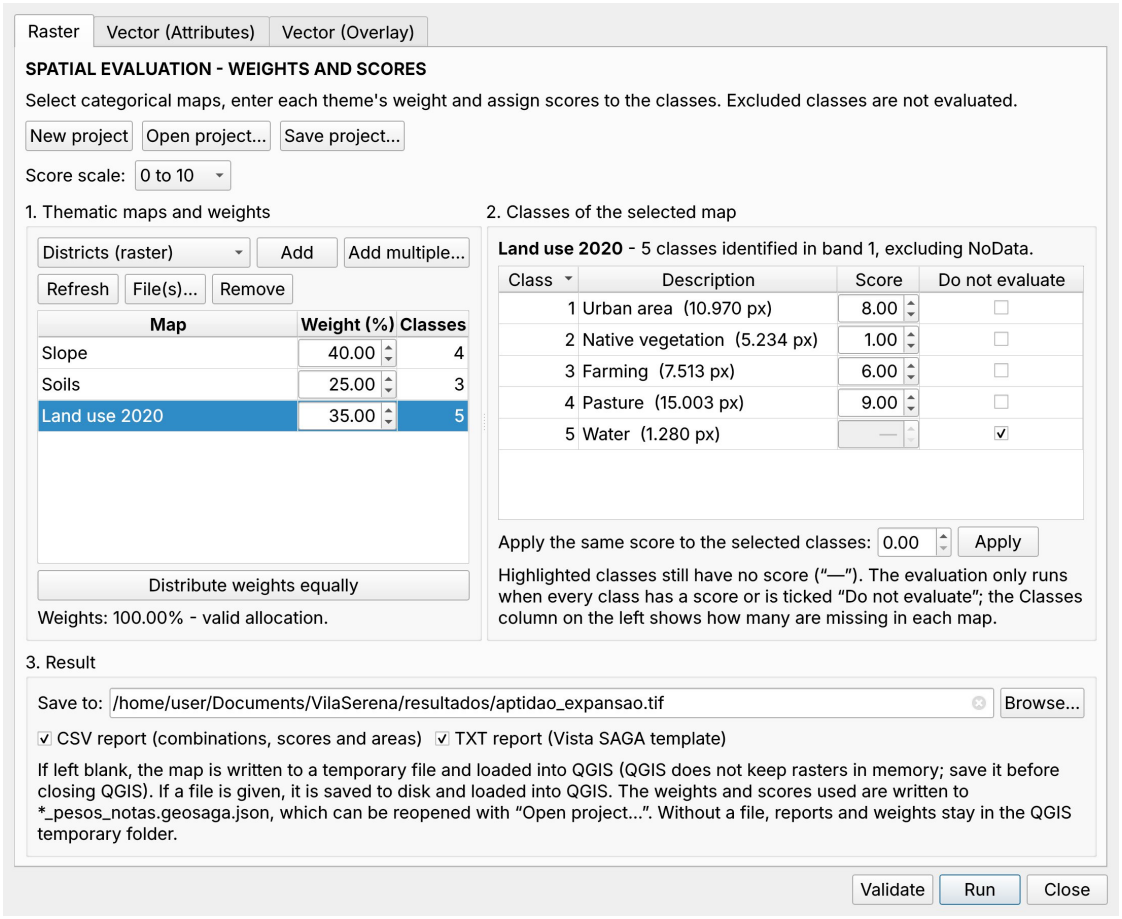


Figure 13 - Evaluation: weights, scores and Water set to "Do not evaluate"

Expected result

38,720 cells evaluated (387.2 ha) and 1,280 not evaluated (the water, 12.8 ha). Minimum score **3.0**, maximum **8.9**, mean **6.34**. Area per final score (as in the report):

Final score	3	4	5	6	7	8	9
Area (ha)	21.83	2.76	86.49	70.35	107.70	93.44	4.63

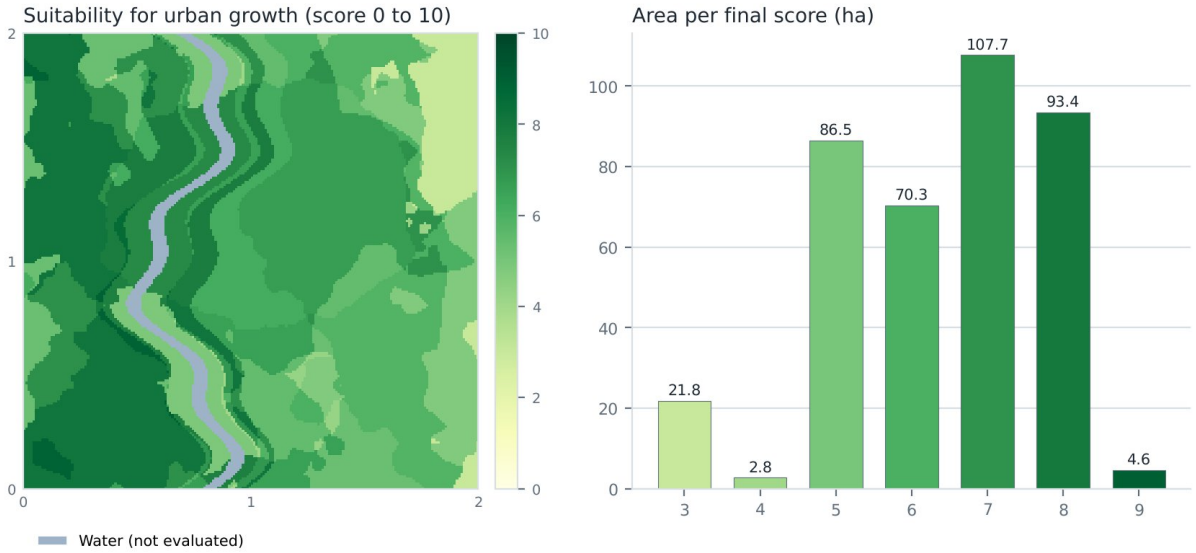


Figure 14 - Suitability-for-urban-growth map and area per final score

How to read it

- Scores **8 and 9** (98.07 ha) are the most suitable areas: almost all on flat or gently rolling land, on argisol, under pasture or already urban.
- Score **3** (21.83 ha) brings together the worst of everything: native vegetation on steep slopes.
- A telling result: **latosol**, despite its score of 9, has the lowest mean score (5.51), because it lies on the hills, on steep slopes. Slope (40%) weighs more than soil (25%) and dominates. The floodplain (fluvic neosol, score 2) gets a mean of 6.18: it is flat, and the soil penalizes it only in part. If the council wants to exclude the floodplain altogether, a low score is not enough: set the class to **Do not evaluate**.

Tips only the tutorial tells you

- The score "—" blocks the run: the plugin **never assumes a score of 0**. This is deliberate, so that no class enters the calculation without your decision.
- Each run writes *_pesos_notas.geosaga.json (weights and scores) next to the map: it is the exact record of what you used. Keep it with the study report.
- Test the sensitivity: change the weights to 50/20/30 and compare the maps. If the map changes a lot, the choice of weights is critical and needs a strong justification.

8. Lesson 6 - Voronoi analyses: which school serves each part of the town?

Three versions of the same question: by pure distance (**Simple**), by school size (**With mass**, enrolment) and by travel difficulty (**With Friction**: the river is expensive to cross).

6.1 With mass

1. Open **Vista Saga Plugin > Voronoi analyses**, **Raster** tab.
2. In **Mode**, choose **With mass**.
3. In **Generating points**, **Schools**; in **Point identifier**, **NOME**; in **Mass field**, **MATRICULAS**.
4. In **Analysis extent**, choose **Reference raster grid** and, in **Reference raster**, **Friction**: this way the result falls exactly on the grid of the other maps.
5. In **Save to**, resultados\voronoi_com_massa.tif. Click **Run**.

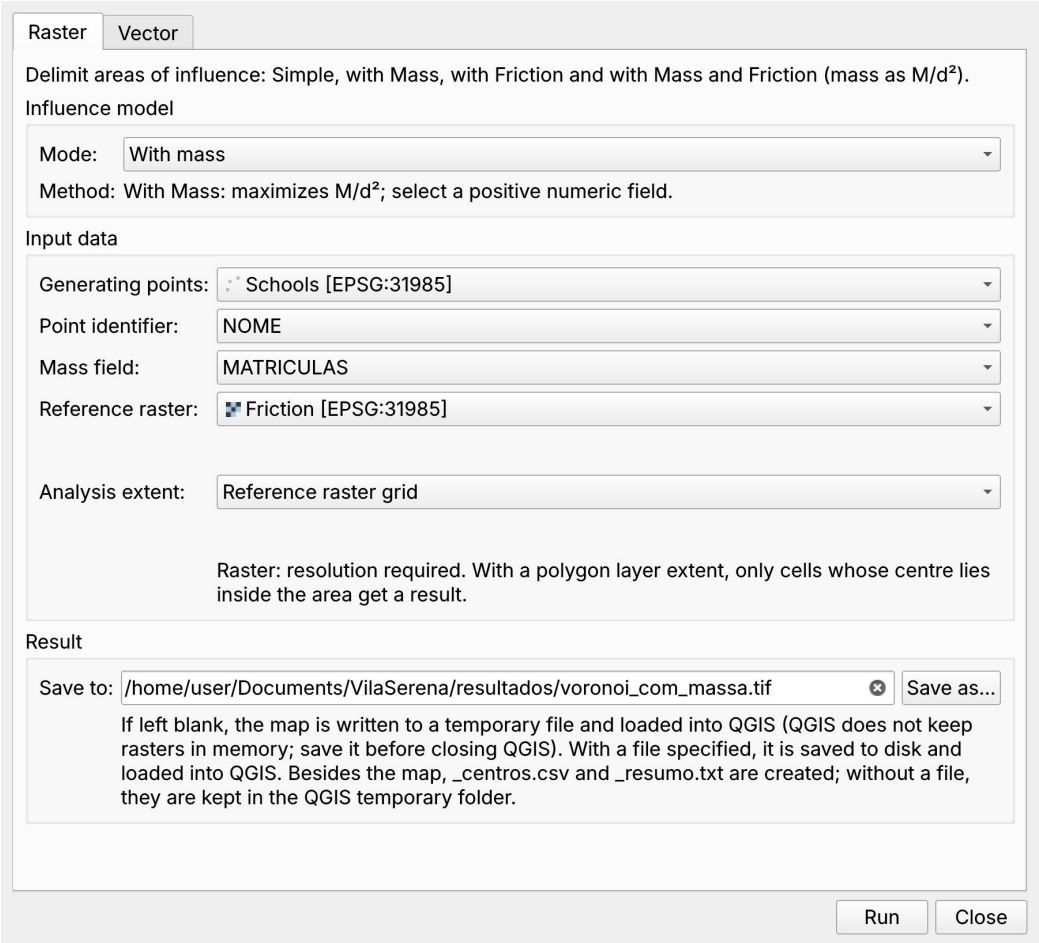


Figure 15 - Voronoi analyses, With mass: enrolment as mass, friction raster grid

6.2 With friction

1. Switch **Mode** to **With Friction**.

2. In **Surface type**, **Raster**; in **Friction surface**, **Friction**.
3. Keep the reference raster grid; in **Save to**, resultados\voronoi_com_atrito.tif. Click **Run**.
4. For comparison, also run the **Simple** mode (resultados\voronoi_simples.tif).

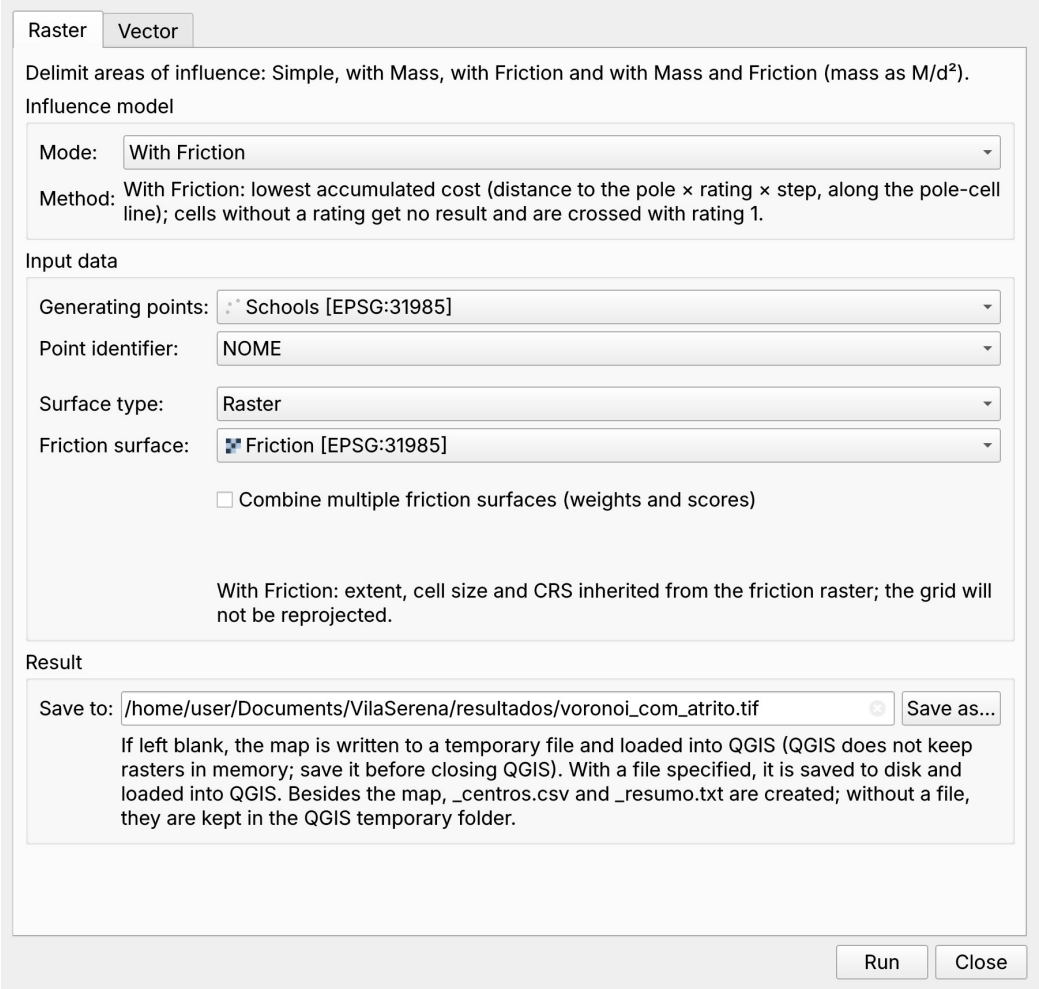


Figure 16 - Voronoi analyses, With Friction: raster friction surface

Expected result

School (enrolment)	Simple (ha)	With mass (ha)	With Friction (ha)
E. M. Monteiro Lobato (900)	59.40	72.94	49.70
E. E. Cecília Meireles (600)	85.86	76.92	97.85
E. M. Paulo Freire (450)	83.50	69.66	68.12
E. M. Rachel de Queiroz (300)	90.14	57.55	86.83
E. E. Darcy Ribeiro (1,200)	40.52	100.34	56.99
E. M. Cora Coralina (250)	40.58	22.59	40.51

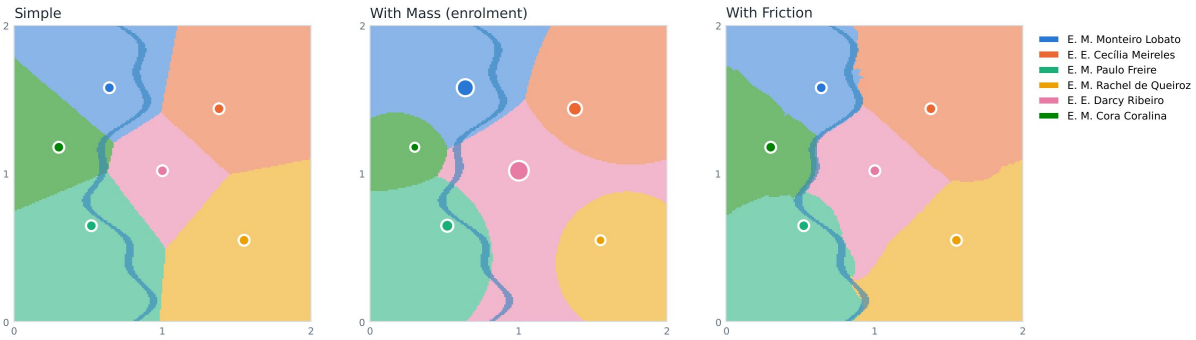


Figure 17 - The areas of influence in the three modes (in With mass, the dot size is proportional to enrolment)

How to read it

- **With mass**, E. E. Darcy Ribeiro (1,200 pupils) grows from 40.52 to **100.34 ha**; E. M. Cora Coralina (250) drops from 40.58 to 22.59 ha. The criterion is M/d^2: a school with 4 times the mass reaches twice the distance, not four times.
- **With Friction**, E. M. Monteiro Lobato, by the river, loses area (59.40 → 49.70 ha): crossing the water costs 10 times more than walking in the city. E. E. Cecília Meireles gains (85.86 → 97.85 ha).
- The cost is measured along the **straight line** between the school and each place, as in Vista SAGA: it is not the least-cost path (GRASS r.cost). The line "pays" for the river; it does not go around it.

Tips only the tutorial tells you

- A friction rating of 0 is refused; for "almost no friction", use 0.1.
- In an exact tie, the first point in the layer wins.
- _centros.csv gives the area (AREA_HA) and % (PCT_AREA) of each school: paste it next to the enrolment table and compute pupils per hectare served.

9. Lesson 7 - Map sequencer: the growth as an animation

1. Open **Vista Saga Plugin > Map sequencer**, **Raster** tab.
2. Add, in this order, **Land use 2000**, **Land use 2010** and **Land use 2020** (the plugin reads the year from the name; use **Sort by date** if needed).
3. In **2. Dimensions and composition**: width and height **600**, duration **1000 ms / frame**, **Show date/period on map** on.
4. In **3. Outputs and preview**, enter resultados\vila_serena_2000_2020.gif and tick **Also export individual PNG frames**. Click **Run**.

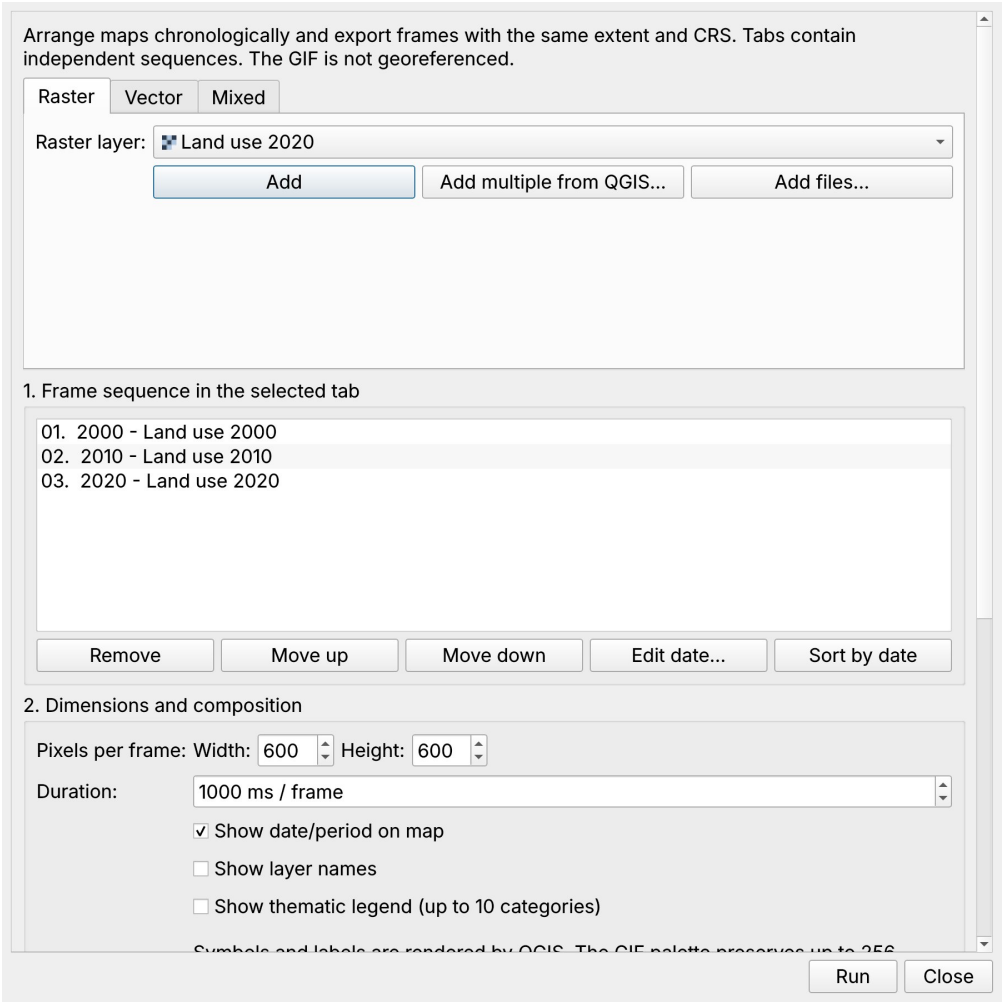


Figure 18 - Map sequencer: three frames, 600 × 600 pixels

Expected result: a 3-frame GIF (2000, 2010, 2020) with the year in the corner, and a folder with the three PNGs (quadro_001_2000.png…). Frames use the symbology set in QGIS.

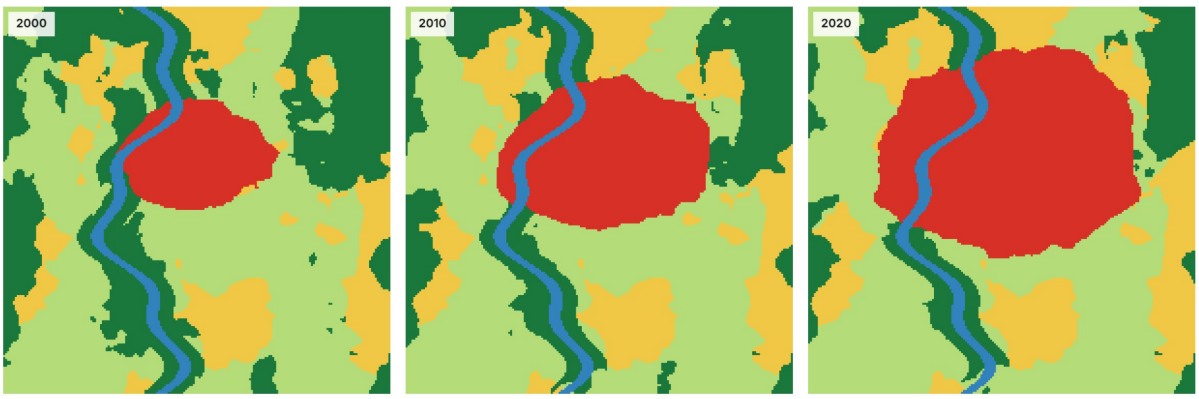


Figure 19 - The three frames created by the Map sequencer

> **A tip only the tutorial tells you**
>
> A GIF has at most 256 colours. For a slide presentation, use the PNGs: colours stay exact and you control the timing of each frame in the presentation software itself.

10. Wrap-up: the diagnosis of Vila Serena

Putting the lessons together, the answer to the council fits in five sentences:

1. Downtown is already 70.8% urban, and a third of it lies on floodplain soil (Signature).
2. In 20 years the town tripled, mainly over pasture, and native vegetation lost more than half of its area (Monitoring).
3. There are 17.89 ha of city on fluvic neosol, a priority for drainage and flood control (Map combination).
4. The most suitable areas for growth (scores 8 and 9, 98.07 ha) lie on flat or gently rolling land, almost all outside the floodplain (Evaluation).
5. The river redraws school catchments: taking the crossing into account changes the area served by most schools (Voronoi).

Checklist

Lesson	Expected file in resultados	Key number
1	bairros.tif, uso_solo_2020.rs2 (+ .rs2.json)	200 × 200 cells; identical round trip
2	assinatura.csv, assinatura.txt	Urban area in the union: 59.19 ha (45.53%)
3	transicoes_2000_2020.tif + _transicoes.csv, _matriz.csv, _resumo.txt	Change: 30.89%
4	uso2020_x_solos.tif + _combinacoes.csv, _resumo.txt	13 combinations
5	aptidao_expansao.tif + CSV and TXT reports + _pesos_notas.geosaga.json	Mean 6.34
6	voronoi_*.tif + _centros.csv, _resumo.txt	Darcy Ribeiro With mass: 100.34 ha
7	vila_serena_2000_2020.gif + PNG folder	3 frames

If your number did not match

- Check that you used the right maps (2000 and 2020, not 2010) and the right order in the list.
- Check the CRS of the project and of the layers (EPSG:31985).
- In Evaluation, check weights and scores against the ready-made project (aptidao_expansao.geosaga.json).
- In Voronoi, check the extent: with "Visible extent in QGIS", the total area changes with the zoom and the areas do not match; use the reference raster grid.

Next steps

- Repeat the lessons with your own data: the route is the same.
- See the **User Manual** for every field, advanced option and tip of each module.
- Watch the video of each module on the project channel (links on the official website).