Mastering Cartography with QGIS

Unlocking its Full Potential

ICC 2025, Vancouver, Canada

ETH zürich

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QGIS

How do new features get implemented in QGIS?

As a QGIS user who wants to get a new feature in QGIS core, one can:

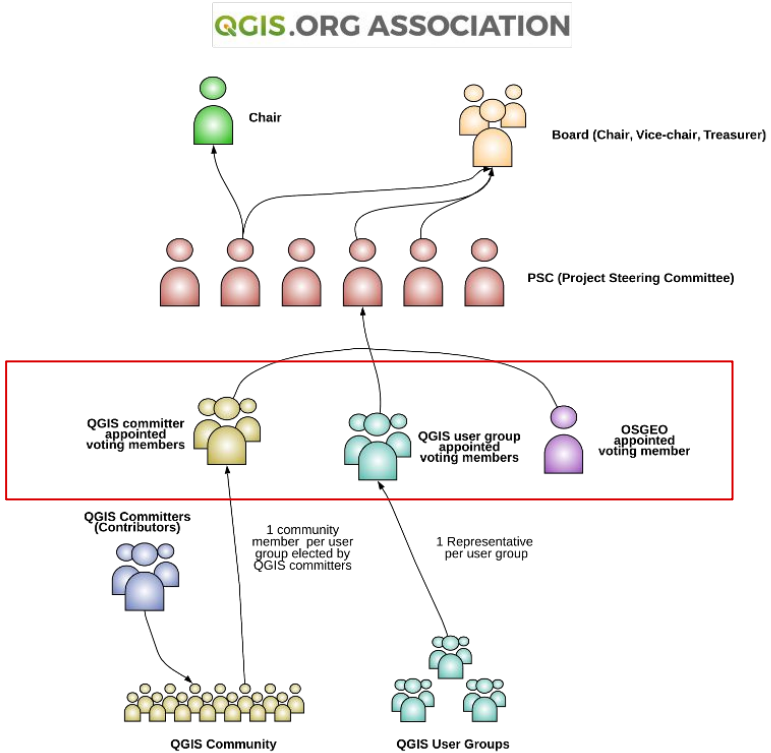
- contract with a QGIS developer and/or support company
- organize a crowdfunding campaign
- implement it yourself (if you have the skills or staff)

More complex changes require a QEP (QGIS enhancement proposal) with a detailed proposal, discussion about side effects and eventually a vote.

Alternative: development of a QGIS plugin for more exotic requirements that don’t make it into QGIS core.

About QGIS and Open Source

About QGIS Association

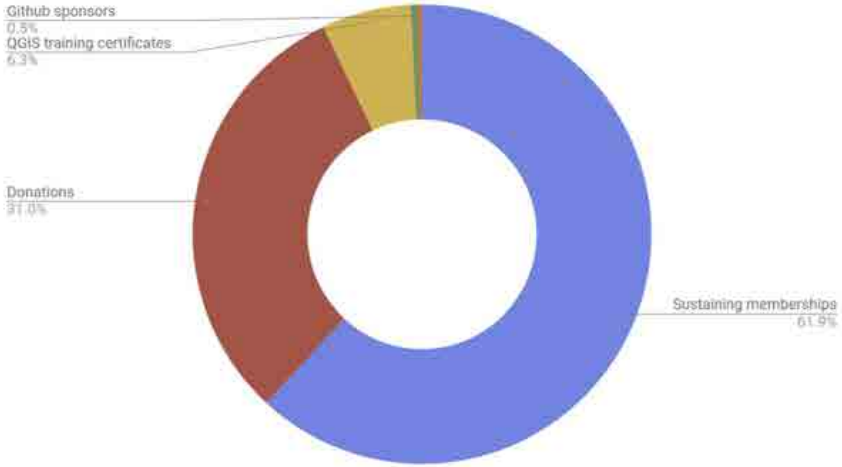


QGIS is a worldwide GIS user community legally represented by an association in Switzerland

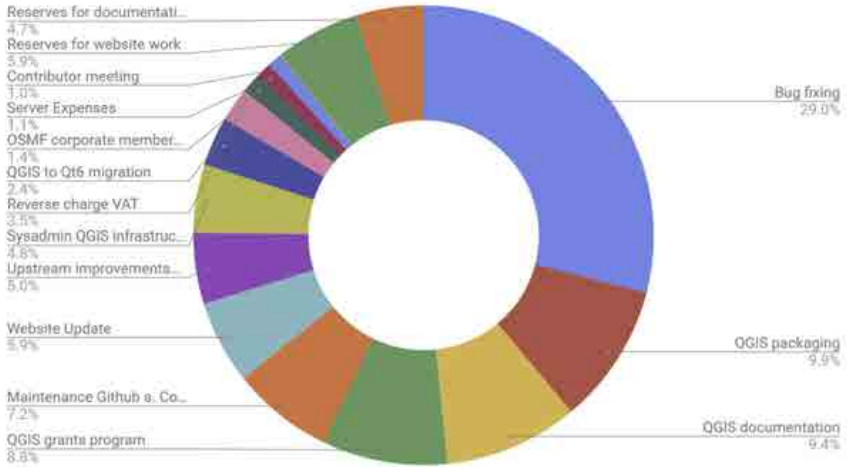
30 country user groups from all continents (except Antarctica)

QGIS finances

Income



Expenses

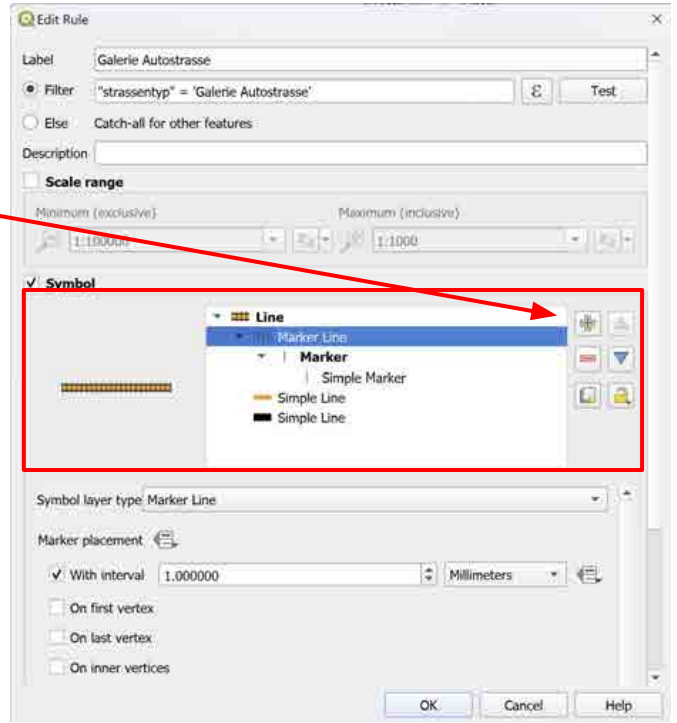


Who offers QGIS core development?

QGIS Cartography Tricks

Multilevel Symbology

- Multilevel symbols are key to more complex symbology
- The buttons on the right allow to add, delete, duplicate and re-order symbol levels
- The order defines the drawing order on the **individual feature**



since QGIS 2.0 ?

Problems with multi-level Symbology

The Problem: ugly line caps and joins!

without symbol level override settings

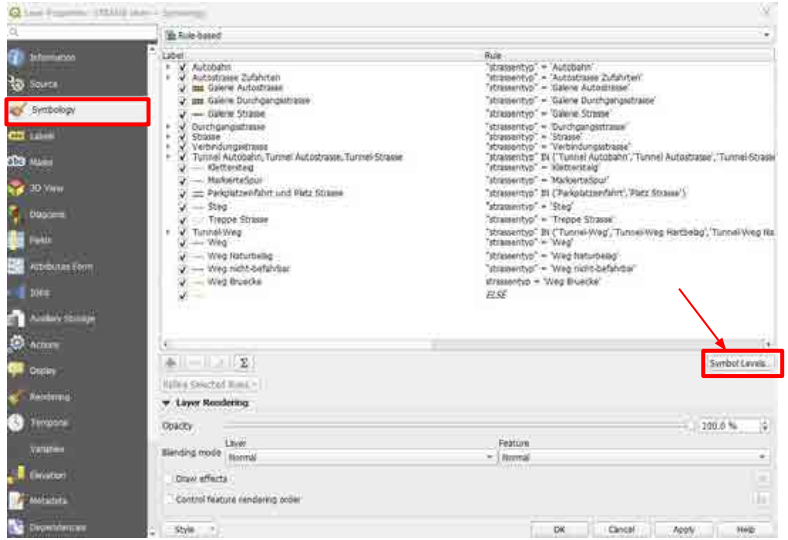
The solution: symbol level control!

with symbol level overrides

since QGIS 2.0 ?

Symbol Level Control

- Allows to control drawing order of multilayer-symbols, with multiple passes
- The higher the number, the later it is drawn within the rendering process

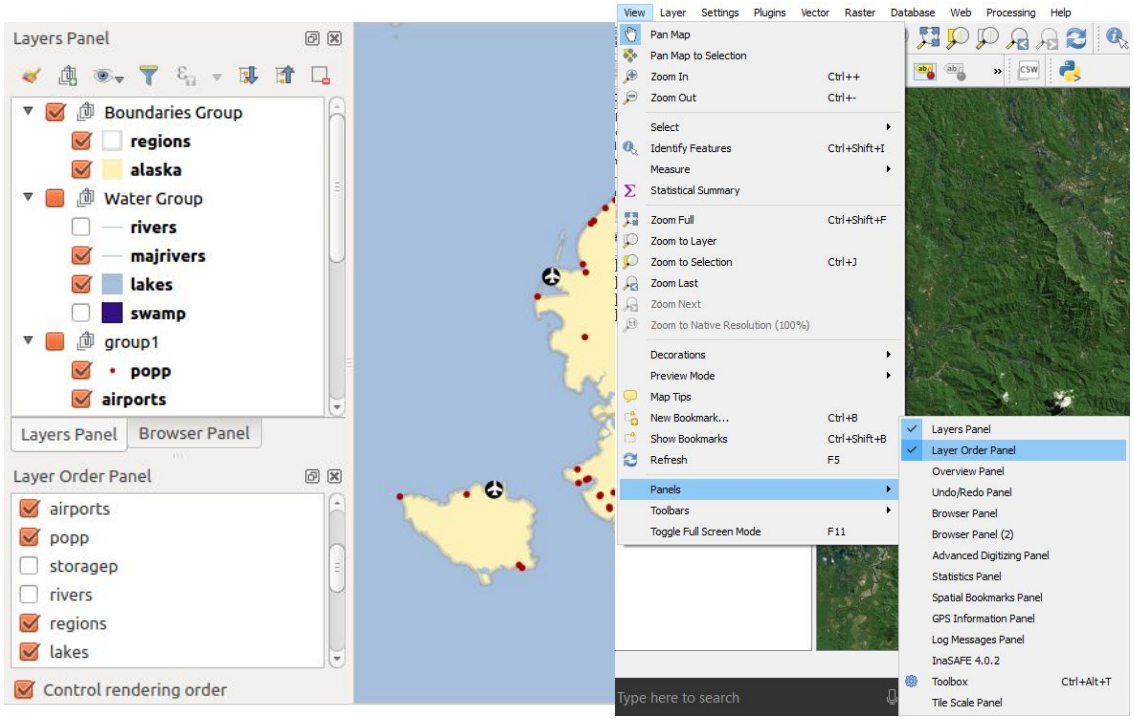


since QGIS 2.0 ?

Separation of Layer Drawing Order

In the layer panel one can hierarchically group layers thematically that belong together.

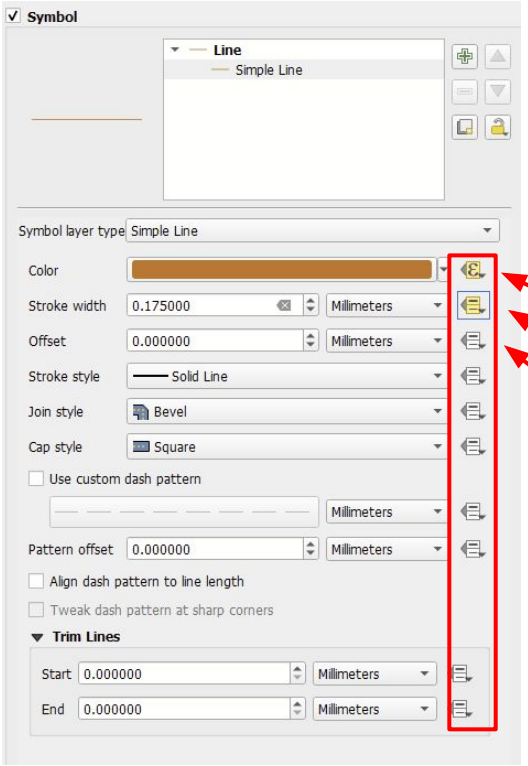
That doesn't necessarily mean it should be same order than for drawing layers. Solution: separate "layer order panel" that doesn't have hierarchies but just a single order.



since QGIS 1.x ?

Data-defined Symbology (overrides)

Almost every graphical property can be overridden with a data field or “expression” (formula)



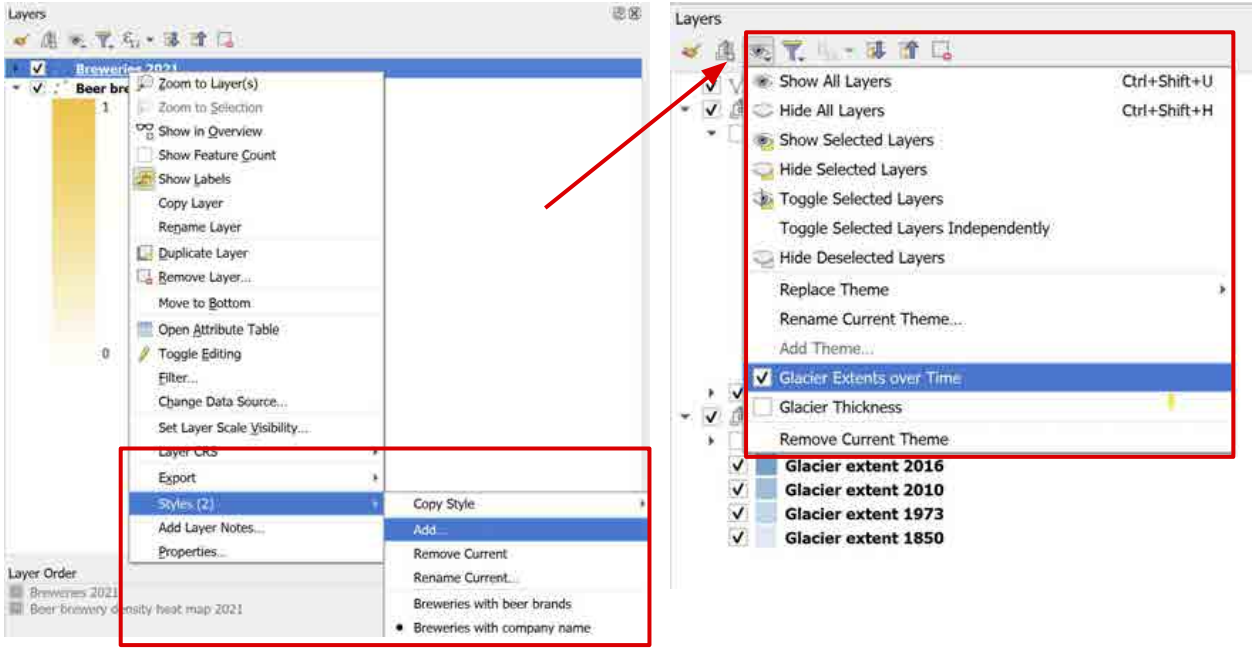
Expression override
Field override
No override

since QGIS 2.x ?

Multiple styles per layer and map themes

A layer can have multiple styles for the same data.

A “map theme” is a “bookmark” to layer visibility and style combinations.



since QGIS 2.x ?

Selective Masking

- Allows to mask specific symbol levels, e.g. darker parts of a symbol
- Works with labels and point symbols

Raw rendering of a dark label on a background made of dark lines

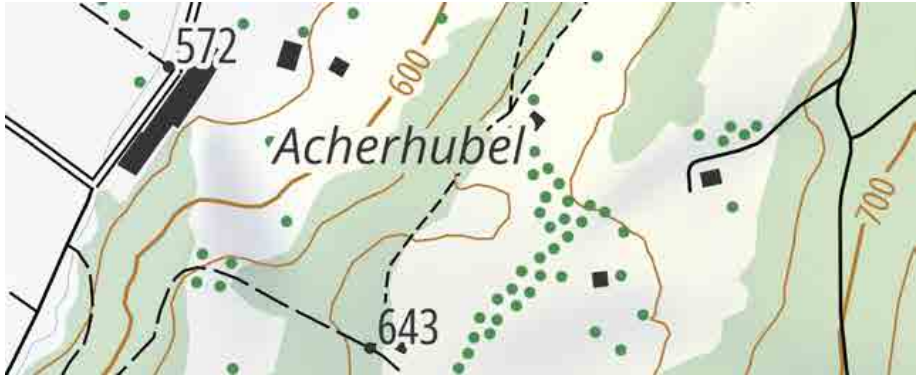
Rendering of the same label, but with a buffer

Rendering example with a selective masking

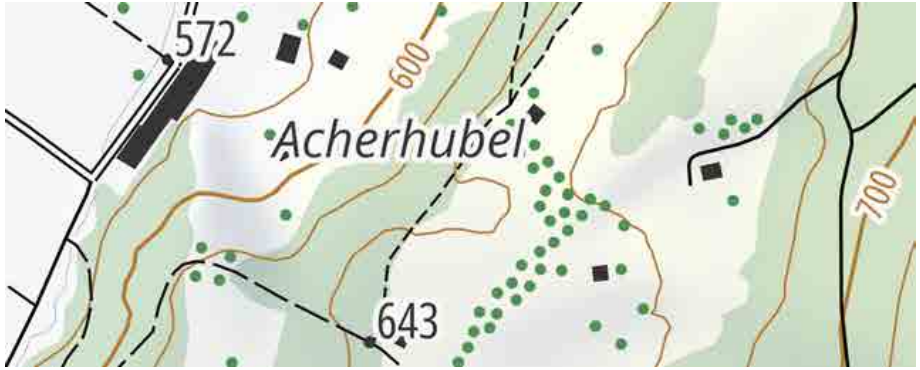

Rendering example of selective masking around a point marker

since QGIS 3.12, but improved multiple times in recent versions

Selective Masking



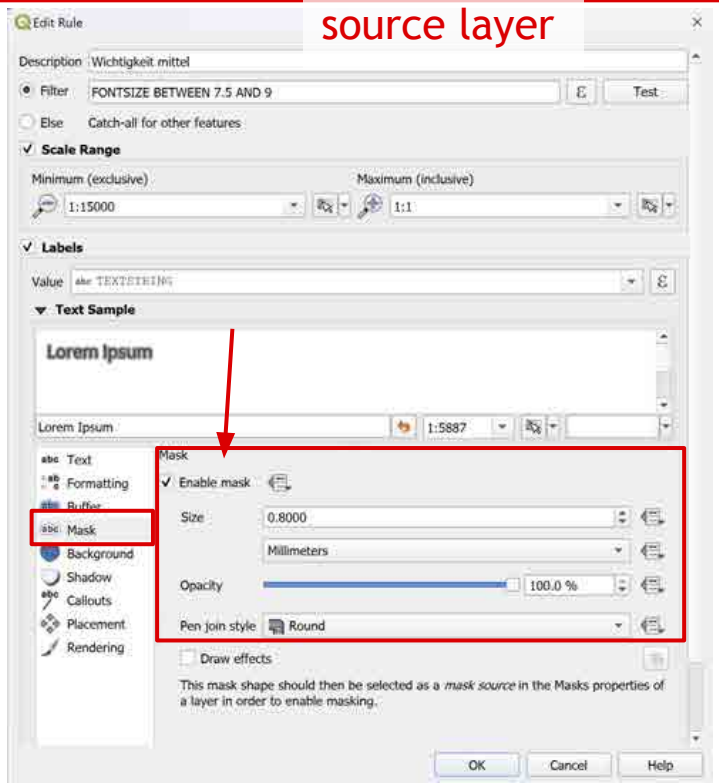
with selective masking

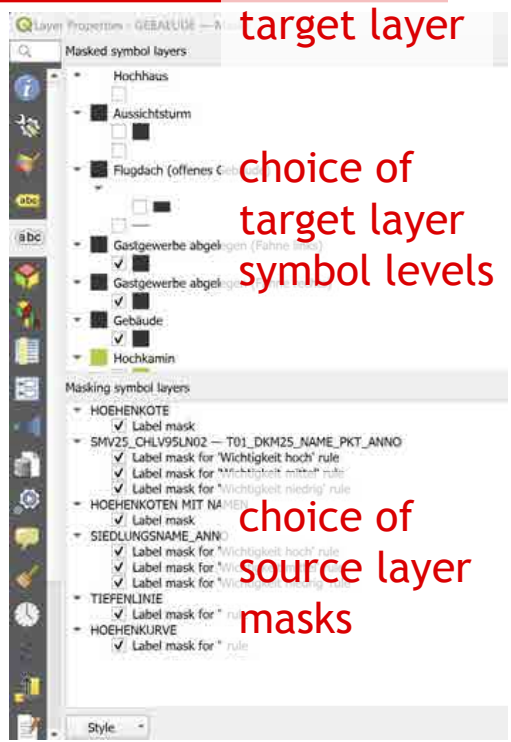


with traditional white buffer

Selective Masking: Howto

1. Define Mask on label or symbol layer (source layer)
2. Choose and assign mask on target layer on individual symbol levels





since QGIS 3.12

Selective Masking: Issues

Problems:

Some QGIS versions had issues*:

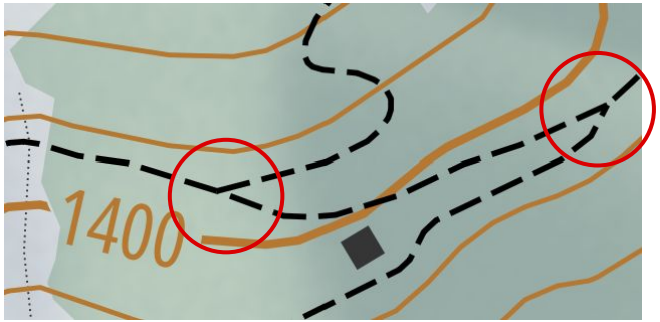
- ~~with symbol duplications (ID uniqueness issues)~~
- ~~with combinations with transparency and blend modes~~
- ~~output was forced into raster~~
- with PDF export (when combined with blend modes)

Selective masking comes at a “cost” (additional rendering passes), they have a negative impact on rendering performance.

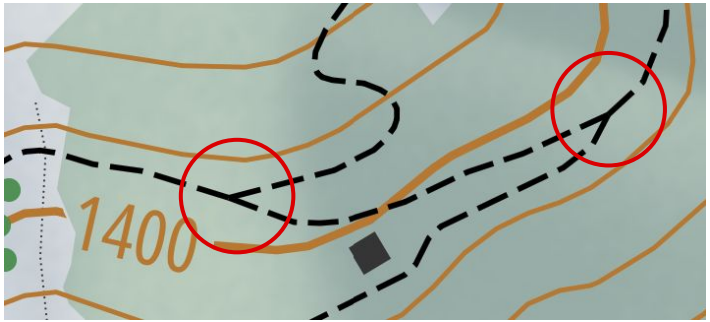
* striked out issues are already resolved, the last one is in the works.

Dashing improvements

Align dash pattern to line length



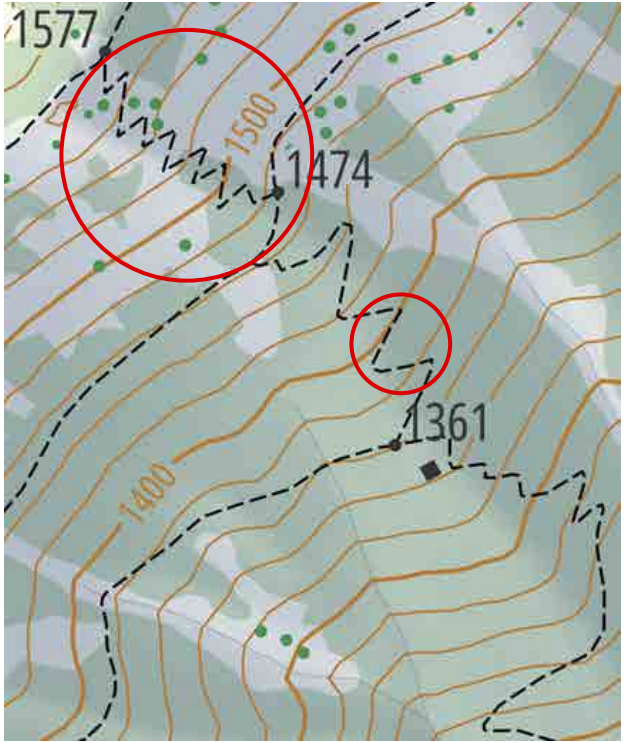
off



on

since QGIS 3.16

Dashing improvements

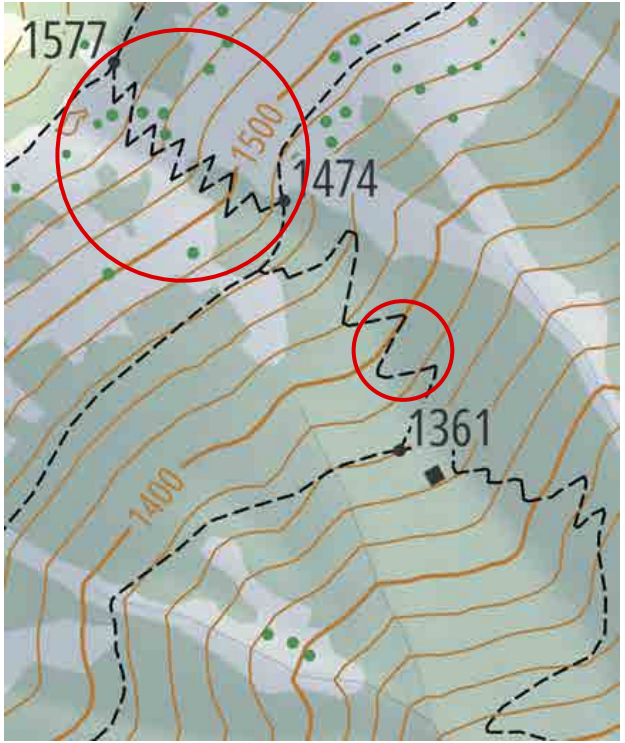


Tweak dash pattern at sharp corners

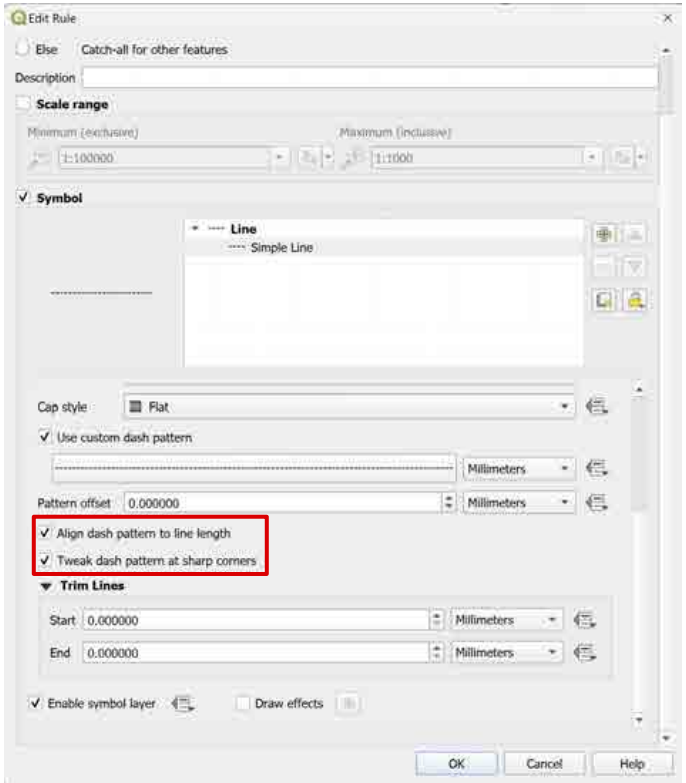
since QGIS 3.16

off

on



Dashing improvements



Align dash pattern to line length:
makes sure that the rendered line always starts and ends with a full dash. The dash pattern is slightly adjusted against the defined dash pattern.

Tweak dash pattern at sharp corners:
Makes sure that a sharp corner (e.g. house corner or trail with switchbacks) is never represented with a “gap”. Also slightly adjusts the defined dash pattern.

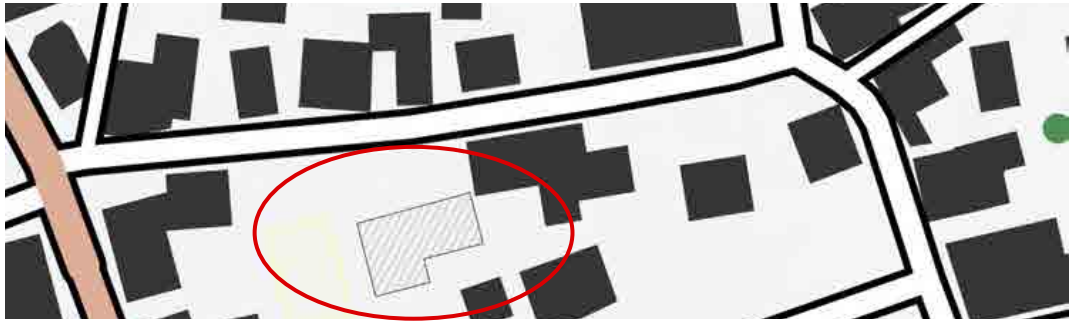
since QGIS 3.16

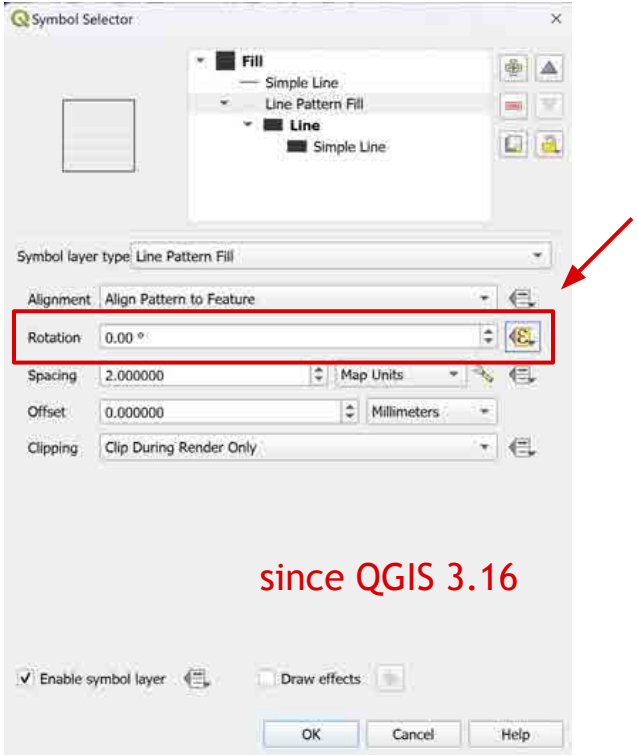
Calculating angles for polygon fill hachures

Goal: Avoid **line pattern fill** angles that are parallel or perpendicular to the longest edges of a building (polygon).

Data-defined setting with expression:

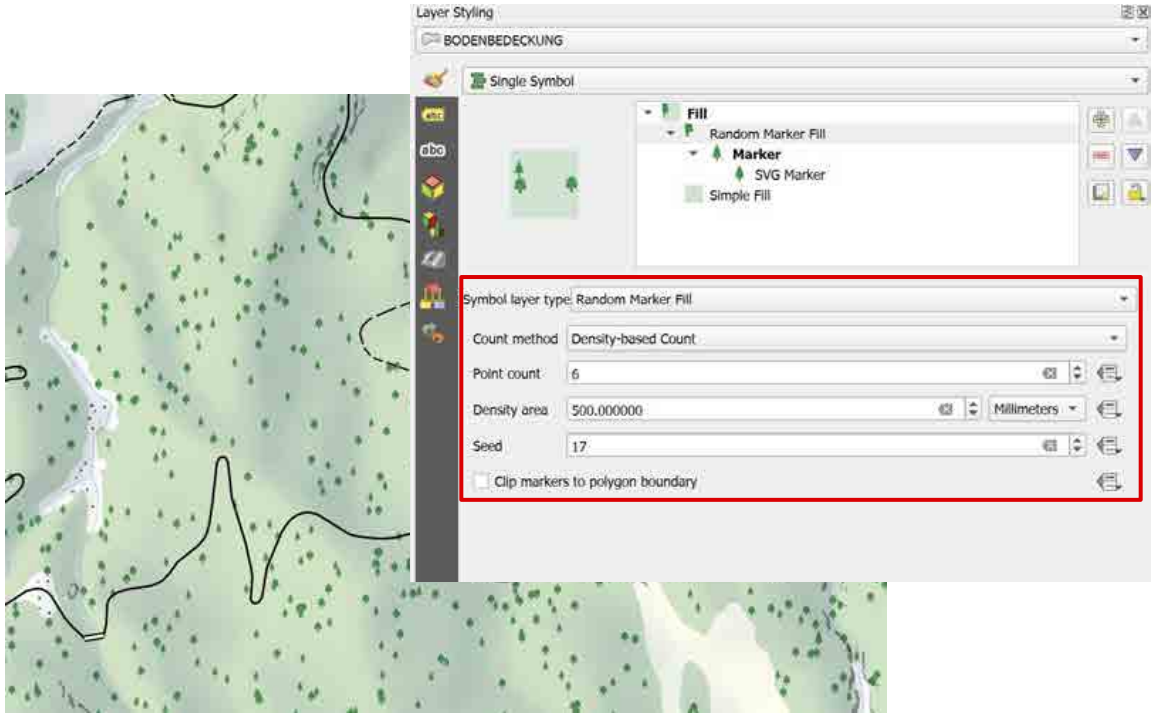
```
90 - main_angle(@geometry) + 45
```





Random Marker-Polygon-Fills

- 2 methods:
  - Absolute count
  - Density based count
- Symbols (basic shapes or SVG symbols) can be randomized using data-defined properties and random expression




```
with_variable(
    'tree',
    randf(0,1),
    CASE WHEN @tree <= 0.5 THEN
        './svg//symbol/landuse_coniferous.svg'
    ELSE
        './svg//symbol/landuse_deciduous.svg'
    END
)
```

since QGIS 3.12

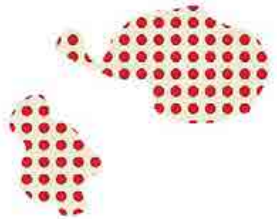
Point-pattern fill options

Point patterns can be rotated and can have offsets in every second row/column

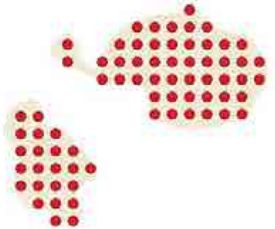
Clipping options:

- Clip to Shape
- Marker centroid within shape
- Marker completely within shape
- No clipping

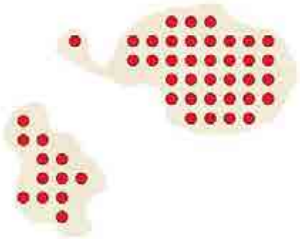
1. "Clip to shape": default behaviour, same as previous versions. Markers are clipped so that only the portions inside the polygon are visible completely visible:



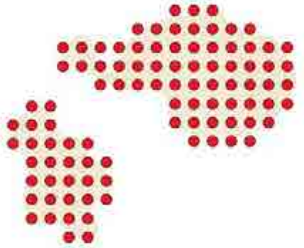
2. "Marker centroid within shape": only markers where the center of the marker falls inside the polygon are drawn, but these markers won't be clipped to the outside of the polygon



3. "Marker Completely Within Shape": only markers which fall completely within the polygon are shown



4. "No clipping": any marker which intersects at all with the polygon will be completely rendered (strictly speaking its the "intersects with the bounding box of the marker")

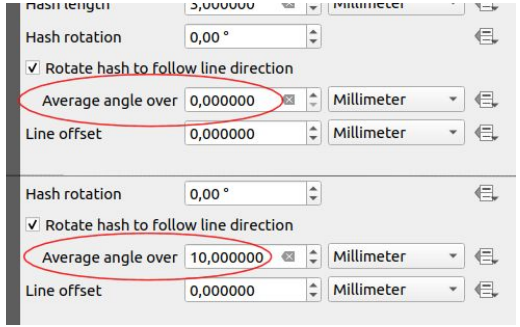


since QGIS 3.24

Averaged Angles for Marker/Hash Lines

existing old method

new average angle method



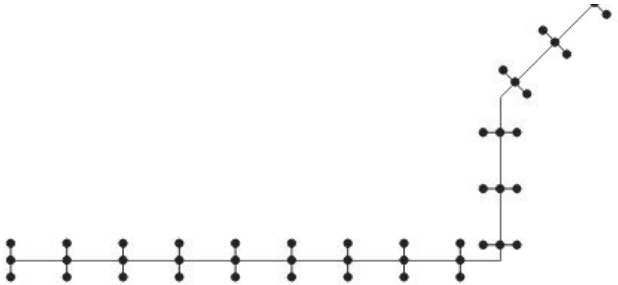
Source: https://north-road.com/2019/04/05/qgis-and-slyr-now-with-hash-lines-support/

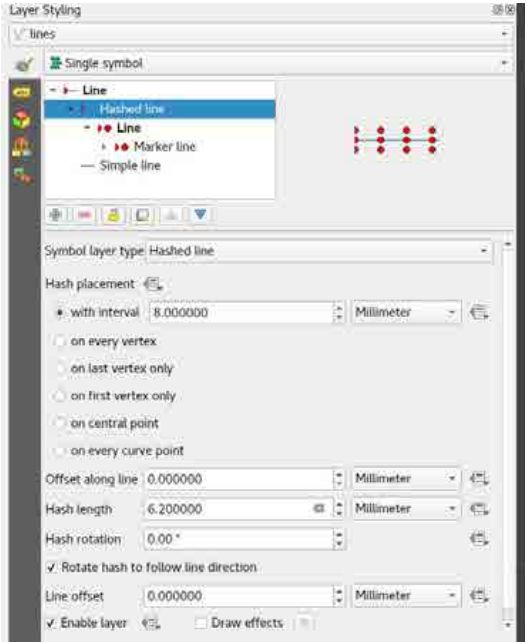
since QGIS 3.8

Hashed lines (Extension of Marker Lines)

Similar to marker lines, but instead of markers there are new lines that are displayed with a certain interval and angle to the original line (default = 90°). It is an additional "level" compared to marker lines.

Hashed lines can have arbitrary lines styles and can be potentially more complex than marker lines.

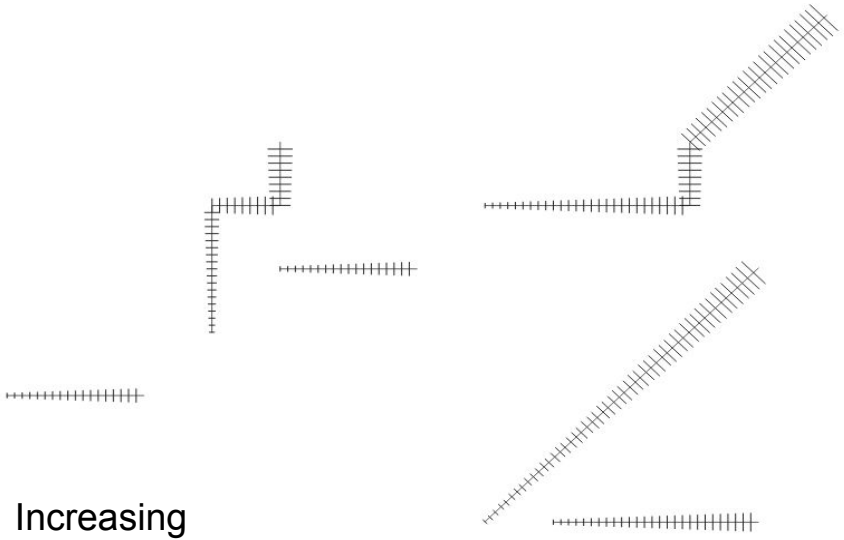




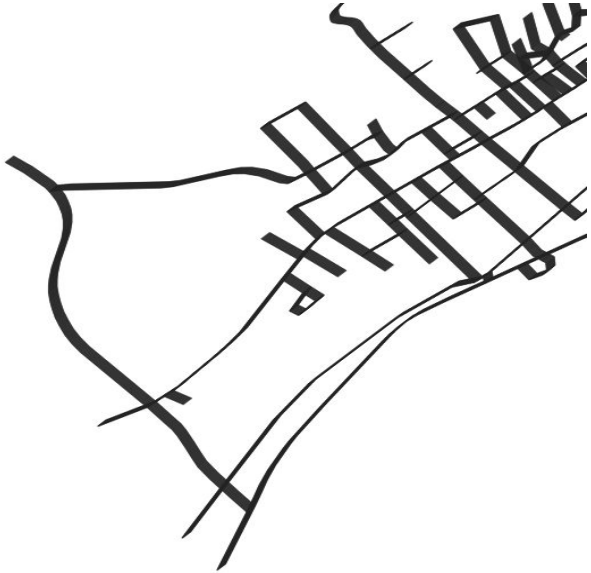
Quelle: https://north-road.com/2019/04/05/qgis-and-slyr-now-with-hash-lines-support/

since QGIS 3.8

Hashed lines



Increasing hash-widths, e.g. to represent increasing height



Calligraphy effect with a fixed hash-angle and very dense hash interval

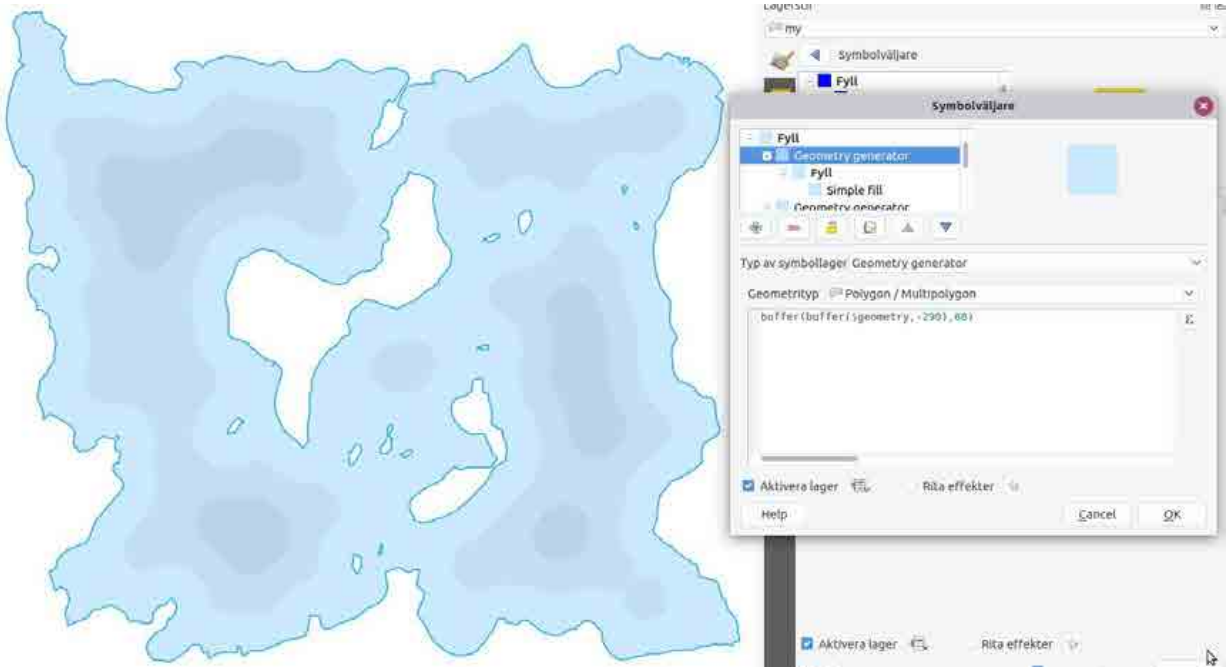
Source: https://north-road.com/2019/04/05/qgis-and-slyr-now-with-hash-lines-support/

since QGIS 3.8

Geometry generators

On the fly modifications of the original geometry for visualization purposes.

Example with multiple negative buffers to the inside of a polygon calculated with “geometry generators”

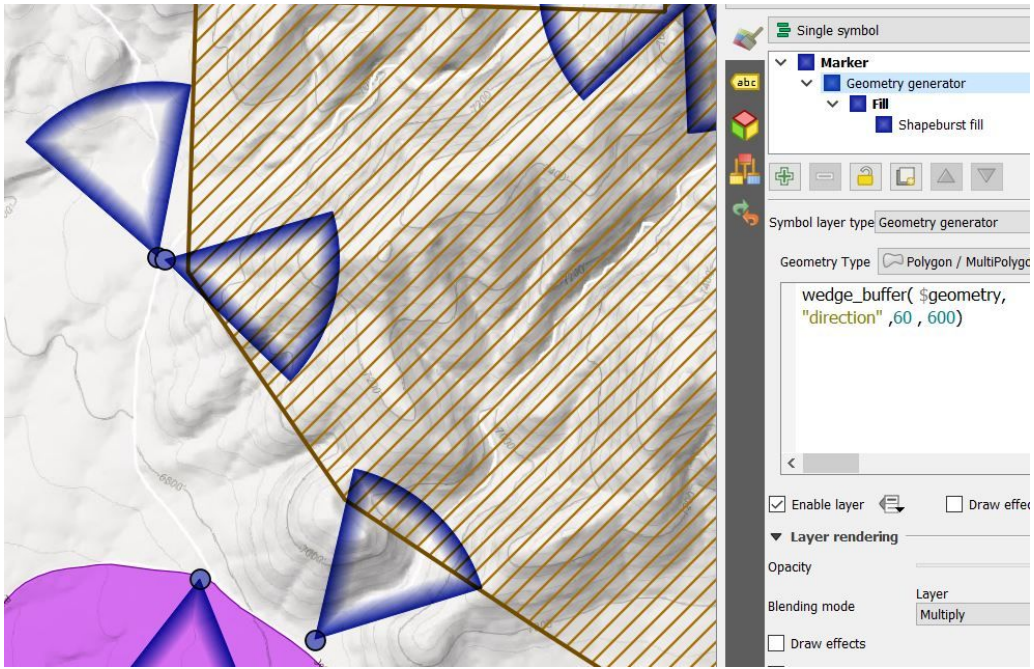


Credit: Klas Karlsson
(https://twitter.com/klaskarlsson/status/1009863307518468102/photo/1)

since QGIS 2.14

Geometry generators

Photo viewing angles with “wedge_buffer()” expression and geometry generators



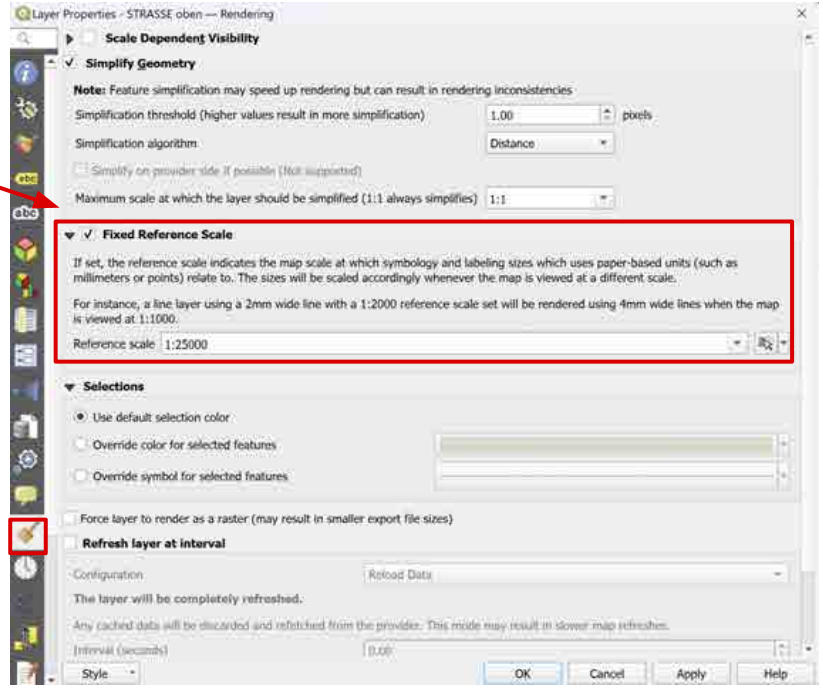
Credit: Kurt Menke (image) and Nyall Dawson (QGIS development)

since QGIS 2.14 (geometry generators) and QGIS 3.8 (wedge_buffer())

Reference Scale

Reference Scale (on layer properties): allows to set a reference scale for paper units (stroke-width, font-sizes, etc.)

When set, it behaves similar to “map units” - it scales the units when zooming in or out.



since QGIS 3.22

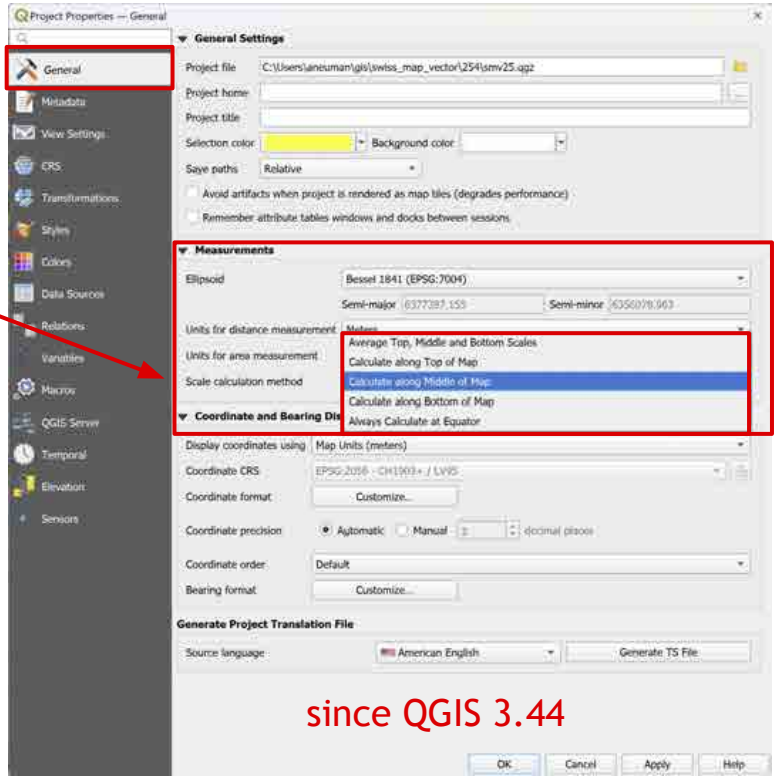
Project setting for scale calculation method

On project level, with choice of:

- at top of map
- at bottom of map
- at middle of map
- average of top, middle and bottom
- always calculate at equator (degree based CRS only, regardless of the actual visible map extent → what ESRI does)

Impact on:

- @map_scale variable
- layouts
- expressions and rule-based renderer
- status bar scale indicator



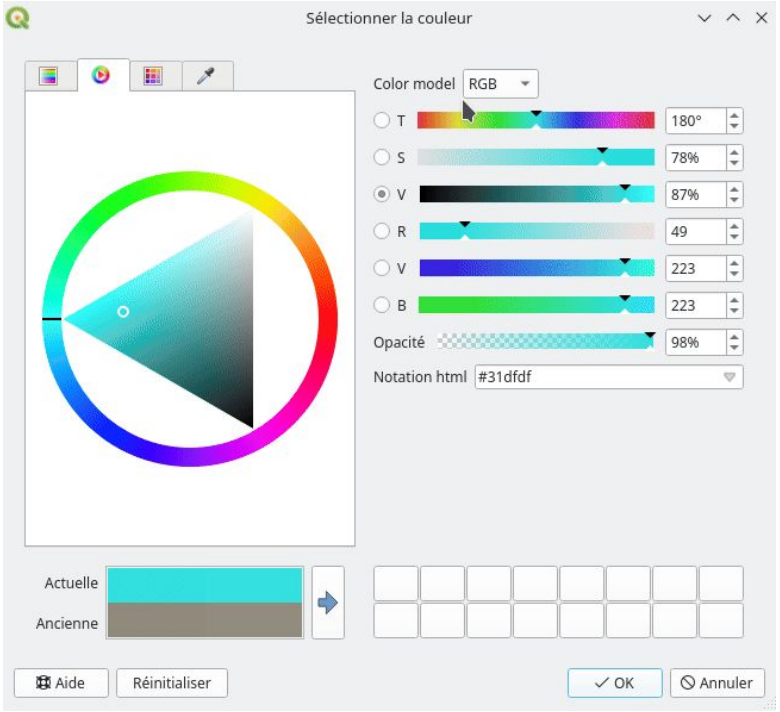
CMYK Support

CMYK-Color support

- CMYK as an alternative color system to RGB, with optional ICC color profiles
- Supports decimal values and opacity
- Supports CMYK output in PDF files for printing
- Expression functions for color conversion available

Requires Qt6 builds (currently experimental, will be shipped with QGIS 4.x)

Was implemented upstream in the Qt library by KDAB and financed through donations and sustaining memberships.

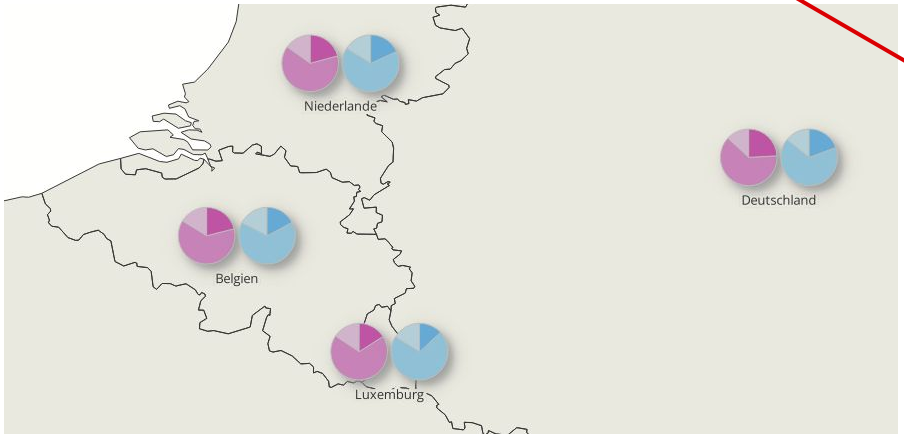


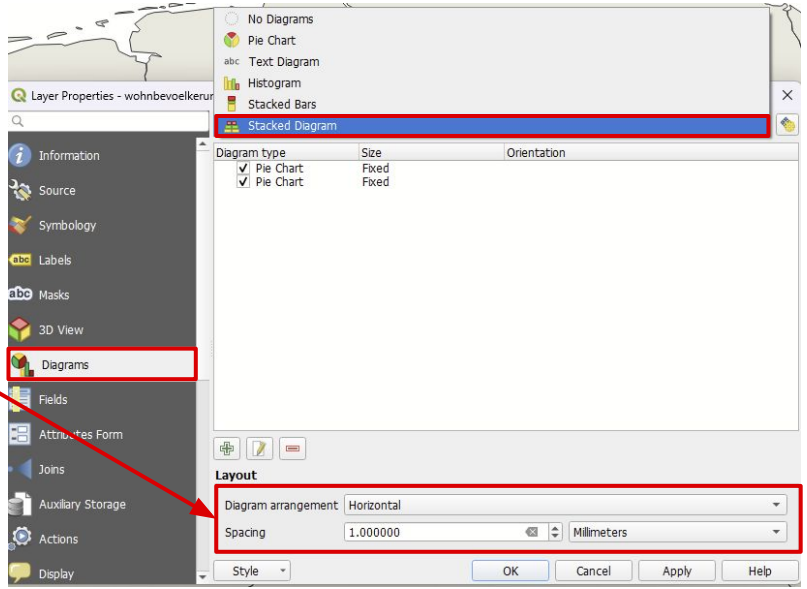
since QGIS 3.38 / 3.40

Charts / Diagrams

Stacked Diagrams

- Allows to place 2 or more diagrams on the same feature
- Arrangement “Horizontal” (next to each other) or “Vertical” (below/above each other) with spacing settings

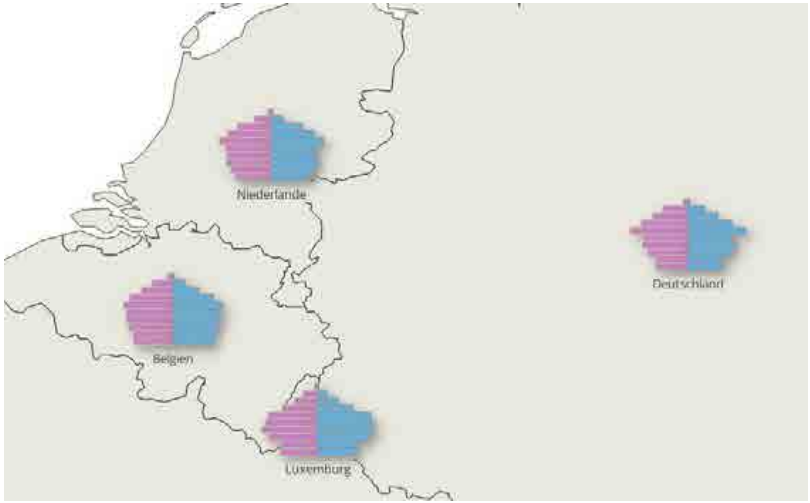


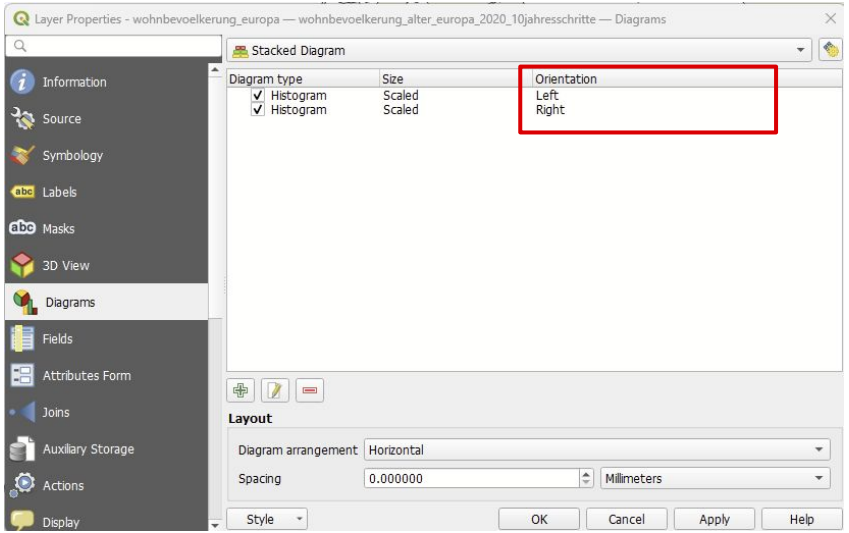


since QGIS 3.40

Stacked Diagrams

- Certain diagram types have a new “orientation” setting
- Allows to have 2 histograms next to each other to create age pyramids

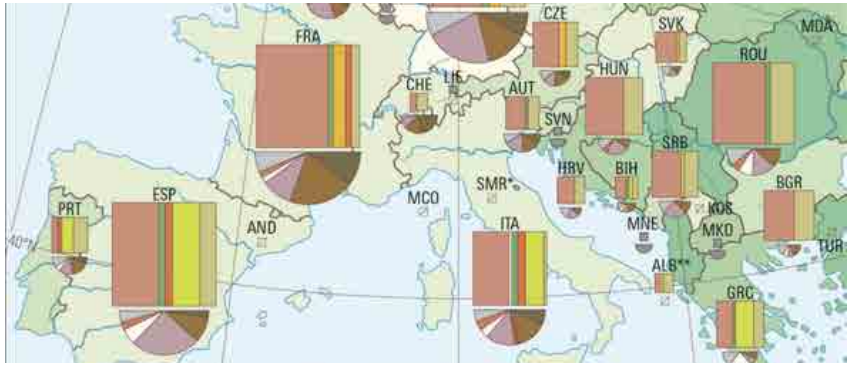


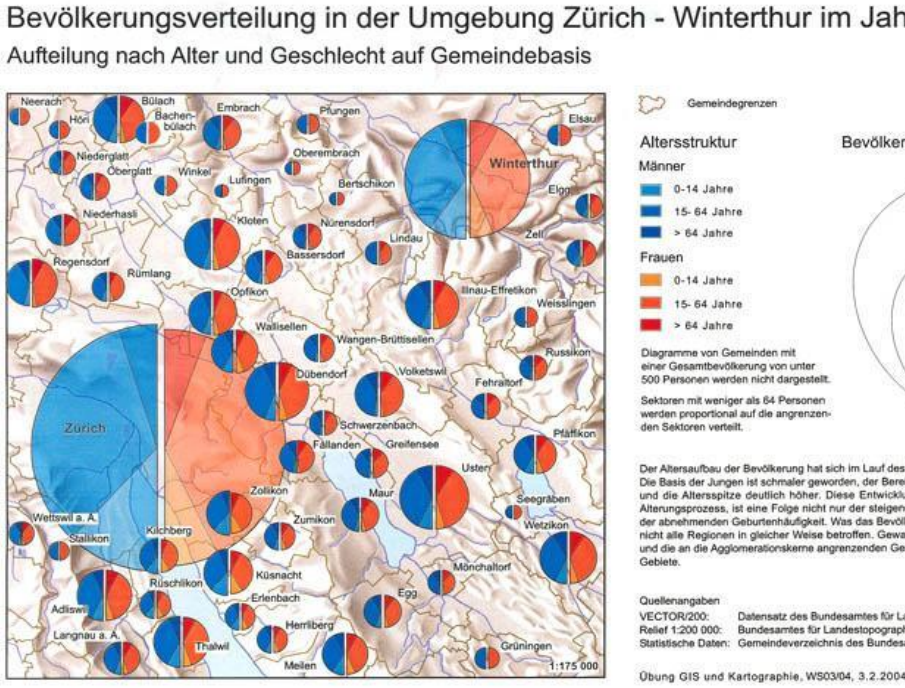


since QGIS 3.40

Planned: partial pie charts

- Implement partial pie charts where a fraction of a circle represents 100%
- Allows to place two half-circles or four quadrangles to be placed next to each other and save space
- Co-Funding appreciated

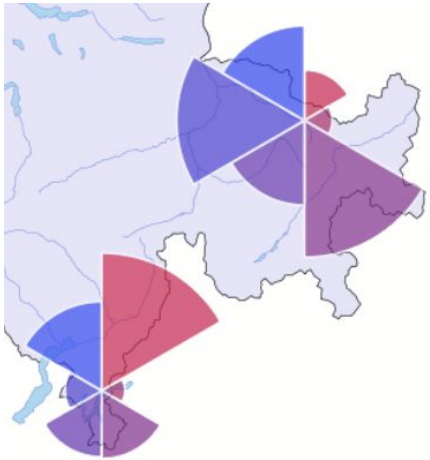


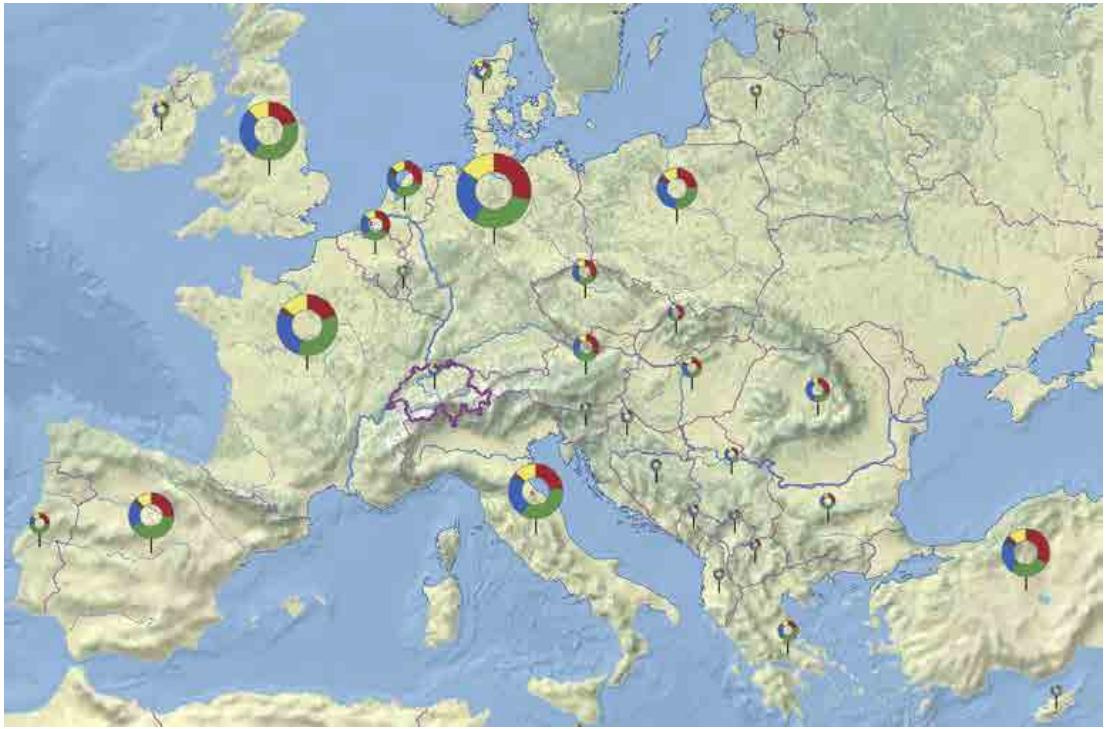


in 2026?

Planned: wing charts and donut charts

- Implement donut charts
- Implement wing charts
- Co-Funding appreciated



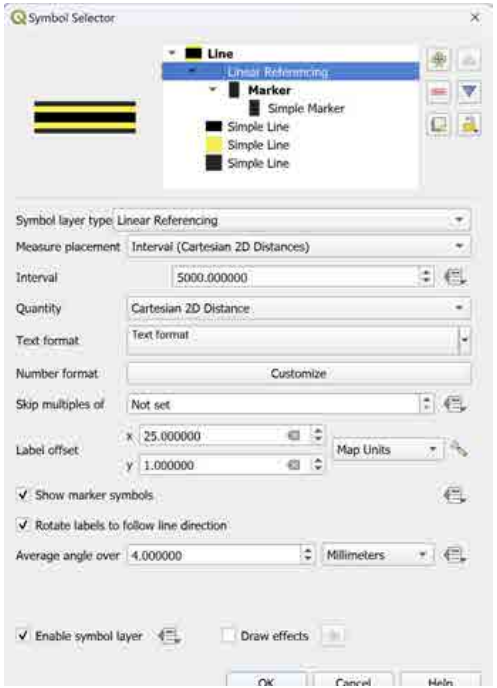


in 2026?

Labelling

Linear Referencing Renderer

- Label linear features (regular intervals or at every vertex)
- New renderer type (not in labelling)
- Supports M and Z values
- Fully integrated with QGIS label engine
- Skip multiples option for major/minor labels
- Numeric formatting and expression support



since QGIS 3.40

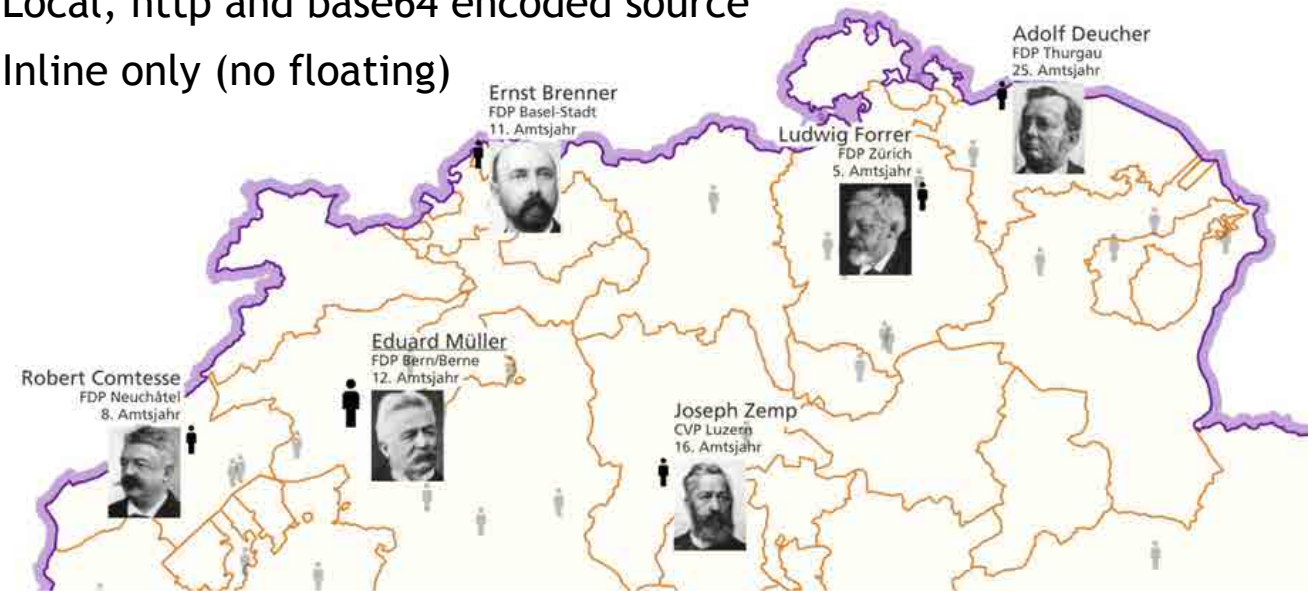
Improved HTML Labels

- horizontal text-alignment (left, center, right, justify) (QGIS 3.40)
- header support (h1 to h6) (QGIS 3.40)
- CSS word-spacing support (QGIS 3.40)
- CSS line-height support (QGIS 3.42)
- support for CSS-margins (QGIS 3.42)
- support for CSS-backgrounds on block level elements (<p/>, ,) - not supported in curved labels (QGIS 3.42)
- tabulator and custom tab distance support (to simulate tables)

since QGIS 3.40 and 3.42

Images in HTML Labels

- Images can be part of HTML labels (no support on curved labels)
- They follow text alignment
- Local, http and base64 encoded source
- Inline only (no floating)

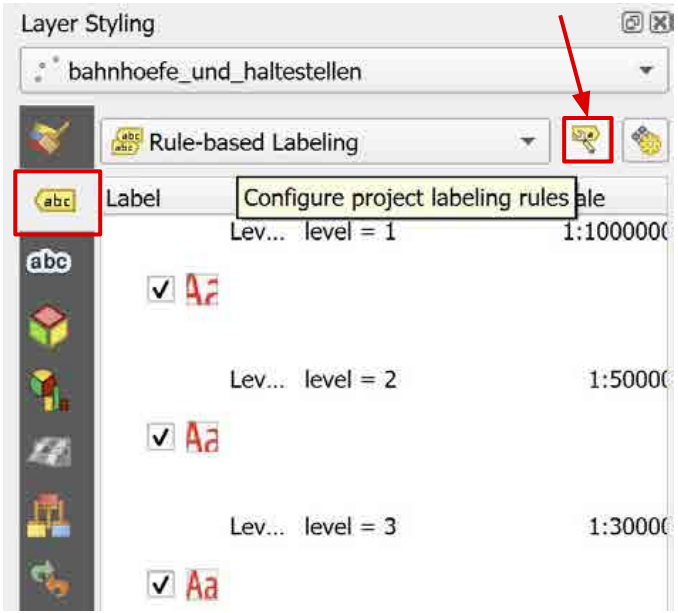


since QGIS 3.40

New labelling rules framework

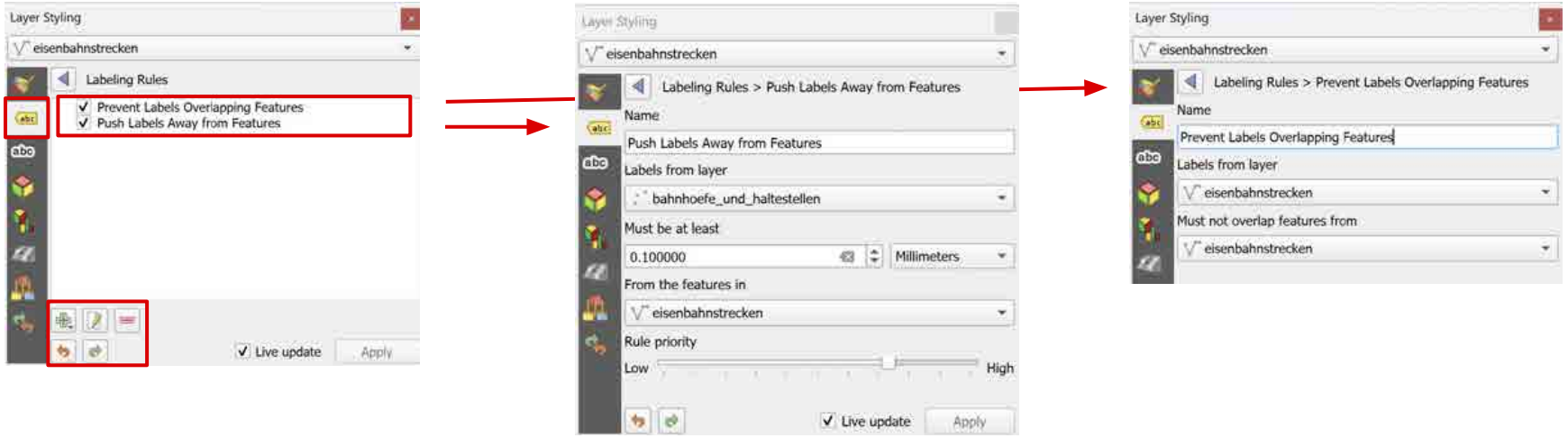
Label rules framework works across multiple layers (on project level)

- prevent labels being placed *too close* to *features* from a different layer
- prevent labels being placed *too far* from features from a different layer
- prevent labels being placed *too close* to *labels* from a different layer
- prevent labels being placed *overlapping features* from a different layer



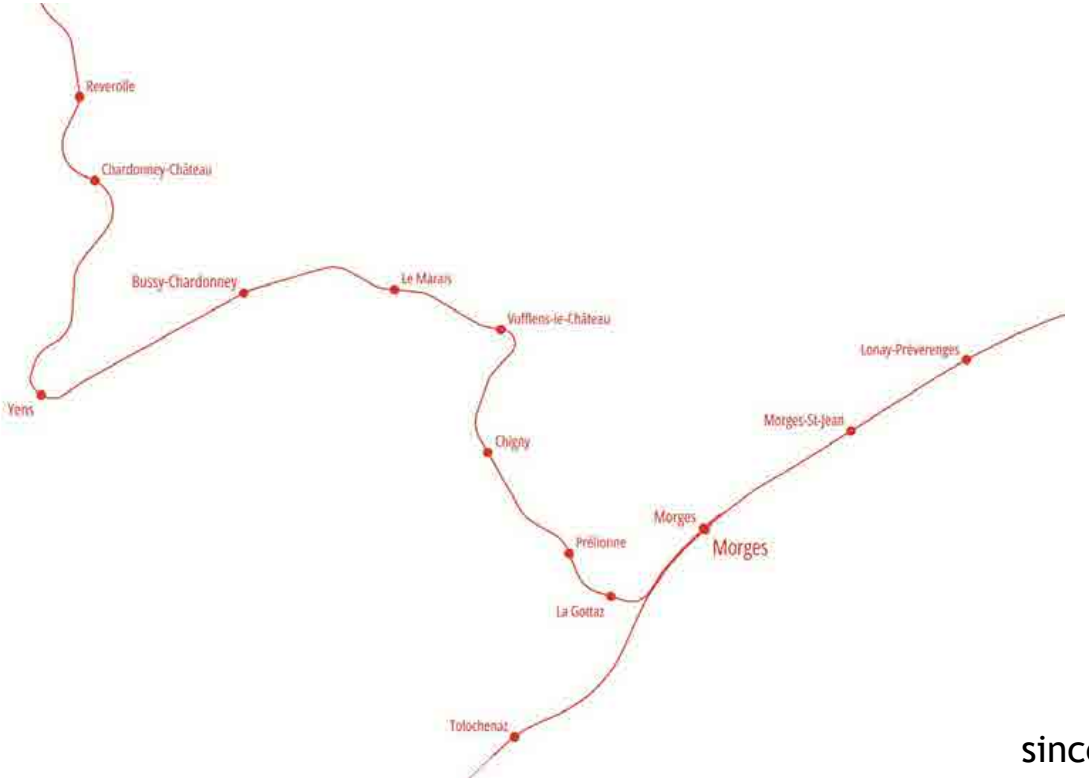
since QGIS 3.40

New labelling rules framework



since QGIS 3.40

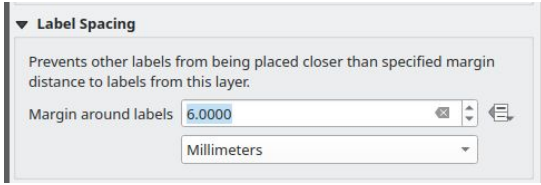
New labelling rules framework



since QGIS 3.40

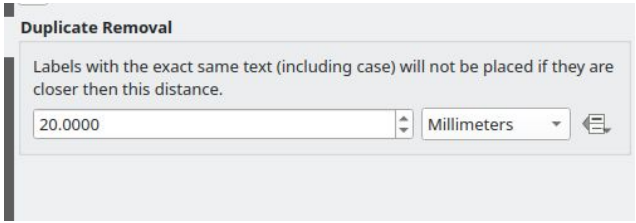
Label margins and duplicate label handling

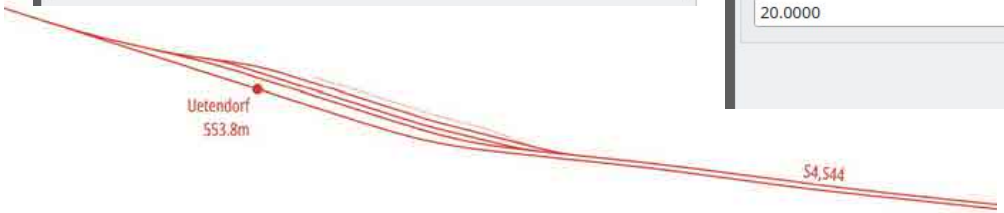
New label margin property to prevent other labels to overlap with the additional margin



New duplicate handling:

- prevent duplicate labels with exact same text within given distance
- works across multiple layers





since QGIS 3.44

Credits

- Developers: Nyall Dawson, Julien Cabieces, Mathieu Pellerin, Matthias Kuhn, German Carillo, Denis Rouzaud, Vincent Cloarec, Peter Petrik
- Crowd-Funding contributors and QGIS users who contributed to the financing of the new cartographic features
- Contributors to the QGIS visual changelogs, blog posts and video tutorials explaining some advanced cartographic features (e.g. Klas Karlsson, Kurt Menke, Ujaval, Anita Graser, …)