# QGIS User Guide

Реліз 2.14

**QGIS** Project

1	Preamble	1
2	Conventions2.1GUI Conventions2.2Text or Keyboard Conventions2.3Platform-specific instructions	3 3 4
3	Foreword	5
4	Features 4.1 View data 4.2 Explore data and compose maps 4.3 Create, edit, manage and export data 4.4 Analyze data 4.5 Publish maps on the Internet 4.6 Extend QGIS functionality through plugins 4.7 Python Console 4.8 Known Issues	7 7 8 8 8 8 9
5	What's new in QGIS 2.14	. 1
6	6.1 Installation	. <b>3</b> 13 14 17 18
7	7.1 Menu Bar       2         7.2 Panels and Toolbars       2         7.3 Map View       3	21 27 33
8	8.1       Keyboard shortcuts       3         8.2       Context help       3         8.3       Rendering       3         8.4       Color Selector       3         8.5       Blending Modes       3         8.6       Zooming and Panning       4         8.7       Measuring       4	35 35 36 37 39
	8.8 Select and deselect features	4

	8.9 8.10 8.11 8.12 8.13 8.14 8.15 8.16 8.17	Identify features Annotation Tools Spatial Bookmarks Nesting Projects Decorations Authentication Save layer into file	42 43 44 46 47 50 51
9	<b>QGI</b> 9.1 9.2 9.3	Project Properties	53 53 55 64
10	Wor 10.1 10.2 10.3 10.4	Coverview of Projection Support Global Projection Specification Define On The Fly (OTF) Reprojection Custom Coordinate Reference System	67 67 68 70
11	11.1	QGIS Browser widget	<b>73</b> 73 74
12	12.1 12.2 12.3 12.4 12.5 12.6	Supported Data Formats The Symbol Library The Vector Properties Dialog Expressions  Working with the Attribute Table Editing Virtual layers  1	91 98 41 51
	13.1 13.2 13.3 <b>Wor</b>	king with Raster Data17Working with Raster Data1Raster Properties Dialog1Raster Analysis1king with OGC Data19QGIS as OGC Data Client1	77 78 87
1 -	14.2	QGIS as OGC Data Server	00
19	15.1	cing with GPS Data         21           GPS Plugin         2           Live GPS tracking         2	13
16	16.1 16.2	Authentication System Overview	23 30
17		Demo dataset	45 46 46 46

1 1 1 1 1	7.8 7.9 7.10 7.11 7.12 7.13	Opening GRASS mapset  GRASS LOCATION and MAPSET  Importing data into a GRASS LOCATION  The GRASS vector data model  Creating a new GRASS vector layer  Digitizing and editing a GRASS vector layer  The GRASS region tool  The GRASS Toolbox  25	47 47 50 50 51 53
1 1 1 1 1 1 1 1 1 1 1	8.1 8.2 8.3 8.4 8.5 8.6 8.7 8.8 8.9 8.10 8.11 8.12 8.13 8.14	Introduction	63 76 82 85 90 92 93 94 94 95 95
1 1	9.1 9.2	Composer36Overview of the Print Composer3Composer Items3Creating an Output3	14
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 0.10 0.11 0.12 0.13 0.14 0.15 0.16 0.17 0.18 0.16 0.17	QGIS Plugins       3         Using QGIS Core Plugins       3         Coordinate Capture Plugin       3         DB Manager Plugin       3         Dxf2Shp Converter Plugin       3         eVis Plugin       3         fTools Plugin       3         GDAL Tools Plugin       3         Geometry Checker Plugin       3         Geometry Snapper Plugin       3         Georeferencer Plugin       3         Heatmap Plugin       3         Interpolation Plugin       3         MetaSearch Catalogue Client       3         Offline Editing Plugin       3	49 $54$ $55$ $56$ $68$ $71$ $77$ $82$ $84$ $87$ $91$ $92$ $94$ $95$ $96$
2 2 2	21.1 21.2 21.3	and Support       40         Mailing lists       41         IRC       42         BugTracker       44         Blog       44	$\frac{04}{05}$

		Plugi Wiki																							
		endix GNU		ner	al I	Pub	olic	Li	cer	ıse														_	0 <b>7</b> 07
		GNU																							
23	Lite	rature	aı	nd	We	b I	Re	fer	en	ce	$\mathbf{s}$													4	17
Ιн,	декс																							4	19

### Preamble

This document is the original user guide of the described software QGIS. The software and hardware described in this document are in most cases registered trademarks and are therefore subject to legal requirements. QGIS is subject to the GNU General Public License. Find more information on the QGIS homepage, http://www.qgis.org.

The details, data, and results in this document have been written and verified to the best of the knowledge and responsibility of the authors and editors. Nevertheless, mistakes concerning the content are possible.

Therefore, data are not liable to any duties or guarantees. The authors, editors and publishers do not take any responsibility or liability for failures and their consequences. You are always welcome to report possible mistakes.

This document has been typeset with reStructuredText. It is available as reST source code via github and online as HTML and PDF via http://www.qgis.org/en/docs/. Translated versions of this document can be downloaded in several formats via the documentation area of the QGIS project as well. For more information about contributing to this document and about translating it, please visit http://qgis.org/en/site/getinvolved/index.html.

#### Links in this Document

This document contains internal and external links. Clicking on an internal link moves within the document, while clicking on an external link opens an internet address. In PDF form, internal and external links are shown in blue and are handled by the system browser. In HTML form, the browser displays and handles both identically.

#### User, Installation and Coding Guide Authors and Editors:

Tara Athan	Radim Blazek	Godofredo Contreras	Otto Dassau	Martin Dobias
Peter Ersts	Anne Ghisla	Stephan Holl	N. Horning	Magnus Homann
Werner Macho	Carson J.Q. Farmer	Tyler Mitchell	K. Koy	Lars Luthman
Claudia A. Engel	Brendan Morely	David Willis	Jürgen E. Fischer	Marco Hugentobler
Larissa Junek	Diethard Jansen	Paolo Corti	Gavin Macaulay	Gary E. Sherman
Tim Sutton	Alex Bruy	Raymond Nijssen	Richard Duivenvoorde	Andreas Neumann
Astrid Emde	Yves Jacolin	Alexandre Neto	Andy Schmid	Hien Tran-Quang

Copyright (c) 2004 - 2014 QGIS Development Team

Internet: http://www.qgis.org

#### License of this document

Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.3 or any later version published by the Free Software Foundation; with no Invariant Sections, no Front-Cover Texts and no Back-Cover Texts. A copy of the license is included in Appendix *GNU Free Documentation License*.

2 Poзділ 1. Preamble

# Conventions

This section describes the uniform styles that will be used throughout this manual.

# 2.1 GUI Conventions

The GUI convention styles are intended to mimic the appearance of the GUI. In general, a style will reflect the non-hover appearance, so a user can visually scan the GUI to find something that looks like the instruction in the manual.

- ullet Menu Options: Layer o Add a Raster Layer or Settings o Toolbars o Digitizing
- Tool: Add a Raster Layer
- Button : [Save as Default]
- Dialog Box Title: Layer Properties
- Tab: General
- Checkbox: **M** Render
- Radio Button: Postgis SRID EPSG ID
- Select a number: 1,00 \$
- Select a string:
- Browse for a file: \_\_\_\_
- Select a color:
- Slider:
- Input Text: Display name [lakes.shp]

A shadow indicates a clickable GUI component.

# 2.2 Text or Keyboard Conventions

This manual also includes styles related to text, keyboard commands and coding to indicate different entities, such as classes or methods. These styles do not correspond to the actual appearance of any text or coding within QGIS.

- Hyperlinks: http://qgis.org
- Keystroke Combinations: Press Ctrl+B, meaning press and hold the Ctrl key and then press the B key.

• Name of a File: lakes.shp

• Name of a Class: NewLayer

 $\bullet$  Method: classFactory

 $\bullet$  Server: myhost.de

• User Text: qgis --help

Lines of code are indicated by a fixed-width font:

```
PROJCS["NAD_1927_Albers",
GEOGCS["GCS_North_American_1927",
```

# 2.3 Platform-specific instructions

GUI sequences and small amounts of text may be formatted inline: Click  $^{\bullet}$  File  $\times$  QGIS  $\rightarrow$  Quit to close QGIS. This indicates that on Linux, Unix and Windows platforms, you should click the File menu first, then Quit, while on Macintosh OS X platforms, you should click the QGIS menu first, then Quit.

Larger amounts of text may be formatted as a list:

- $\Delta$  Do this
- ಶ Do that
- X Do something else

or as paragraphs:

△ X Do this and this and this. Then do this and this and this, and this and this and this and this and this.

Do that. Then do that and that and that, and that and that and that, and that and that and that and that and that and that and that.

Screenshots that appear throughout the user guide have been created on different platforms; the platform is indicated by the platform-specific icon at the end of the figure caption.

# **Foreword**

Welcome to the wonderful world of Geographical Information Systems (GIS)!

QGIS is an Open Source Geographic Information System. The project was born in May of 2002 and was established as a project on SourceForge in June of the same year. We've worked hard to make GIS software (which is traditionally expensive proprietary software) a viable prospect for anyone with basic access to a personal computer. QGIS currently runs on most Unix platforms, Windows, and OS X. QGIS is developed using the Qt toolkit (https://www.qt.io) and C++. This means that QGIS feels snappy and has a pleasing, easy-to-use graphical user interface (GUI).

QGIS aims to be a user-friendly GIS, providing common functions and features. The initial goal of the project was to provide a GIS data viewer. QGIS has reached the point in its evolution where it is being used by many for their daily GIS data-viewing needs. QGIS supports a number of raster and vector data formats, with new format support easily added using the plugin architecture.

QGIS is released under the GNU General Public License (GPL). Developing QGIS under this license means that you can inspect and modify the source code, and guarantees that you, our happy user, will always have access to a GIS program that is free of cost and can be freely modified. You should have received a full copy of the license with your copy of QGIS, and you also can find it in Appendix *GNU General Public License*.

#### Порада: Up-to-date Documentation

The latest version of this document can always be found in the documentation area of the QGIS website at http://www.qgis.org/en/docs/.

6 Розділ 3. Foreword

### **Features**

QGIS offers many common GIS functionalities provided by core features and plugins. A short summary of six general categories of features and plugins is presented below, followed by first insights into the integrated Python console.

### 4.1 View data

You can view and overlay vector and raster data in different formats and projections without conversion to an internal or common format. Supported formats include:

- Spatially-enabled tables and views using PostGIS, SpatiaLite and MS SQL Spatial, Oracle Spatial, vector formats supported by the installed OGR library, including ESRI shapefiles, MapInfo, SDTS, GML and many more. See section Working with Vector Data.
- Raster and imagery formats supported by the installed GDAL (Geospatial Data Abstraction Library) library, such as GeoTIFF, ERDAS IMG, ArcInfo ASCII GRID, JPEG, PNG and many more. See section Working with Raster Data.
- GRASS raster and vector data from GRASS databases (location/mapset). See section GRASS GIS Integration.
- Online spatial data served as OGC Web Services, including WMS, WMTS, WCS, WFS, and WFS-T. See section *Working with OGC Data*.

# 4.2 Explore data and compose maps

You can compose maps and interactively explore spatial data with a friendly GUI. The many helpful tools available in the GUI include:

- QGIS browser
- On-the-fly reprojection
- DB Manager
- Map composer
- Overview panel
- Spatial bookmarks
- Annotation tools
- Identify/select features
- Edit/view/search attributes
- Data-defined feature labelling

- Data-defined vector and raster symbology tools
- Atlas map composition with graticule layers
- North arrow scale bar and copyright label for maps
- Support for saving and restoring projects

# 4.3 Create, edit, manage and export data

You can create, edit, manage and export vector and raster layers in several formats. QGIS offers the following:

- Digitizing tools for OGR-supported formats and GRASS vector layers
- Ability to create and edit shapefiles and GRASS vector layers
- Georeferencer plugin to geocode images
- GPS tools to import and export GPX format, and convert other GPS formats to GPX or down/upload directly to a GPS unit (On Linux, usb: has been added to list of GPS devices.)
- Support for visualizing and editing OpenStreetMap data
- Ability to create spatial database tables from shapefiles with DB Manager plugin
- Improved handling of spatial database tables
- Tools for managing vector attribute tables
- Option to save screenshots as georeferenced images
- DXF-Export tool with enhanced capabilities to export styles and plugins to perform CAD-like functions

# 4.4 Analyze data

You can perform spatial data analysis on spatial databases and other OGR- supported formats. QGIS currently offers vector analysis, sampling, geoprocessing, geometry and database management tools. You can also use the integrated GRASS tools, which include the complete GRASS functionality of more than 400 modules. (See section *GRASS GIS Integration*.) Or, you can work with the Processing Plugin, which provides a powerful geospatial analysis framework to call native and third-party algorithms from QGIS, such as GDAL, SAGA, GRASS, fTools and more. (See section *Introduction*.)

# 4.5 Publish maps on the Internet

QGIS can be used as a WMS, WMTS, WMS-C or WFS and WFS-T client, and as a WMS, WCS or WFS server. (See section *Working with OGC Data*.) Additionally, you can publish your data on the Internet using a webserver with UMN MapServer or GeoServer installed.

# 4.6 Extend QGIS functionality through plugins

QGIS can be adapted to your special needs with the extensible plugin architecture and libraries that can be used to create plugins. You can even create new applications with C++ or Python!

8 Poздiл 4. Features

### 4.6.1 Core Plugins

Core plugins include:

- 1. Coordinate Capture (Capture mouse coordinates in different CRSs)
- 2. DB Manager (Exchange, edit and view layers and tables from/to databases; execute SQL queries)
- 3. Dxf2Shp Converter (Convert DXF files to shapefiles)
- 4. eVIS (Visualize events)
- 5. fTools (Analyze and manage vector data)
- 6. GDALTools (Integrate GDAL Tools into QGIS)
- 7. Georeferencer GDAL (Add projection information to rasters using GDAL)
- 8. GPS Tools (Load and import GPS data)
- 9. GRASS (Integrate GRASS GIS)
- 10. Heatmap (Generate raster heatmaps from point data)
- 11. Interpolation Plugin (Interpolate based on vertices of a vector layer)
- 12. Metasearch Catalogue Client
- 13. Offline Editing (Allow offline editing and synchronizing with databases)
- 14. Oracle Spatial GeoRaster
- 15. Processing (formerly SEXTANTE)
- 16. Raster Terrain Analysis (Analyze raster-based terrain)
- 17. Road Graph Plugin (Analyze a shortest-path network)
- 18. Spatial Query Plugin
- 19. Topology Checker (Find topological errors in vector layers)
- 20. Zonal Statistics Plugin (Calculate count, sum, and mean of a raster for each polygon of a vector layer)

#### 4.6.2 External Python Plugins

QGIS offers a growing number of external Python plugins that are provided by the community. These plugins reside in the official Plugins Repository and can be easily installed using the Python Plugin Installer. See Section *The Plugins Dialog*.

# 4.7 Python Console

For scripting, it is possible to take advantage of an integrated Python console, which can be opened from menu:  $Plugins \rightarrow Python\ Console$ . The console opens as a non-modal utility window. For interaction with the QGIS environment, there is the qgis.utils.iface variable, which is an instance of QgsInterface. This interface allows access to the map canvas, menus, toolbars and other parts of the QGIS application. You can create a script, then drag and drop it into the QGIS window and it will be executed automatically.

For further information about working with the Python console and programming QGIS plugins and applications, please refer to PyQGIS-Developer-Cookbook.

4.7. Python Console

### 4.8 Known Issues

### 4.8.1 Number of open files limitation

If you are opening a large QGIS project and you are sure that all layers are valid, but some layers are flagged as bad, you are probably faced with this issue. Linux (and other OSs, likewise) has a limit of opened files by process. Resource limits are per-process and inherited. The ulimit command, which is a shell built-in, changes the limits only for the current shell process; the new limit will be inherited by any child processes.

You can see all current ulimit info by typing

```
user@host:~$ ulimit -aS
```

You can see the current allowed number of opened files per process with the following command on a console

```
user@host:~$ ulimit -Sn
```

To change the limits for an existing session, you may be able to use something like

```
user@host:~$ ulimit -Sn #number_of_allowed_open_files
user@host:~$ ulimit -Sn
user@host:~$ qgis
```

#### To fix it forever

On most Linux systems, resource limits are set on login by the pam\_limits module according to the settings contained in /etc/security/limits.conf or /etc/security/limits.d/\*.conf. You should be able to edit those files if you have root privilege (also via sudo), but you will need to log in again before any changes take effect.

More info:

```
http://www.cyberciti.biz/faq/linux-increase-the-maximum-number-of-open-files/http://linuxaria.com/article/open-files-in-linux?lang=en
```

10 Розділ 4. Features

# What's new in QGIS 2.14

This release contains new features and extends the programmatic interface over previous versions. We recommend that you use this version over previous releases.

This release includes hundreds of bug fixes and many new features and enhancements over QGIS 2.8 that will be described in this manual. You may also review the visual changelog at:

- http://qgis.org/en/site/forusers/visualchangelog210/index.html
- $\bullet \ \ http://qgis.org/en/site/forusers/visualchangelog212/index.html$
- $\bullet \ http://qgis.org/en/site/forusers/visualchangelog214/index.html$

# **Getting Started**

This chapter gives a quick overview of installing QGIS, some sample data from the QGIS web page, and running a first and simple session visualizing raster and vector layers.

# 6.1 Installation

Installation of QGIS is very simple. Standard installer packages are available for MS Windows and Mac OS X. For many flavors of GNU/Linux, binary packages (rpm and deb) or software repositories are provided to add to your installation manager. Get the latest information on binary packages at the QGIS website at http://download.qgis.org.

#### 6.1.1 Installation from source

If you need to build QGIS from source, please refer to the installation instructions. They are distributed with the QGIS source code in a file called INSTALL. You can also find them online at  $\frac{\text{http:}}{\text{htmlpreview.github.io}} / \frac{\text{raw.github.com}}{\text{qgis}} / \frac{\text{QGIS}}{\text{master}} / \frac{\text{doc}}{\text{INSTALL.html}}$ 

#### 6.1.2 Installation on external media

QGIS allows you to define a --configpath option that overrides the default path for user configuration (e.g., ~/.qgis2 under Linux) and forces **QSettings** to use this directory, too. This allows you to, for instance, carry a QGIS installation on a flash drive together with all plugins and settings. See section *System Menu* for additional information.

#### 6.1.3 Sample Data

The user guide contains examples based on the QGIS sample dataset.

The Windows installer has an option to download the QGIS sample dataset. If checked, the data will be downloaded to your My Documents folder and placed in a folder called GIS Database. You may use Windows Explorer to move this folder to any convenient location. If you did not select the checkbox to install the sample dataset during the initial QGIS installation, you may do one of the following:

- Use GIS data that you already have
- Download sample data from http://qgis.org/downloads/data/qgis sample data.zip
- Uninstall QGIS and reinstall with the data download option checked (only recommended if the above solutions are unsuccessful)

To GNU/Linux and Mac OS X, there are not yet dataset installation packages available as rpm, deb or dmg. To use the sample dataset, download the file qgis\_sample\_data as a ZIP archive from http://qgis.org/downloads/data/ and unzip the archive on your system.

The Alaska dataset includes all GIS data that are used for examples and screenshots in the user guide; it also includes a small GRASS database. The projection for the QGIS sample dataset is Alaska Albers Equal Area with units feet. The EPSG code is 2964.

```
PROJCS["Albers Equal Area",
GEOGCS ["NAD27",
DATUM ["North_American_Datum_1927",
SPHEROID ["Clarke 1866", 6378206.4, 294.978698213898,
AUTHORITY["EPSG", "7008"]],
TOWGS84[-3,142,183,0,0,0,0],
AUTHORITY["EPSG", "6267"]],
PRIMEM["Greenwich",0,
AUTHORITY["EPSG", "8901"]],
UNIT["degree", 0.0174532925199433,
AUTHORITY ["EPSG", "9108"]],
AUTHORITY["EPSG", "4267"]],
PROJECTION["Albers_Conic_Equal_Area"],
PARAMETER["standard_parallel_1",55],
PARAMETER["standard_parallel_2",65],
PARAMETER["latitude_of_center",50],
PARAMETER["longitude_of_center",-154],
PARAMETER["false_easting",0],
PARAMETER["false_northing",0],
UNIT["us_survey_feet",0.3048006096012192]]
```

If you intend to use QGIS as a graphical front end for GRASS, you can find a selection of sample locations (e.g., Spearfish or South Dakota) at the official GRASS GIS website, http://grass.osgeo.org/download/sample-data/.

# 6.2 Launching QGIS

#### 6.2.1 Starting and Stopping QGIS

Starting QGIS is done as you usually do for any other application on your platform. It means that you can launch QGIS by:

- typing qgis at a command prompt, assuming that QGIS is added to your PATH or you're in its installation folder
- ullet using  $igstyle\Delta$  the Applications menu if using a precompiled binary,  $m{z}$  the Start menu or  $m{X}$  the Dock
- double clicking the icon in your Applications folder or desktop shortcut
- double clicking an existing QGIS project (.qgs) file. Note that this will also open the project

To stop QGIS, click:

- $\triangle$  the menu option  $Project \rightarrow Exit\ QGIS$  or use the shortcut Ctrl+Q
- $\mathbf{X}$   $QGIS \rightarrow Quit \ QGIS$ , or use the shortcut Cmd+Q
- or use the red cross at the right top corner of the main interface of the application.

#### 6.2.2 Command Line Options

In previous section you learned how to start QGIS. You will see that QGIS also provides further command line options.

QGIS supports a number of options when started from the command line. To get a list of the options, enter qgis --help on the command line. The usage statement for QGIS is:

```
QGIS - 2.6.0-Brighton 'Brighton' (exported)
QGIS is a user friendly Open Source Geographic Information System.
Usage: /usr/bin/qgis.bin [OPTION] [FILE]
OPTION:
  [--snapshot filename]
                         emit snapshot of loaded datasets to given file
  [--width width] width of snapshot to emit
  [--height height]
                         height of snapshot to emit
  [--lang language]
                         use language for interface text
  [--project projectfile] load the given QGIS project
  [--extent xmin,ymin,xmax,ymax] set initial map extent
  [--nologo] hide splash screen
  [--noversioncheck]
                         don't check for new version of QGIS at startup
  [--noplugins] don't restore plugins on startup
  [--nocustomization]
                        don't apply GUI customization
  [--customizationfile] use the given ini file as GUI customization
  [--optionspath path]
                         use the given QSettings path
  [--configpath path]
                         use the given path for all user configuration
  [--authdbdirectory path] use the given directory for authentication database
  [--code path] run the given python file on load
                 start by resetting user ui settings to default
  [--defaultui]
  [--dxf-export filename.dxf]
                                 emit dxf output of loaded datasets to given file
  [--dxf-extent xmin,ymin,xmax,ymax]
                                         set extent to export to dxf
  [--dxf-symbology-mode none|symbollayer|feature] symbology mode for dxf output
  [--dxf-scale-denom scale]
                                 scale for dxf output
  [--dxf-encoding encoding]
                                 encoding to use for dxf output
  [--dxf-preset visiblity-preset] layer visibility preset to use for dxf output
                         this text
  [--help]
  [--]
                 treat all following arguments as FILEs
FILE:
  Files specified on the command line can include rasters,
  vectors, and QGIS project files (.qgs):
   1. Rasters - supported formats include GeoTiff, DEM
     and others supported by GDAL
   2. Vectors - supported formats include ESRI Shapefiles
     and others supported by OGR and PostgreSQL layers using
      the PostGIS extension
```

### Порада: Example Using command line arguments

You can start QGIS by specifying one or more data files on the command line. For example, assuming you are in the qgis\_sample\_data directory, you could start QGIS with a vector layer and a raster file set to load on startup using the following command: qgis ./raster/landcover.img ./gml/lakes.gml

#### Command line option -- snapshot

This option allows you to create a snapshot in PNG format from the current view. This comes in handy when you have a lot of projects and want to generate snapshots from your data.

Currently, it generates a PNG file with 800x600 pixels. This can be adjusted using the --width and --height command line arguments. A filename can be added after --snapshot.

### Command line option -- lang

Based on your locale, QGIS selects the correct localization. If you would like to change your language, you can specify a language code. For example, qgis --lang it starts QGIS in Italian localization.

### Command line option --project

Starting QGIS with an existing project file is also possible. Just add the command line option --project followed by your project name and QGIS will open with all layers in the given file loaded.

#### Command line option --extent

To start with a specific map extent use this option. You need to add the bounding box of your extent in the following order separated by a comma:

```
--extent xmin,ymin,xmax,ymax
```

#### Command line option --nologo

This command line argument hides the splash screen when you start QGIS.

#### command line option --noversioncheck

Don't check for new version of QGIS at startup.

#### Command line option --noplugins

If you have trouble at start-up with plugins, you can avoid loading them at start-up with this option. They will still be available from the Plugins Manager afterwards. Command line option --customizationfile

Using this command line argument, you can define a GUI customization file, that will be used at startup.

#### Command line option --nocustomization

Using this command line argument, existing GUI customization will not be applied at startup.

#### Command line option -- optionspath

You can have multiple configurations and decide which one to use when starting QGIS with this option. See *Options* to confirm where the operating system saves the settings files. Presently, there is no way to specify a file to write settings to; therefore, you can create a copy of the original settings file and rename it. The option specifies path to directory with settings. For example, to use /path/to/config/QGIS/QGIS2.ini settings file, use option:

```
--optionspath /path/to/config/
```

#### Command line option --configpath

This option is similar to the one above, but furthermore overrides the default path for user configuration (~/.qgis2) and forces **QSettings** to use this directory, too. This allows users to, for instance, carry a QGIS installation on a flash drive together with all plugins and settings.

#### Command line option --authobdirectory

Again, this option is similar to the one above but define the path to the directory where the authentication database will be stored.

#### Command line option --code

This option can be used to run a given python file directly after QGIS has started.

For example, when you have a python file named load\_alaska.py with following content:

```
from qgis.utils import iface
raster_file = "/home/gisadmin/Documents/qgis_sample_data/raster/landcover.img"
layer_name = "Alaska"
iface.addRasterLayer(raster_file, layer_name)
```

Assuming you are in the directory where the file load\_alaska.py is located, you can start QGIS, load the raster file landcover.img and give the layer the name 'Alaska' using the following command: qgis--code load\_alaska.py

#### Command line options --dxf-\*

These options can be used to export QGIS project into a DXF file. Several options are available:

- $\bullet$  -dxf-export: the DXF file name into which to export the layers;
- -dxf-extent: the extent of the final DXF file;

- -dxf-symbology-mode: several values can be used here: none (no symbology), symbollayer (Symbol layer symbology), feature (feature symbology);
- -dxf-scale-deno: the scale denominator of the symbology;
- -dxf-encoding: the file encoding;
- -dxf-preset: choose a visibility preset. These presets are defined in the layer tree, see Layers Panel.

# 6.3 Sample Session: Load raster and vector layers

Now that you have QGIS installed and a sample dataset available, we would like to demonstrate a short and simple QGIS sample session. We will visualize a raster and a vector layer. We will use:

- the landcover raster layer i.e., qgis\_sample\_data/raster/landcover.img
- and the lakes vector layer i.e., qgis\_sample\_data/gml/lakes.gml.
- 1. Start QGIS as seen in Starting and Stopping QGIS
- 2. Click on the Add Raster Layer icon.
- 3. Browse to the folder qgis\_sample\_data/raster/, select the ERDAS IMG file landcover.img and click [Open].
- 4. If the file is not listed, check if the *Files of type* combo box at the bottom of the dialog is set on the right type, in this case **Erdas Imagine Images** (\*.img \*.IMG).
- 5. Now click on the Add Vector Layer icon.
- 6. File should be selected as Source Type in the new Add vector layer dialog. Now click [Browse] to select the vector layer.
- 7. Browse to the folder qgis\_sample\_data/gml/, select Geography Markup Language [GML] [OGR] (\*.gml \*.GML) from the Filter combo box, then select the GML file lakes.gml and click [Open]. In the Add vector layer dialog, click [OK]. The Coordinate Reference System Selector dialog opens with NAD27 / Alaska Alberts selected, click [OK].
- 8. Zoom in a bit to your favourite area with some lakes.
- 9. Double click the lakes layer in the map legend to open the *Properties* dialog.
- 10. Click on the Style tab and select a blue as fill color.
- 11. Click on the *Labels* tab and select *Show labels for this layer* in the drop-down menu to enable labeling. Then from the *Label with* list, choose the NAMES field as the field containing labels.
- 12. To improve readability of labels, you can add a white buffer around them by clicking *Buffer* in the list on the left, checking *Draw text buffer* and choosing 3 as buffer size.
- 13. Click [Apply]. Check if the result looks good, and finally click [OK].

You can see how easy it is to visualize raster and vector layers in QGIS. Let's move on to the sections that follow to learn more about the available functionality, features and settings, and how to use them.

# 6.4 Projects

The state of your QGIS session is considered a project. QGIS works on one project at a time. Settings are considered as being either per-project or as a default for new projects (see section Options). QGIS can save the state of your workspace into a project file using the menu options  $Project \rightarrow \square$  Save or  $Project \rightarrow \square$  Save As.... If the loaded project file on disk was meanwhile changed, by default, QGIS

will ask you if you want to overwrite the changes into the project file. This behavior is set by checking  $Prompt\ to\ save\ project\ and\ data\ source\ changes\ when\ required\ under\ Settings <math>\to\ Options \to\ General$  menu .

Load saved projects into a QGIS session using  $Project \rightarrow \cite{Project} \rightarrow Project \rightarrow New from template$  or  $Project \rightarrow Open Recent \rightarrow$ .

At startup, a list of screenshot with the name and path of each of the most recent projects (up to ten) is shown instead of a white and empty map canvas. This is a handy and quicker way to remember what a project was about and double-click a row opens the selected project. If you're willing to create a new project, just add new layers and the list disappears.

If you wish to clear your session and start fresh, choose  $Project \rightarrow \square$  New. Either of these menu options will prompt you to save the existing project if changes have been made since it was opened or last saved.

The kinds of information saved in a project file include:

- Layers added
- Which layers can be queried
- Layer properties, including symbolization and styles
- Projection for the map view
- Last viewed extent
- Print Composers
- Print Composer elements with settings
- Print Composer atlas settings
- Digitizing settings
- Table Relations
- Project Macros
- Project default styles
- Plugins settings
- QGIS Server settings from the OWS settings tab in the Project properties
- Queries stored in the DB Manager

The project file is saved in XML format, so it is possible to edit the file outside QGIS if you know what you are doing. The file format has been updated several times compared with earlier QGIS versions. Project files from older QGIS versions may not work properly any more. To be made aware of this, in the General tab under Settings  $\rightarrow$  Options you should tick  $\bowtie$  Warn when opening a project file saved with an older version of OGIS.

Whenever you save a project in QGIS a backup of the project file is made with the extension .qgs~.

# 6.5 Output

There are several ways to generate output from your QGIS session. We have discussed one already in section *Projects*, saving as a project file. Here is a sampling of other ways to produce output files:

• Menu option Project → Save as Image... opens a file dialog where you select the name, path and type of image (PNG, JPG and many other formats). A world file with extension PNGW or JPGW saved in the same folder georeferences the image.

- Menu option  $Project \to DXF\ Export...$  opens a dialog where you can define the 'Symbology mode', the 'Symbology scale' and vector layers you want to export to DXF. Through the 'Symbology mode' symbols from the original QGIS Symbology can be exported with high fidelity.
- Menu option  $Project \rightarrow \square$  New  $Print\ Composer...$  opens a dialog where you can layout and print the current map canvas (see section  $Print\ Composer$ ).

6.5. Output 19

# **QGIS GUI**

When QGIS starts, you are presented with the GUI as shown in the figure (the numbers 1 through 5 in yellow circles are discussed below).

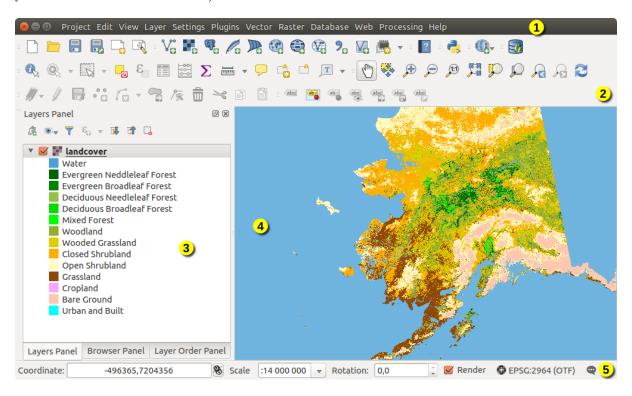


Рис. 7.1: QGIS GUI with Alaska sample data

Примітка: Your window decorations (title bar, etc.) may appear different depending on your operating system and window manager.

The QGIS GUI is divided into five areas:

- 1. Menu Bar
- 2. Toolbars
- 3. Panels
- 4. Map View
- 5. Status Bar

These five components of the QGIS interface are described in more detail in the following sections. Two more sections present keyboard shortcuts and context help.

### 7.1 Menu Bar

The menu bar provides access to various QGIS features using a standard hierarchical menu. The top-level menus and a summary of some of the menu options are listed below, together with the associated icons as they appear on the toolbar, and keyboard shortcuts. The shortcuts presented in this section are the defaults; however, keyboard shortcuts can also be configured manually using the Configure shortcuts dialog, opened from  $Settings \rightarrow Configure$  Shortcuts....

Although most menu options have a corresponding tool and vice-versa, the menus are not organized exactly like the toolbars. The toolbar containing the tool is listed after each menu option as a checkbox entry. Some menu options only appear if the corresponding plugin is loaded. For more information about tools and toolbars, see section *Toolbars*.

Примітка: QGIS is a cross-platform application meaning that though it provides you with the same tools, they may be placed in different menus according to the operating system specification. The lists below show the most common location and precise when there is a variation.

# 7.1.1 Project

Menu Option	Shortcut	Reference	Toolbar
New	Ctrl+N	see Projects	Project
$\bigcap$ Open	Ctrl+0	see Projects	Project
$New \ from \ template  ightarrow$		see Projects	-
$Open \ Recent \rightarrow$		see $Projects$	
$\blacksquare$ Save	Ctrl+S	see Projects	Project
Save As	Ctrl+Shift+S	see Projects	Project
Save as Image		see Output	
$DXF\ Export$		see $Output$	
Project Properties	Ctrl+Shift+P	see Projects	
New Print Composer	Ctrl+P	see Print Composer	Project
Composer manager		see Print Composer	Project
$\underline{Print}\ Composers  ightarrow$		see Print Composer	
$\bigcirc$ Exit QGIS	Ctrl+Q		

Under **X** Mac OSX, the *Exit QGIS* command corresponds to  $QGIS \rightarrow Quit \ QGIS \ (Cmd+Q)$ .

# 7.1.2 Edit

Menu Option	Shortcut	Reference	Toolbar
◆ Undo	Ctrl+Z	see Advanced digitizing	$Advanced \ Digitizing$
Redo	Ctrl+Shift+7	z see Advanced digitizing	$Advanced \ Digitizing$
Cut Features	Ctrl+X	see Digitizing an existing layer	Digitizing
Copy Features	Ctrl+C	see Digitizing an existing layer	Digitizing
$Paste\ Features$ $Paste\ features\ as  ightarrow$	Ctrl+V	see Digitizing an existing layer see Working with the Attribute Table	Digitizing
☑ Add Feature	Ctrl+.	see Digitizing an existing layer	Digitizing
$\bigcirc$ Move Feature(s)		see Digitizing an existing layer	Digitizing
Delete Selected		see Digitizing an existing layer	Digitizing
Rotate Feature(s)		see Advanced digitizing	$Advanced \ Digitizing$
Simplify Feature		see Advanced digitizing	$Advanced \ Digitizing$
Add Ring		see Advanced digitizing	$Advanced \ Digitizing$
Add Part		see Advanced digitizing	$Advanced \ Digitizing$
Fill Ring		see Advanced digitizing	$Advanced \ Digitizing$
Delete Ring		see Advanced digitizing	$Advanced \ Digitizing$
Delete Part		see Advanced digitizing	$Advanced \ Digitizing$
Reshape Features		see Advanced digitizing	$Advanced \ Digitizing$
Offset Curve		see Advanced digitizing	$Advanced \ Digitizing$
Split Features		see Advanced digitizing	$Advanced \ Digitizing$
Split Parts		see Advanced digitizing	$Advanced \ Digitizing$
Merge Selected Features		see Advanced digitizing	$Advanced \ Digitizing$
Merge Attr. of Selected Features		see Advanced digitizing	$Advanced \ Digitizing$
Node Tool		see Digitizing an existing layer	Digitizing
Rotate Point Symbols		see Advanced digitizing	$Advanced \ Digitizing$

7.1. Menu Bar 23

After activating Toggle editing mode for a layer, you will enable the Add Feature icon in the Edit menu depending on the layer type (point, line or polygon).

# 7.1.3 Edit (extra)

Menu Option	Shortcut	Reference	Toolbar
Add Feature		see Digitizing an existing layer	Digitizing
Add Feature		see Digitizing an existing layer	Digitizing
Add Feature		see Digitizing an existing layer	Digitizing

# 7.1.4 View

Menu Option	Shortcut	Reference	Toolbar
Pan Map		see Zooming and Panning	Map Navigation
Pan Map to Selection			Map Navigation
Zoom In	Ctrl++	see Zooming and Panning	Map Navigation
	Ctrl+-	see Zooming and Panning see Select and deselect features	$egin{array}{c} Map\ Navigation \ Attributes \end{array}$
$igwedge \mathbb{R}$ Identify Features $Measure  ightarrow$	Ctrl+Shift+I	see Identify features see Measuring	$Attributes \ Attributes$
$\sum$ Statistical Summary		see Statistical Summary Panel	Attributes
Zoom Full	Ctrl+Shift+F		$oxed{Map\ Navigation}$
Zoom To Layer			$oxed{Map\ Navigation}$
Zoom To Selection	Ctrl+J		Map Navigation
Zoom Last			Map Navigation
200m Next			Map Navigation
Zoom To Native Resolution			Map Navigation
$ \begin{array}{c} Decorations \rightarrow \\ Preview \ mode \rightarrow \end{array} $		see Decorations	
Map Tips		see Display Menu	$igg _{Attributes}$
New Bookmark	Ctrl+B	see Spatial Bookmarks	$oxed{Attributes}$
Show Bookmarks	Ctrl+Shift+B	see Spatial Bookmarks	Attributes
	F5		$oxed{Map\ Navigation}$
Panels  ightarrow		see Panels and Toolbars	
Toolbars  ightarrow		see Panels and Toolbars	
Toggle Full Screen Mode	F11		

Under  $\stackrel{\bullet}{\Delta}$  Linux KDE,  $Panels \rightarrow$ ,  $Toolbars \rightarrow$  and  $Toggle\ Full\ Screen\ Mode$  are rather placed in Settings menu.  $Preview\ mode \rightarrow$  is not available under X Mac OS X.

24 Розділ 7. QGIS GUI

# 7.1.5 Layer

Menu Option	Shortcut	Reference	Toolbar
$Create\ Layer  ightarrow$		see Creating new Vector layers	Manage Layers
$Add\ Layer  ightarrow$		see Supported Data Formats	$Manage\ Layers$
Embed Layers and Groups		see Nesting Projects	
Add from Layer Definition File			
Copy style		see Save and Share Layer Properties	
Paste style		see Save and Share Layer Properties	
Open Attribute Table		see Working with the Attribute Table	Attributes
Toggle Editing		see Digitizing an existing layer	Digitizing
Save Layer Edits		see Digitizing an existing layer	Digitizing
$Current\ Edits \rightarrow$		see Digitizing an existing layer	Digitizing
Save As   Save As Layer Definition File		see Save layer into file	
Remove Layer/Group	Ctrl+D		
Duplicate Layers (s) Set Scale Visibility of Layers			
Set CRS of Layer(s)   Set project CRS from Layer	Ctrl+Shift+C		
Properties		see The Vector Properties Dialog	
Filter		see Query Builder	
Labeling		see Labels Menu	
Add to Overview	Ctrl+Shift+O		Manage Layers
Add All To Overview			
Remove All From Overview			
Show All Layers	Ctrl+Shift+U		Manage Layers
Hide All Layers	Ctrl+Shift+H		Manage Layers
Show selected Layers			
Hide selected Layers			

# 7.1.6 Settings

Menu Option	Shortcut	Reference	Toolbar
Custom CRS		see Custom Coordinate Reference System	
Style Manager		see The Style Manager	
<i>Note:</i> Note that Note th			
<i>Note:</i> Note: Not		see Customization	
No Options		see Options	
Snapping Options		see Setting the Snapping Tolerance and Search Radius	

Under  $\Delta$  Linux KDE, you'll find more tools in Settings menu such as Project Properties, Panels  $\rightarrow$ , Toolbars  $\rightarrow$  and Toggle Full Screen Mode.

7.1. Menu Bar 25

# 7.1.7 Plugins

Menu Option	Shortcut	Reference	Toolbar
Manage and Install Plugins		see The Plugins Dialog	
Python Console	Ctrl+Alt+P		

When starting QGIS for the first time not all core plugins are loaded.

# 7.1.8 **Vector**

Menu Option	Shortcut	Reference	Toolbar
$Open\ Street\ Map  ightarrow$		see Loading OpenStreetMap Vectors	
$ extbf{ extit{A}}  ext{ }  ext{Analysis Tools}  o$		see fTools Plugin	
$Research\ Tools \rightarrow$		see fTools Plugin	
$\bigcirc$ Geoprocessing Tools $\rightarrow$		see fTools Plugin	
$\bigcirc$ Geometry Tools $\rightarrow$		see fTools Plugin	
$lacktriangleq Data\ Management\ Tools  ightarrow$		see fTools Plugin	

When starting QGIS for the first time not all core plugins are loaded.

# 7.1.9 Raster

Menu Option	Shortcut	Reference	Toolbar
$Raster\ calculator$		see Raster Calculator	
Align Raster		see Raster Alignment	

When starting QGIS for the first time not all core plugins are loaded.

# 7.1.10 Database

Menu Option	Shortcut	Reference	Toolbar
$Database \rightarrow$		see DB Manager Plugin	Database

When starting QGIS for the first time not all core plugins are loaded.

# 7.1.11 Web

Menu Option	Shortcut	Reference	Toolbar
Metasearch		see MetaSearch Catalogue Client	Web

When starting QGIS for the first time not all core plugins are loaded.

### 7.1.12 Processing

Menu Option	Shortcut	Reference	Toolbar
Toolbox		see The toolbox	
Graphical Modeler		see The graphical modeler	
History and log		see The history manager	
M Options		see Configuring the processing framework	
Results viewer		see Configuring external applications	
>> Commander	Ctrl+Alt+M	see The QGIS Commander	

When starting QGIS for the first time not all core plugins are loaded.

### 7.1.13 Help

Menu Option	Shortcut	Reference	Toolbar
Help Contents	F1		Help
№? What's This?	Shift+F1		$oxed{Help}$
$API\ Documentation$			
Report an Issue			
$oxed{Need\ commercial\ support?}$			
☐ QGIS Home Page	Ctrl+H		
Check QGIS Version			
About			
@ QGIS Sponsors			

### 7.1.14 QGIS

This menu is only available under **X** Mac OS X and contains some OS related commands.

Menu Option	Shortcut	Reference
Preferences		
About QGIS		
$Hide\ QGIS$		
Show All		
Hide Others		
Quit QGIS	Cmd+Q	

Preferences and About QGIS are the same commands as Settings  $\rightarrow$  Options and Help  $\rightarrow$  About. Quit QGIS corresponds to Project  $\rightarrow$  Exit QGIS under the other platforms.

# 7.2 Panels and Toolbars

From the *View* menu (*Settings* under KDE), you can switch on and off QGIS widgets (*Panels*  $\rightarrow$ ) or toolbars (*Toolbars*  $\rightarrow$ ). You can (de)activate any of them by right-clicking the menu bar or a toolbar and choose the item you want. Each panel or toolbar can be moved and placed wherever you feel comfortable with in QGIS interface. The list can also be extended with the activation of *Core or external plugins*.

7.2. Panels and Toolbars

#### 7.2.1 Toolbars

The toolbar provides access to most of the same functions as the menus, plus additional tools for interacting with the map. Each toolbar item has pop-up help available. Hold your mouse over the item and a short description of the tool's purpose will be displayed.

Every toolbar can be moved around according to your needs. Additionally, they can be switched off using the right mouse button context menu, or by holding the mouse over the toolbars.

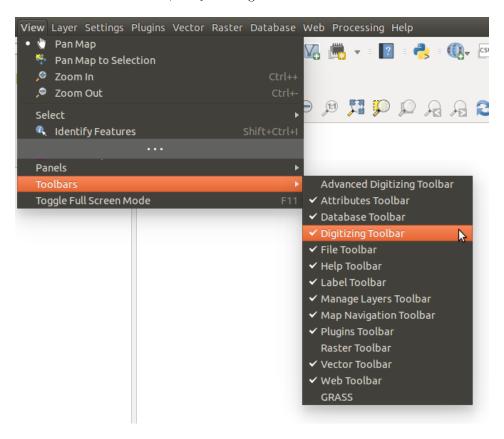


Рис. 7.2: The Toolbars menu

#### Порада: Restoring toolbars

If you have accidentally hidden a toolbar, you can get it back by choosing menu option  $View \to Toolbars$   $\to$  (or  $Settings \to Toolbars \to$  under Linux KDE). If for some reason a toolbar (or any other widget) totally disappears from the interface, you'll find tips to get it back at restoring initial GUI.

#### **7.2.2** Panels

QGIS provides by default many panels to work with.

Some of these panels are described below while others may be found in different parts of the document, namely:

- the Browser Panel
- the Advanced Digitizing Panel
- the Spatial Bookmarks Panel
- the GPS Information Panel
- the Tile Scale Panel

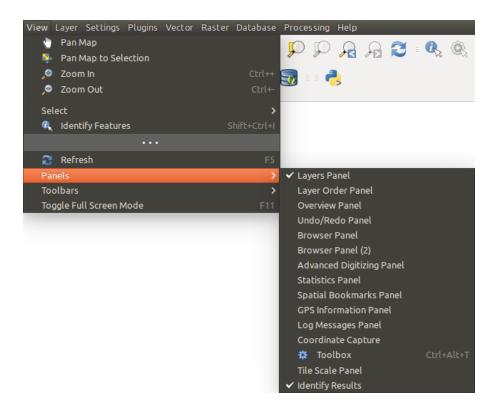


Рис. 7.3: The Panels menu

- the Identify Panel
- the User Input Panel

#### **Layers Panel**

The layers panel lists all the layers in the project. The checkbox in each legend entry can be used to show or hide the layer. The toolbar in the layers panel allows you to:

- Add new group
- $\bullet$   $\,$   $\,$   $\,$   $\,$   $\,$   $\,$   $\,$   $\,$  Manage Visibility: control visibility of layers and preset layers combination
- Filter Legend by Map Content: only the layers that are set visible and whose features intersect the current map canvas have their style rendered in the layers panel. Otherwise, a generic NULL symbol is applied to the layer. Based on the layer symbology, this is a convenient way to identify which kind of features from which layers cover your area of interest.
- Filter Legend by Expression: helps you apply an expression to remove from the selected layer tree styles that have no feature satisfying the condition. This can be used for example to highlight features that are within a given area/feature of another layer. From the drop-down list, you can edit and clear the expression set.
- Expand All or Collapse All layers and groups in the layers panel.
- and Remove Layer/Group currently selected.

The button allows you to add **Presets** views in the legend. Presets are a way to save and easily restore a combination of layers with their current style. To add a preset view, just set visible the layers you want, with their desired symbology, and click on button. Choose *Add Preset...* from the drop-down menu and give a name to the preset. The added preset is listed at the bottom of the drop-down menu and is recalled by clicking on it.

The  $Replace\ Preset \to \text{option}$  helps you overwrite a preset content with the current map view while the  $Remove\ Current\ Preset$  button deletes the active preset.

All the added presets are also present in the map composer in order to allow you to create a map layout based on your specific views (see *Main properties*).

 $\Pi$ римітка: Tools to manage the layers panel are also available to layout the map and legend items of the print composer

A layer can be selected and dragged up or down in the legend to change the Z-ordering. Z-ordering means that layers listed nearer the top of the legend are drawn over layers listed lower down in the legend.

Примітка: This behavior can be overridden by the *Layer Order* panel.

Layers in the legend window can be organized into groups. There are two ways to do this:

- 1. Press the icon to add a new group. Type in a name for the group and press Enter. Now click on an existing layer and drag it onto the group.
- 2. Select some layers, right click in the legend window and choose *Group Selected*. The selected layers will automatically be placed in a new group.

To bring a layer out of a group, you can drag it out, or right click on it and choose *Make to toplevel item*. Groups can also be nested inside other groups.

The checkbox for a group will show or hide all the layers in the group with one click.

The content of the right mouse button context menu depends on whether the selected legend item is a raster or a vector layer. For GRASS vector layers, Toggle editing is not available. See section Digitizing and editing a GRASS vector layer for information on editing GRASS vector layers.

Below are listed available options in context menu depending on the selected item.

Option	Vector Layer	Raster Layer	Group
₽ Zoom to Layer/Group	<b></b>	<b>✓</b>	<b></b> ✓
Show in Overview		$\checkmark$	
Zoom to Native Resolution (100%)			
Stretch Using Current Extent			
Remove			$\checkmark$
Duplicate	<b>₫</b>		
Set Layer Scale Visibility			
Set Layer/Group CRS			
Set Project CRS from Layer			
Styles  ightarrow			
Copy Style			
Paste Style			$\checkmark$
Open Attribute Table			
/ Toggle Editing			
$\mathscr{J}$ Current Edits $\rightarrow$	🗹 (in Edit mode)		
Save As			
Save As Layer Definition File			$\checkmark$
Filter			
Show Feature Count			
Properties			
Move to Top-level			
Rename			
Group Selected			
Properties			
Set Group WMS Data			<b>4</b>
Mutually Exclusive Group			$\checkmark$
Add Group			

Enabling the **Mutually Exclusive Group** option you can make a group have only one layer visible at the same time. Whenever a layer within the group is set visible the others will be toggled not visible.

It is possible to select more than one layer or group at the same time by holding down the Ctrl key while selecting the layers with the left mouse button. You can then move all selected layers to a new group at the same time.

You may also delete more than one layer or group at once by selecting several items with the Ctrl key and pressing Ctrl+D afterwards. This way, all selected layers or groups will be removed from the layers list.

### Editing vector layer style

From the Layers panel, you have shortcuts to easily and quickly edit the layer rendering. Right-click on a vector layer and select  $Styles \rightarrow$  in the list in order to:

• see the currently applied *styles* to the layer. In case you defined many styles for the layer, you can switch from one to another and have your layer rendering automatically updated in the map canvas.

- copy the current style, and when applicable, paste a copied style from another layer
- rename the current style, add a new one (which is actually a copy of the current one) or delete the current style (when multiple styles available).

Примітка: The previous options are also available for raster layer.

Whether the features in the vector layer have all the same unique symbol or they are classified (in that case, the layer is displayed in a tree structure with each class as sub-item), the following options are available at layer level or class level:

- a *Edit Symbol...* button to open the *The symbol Selector* dialog and update any property (symbol, size, color...) of the layer or feature symbol. Double-clicking on a feature does also open the *Symbol Selector* dialog.
- a *Color Selector* widget with a **Color Wheel** from which you can click a color and have it automatically update the symbol fill color. For convenience, **Recent colors** are available at the bottom of the color wheel.
- a Show All Items and Hide All Items to toggle on or off the visibility of all the classes of features. This avoids (un)checking items one by one.

## Порада: Quickly share a layer style

From the context menu, copy the style of a layer and paste it to a group or a selection of layers: the style is applied to all the layers that are of the same type (vector vs raster) as the original layer and, in case of vector, have the same geometry type (point, line or polygon).

### Working with the Legend independent layer order

There is a panel that allows you to define an independent drawing order for the layers panel. You can activate it in the menu  $Settings \rightarrow Panels \rightarrow Layer\ Order\ Panel$ . This feature allows you to, for instance, order your layers in order of importance, but still display them in the correct order (see figure—layer—order).

Checking the Control rendering order box underneath the list of layers will cause a revert to default behavior.

#### Statistical Summary Panel

This panel can show some statistics on a specific vector layers. The panel allows users to choose:

- the vector layer;
- the column or the expression;
- filter statistics to selected features;
- refresh the informations;
- the statistics information to display with the bottom right button;

## **QGIS** Overview Panel

In QGIS, you can use an overview panel that provides a full extent view of layers added to it. Within the view is a rectangle showing the current map extent. This allows you to quickly determine which area of the map you are currently viewing. Note that labels are not rendered to the map overview even if the layers in the map overview have been set up for labelling. If you click and drag the red rectangle in the overview that shows your current extent, the main map view will update accordingly.

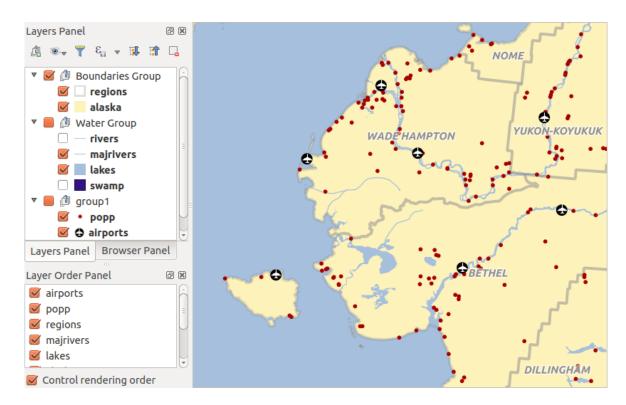


Рис. 7.4: Define a legend independent layer order

### Log Messages Panel

When loading or processing some operations, you can track and follow messages that appear in different tabs using the Quantum Log Messages Panel. It can be activated using the most right icon in the bottom status bar.

### Undo/Redo Panel

For each layer being edited, this panel shows the list of actions done, allowing to quickly undo a set of actions by simply selecting the action listed above.

# 7.3 Map View

Also called **Map canvas**, this is the "business end" of QGIS — maps are displayed in this area. The map displayed in this window will depend on the vector and raster layers you have chosen to load (see sections that follow for more information on how to load layers). The map view can be panned, shifting the focus of the map display to another region, and it can be zoomed in and out. Various other operations can be performed on the map as described in the label\_toolbars description above. The map view and the legend are tightly bound to each other — the maps in view reflect changes you make in the legend area.

### Порада: Zooming the Map with the Mouse Wheel

You can use the mouse wheel to zoom in and out on the map. Place the mouse cursor inside the map area and roll the wheel forward (away from you) to zoom in and backwards (towards you) to zoom out. The zoom is centered on the mouse cursor position. You can customize the behavior of the mouse wheel zoom using the  $Map\ tools\$ tab under the  $Settings \to Options\$ menu.

### Порада: Panning the Map with the Arrow Keys and Space Bar

7.3. Map View 33

You can use the arrow keys to pan the map. Place the mouse cursor inside the map area and click on the right arrow key to pan east, left arrow key to pan west, up arrow key to pan north and down arrow key to pan south. You can also pan the map using the space bar or the click on mouse wheel: just move the mouse while holding down space bar or click on mouse wheel.

# 7.4 Status Bar

The status bar provides you with general information about the map view, and actions processed or available and offers you tools to manage the map view.

On the left side of the status bar, you can get a summary of actions you've done (such as selecting features in a layer, removing layer) or a long description of the tool you are hovering over (not available for all tools). On startup, the bar status also informs you about availability of new or upgradeable plugins (if checked in *Plugin Manager settings*).

In case of lengthy operations, such as gathering of statistics in raster layers or rendering several layers in map view, a progress bar is displayed in the status bar to show the current progress of the action.

The \*\*Coordinate\* option shows the current position of the mouse, following it while moving across the map view. You can set the unit (and precision) to use in the project properties, General tab. Click on

the small button at the left of the textbox to toggle between the Coordinate option and the Extents option that displays in map units, the coordinates of the current lower leftmost and upper rightmost points of the map view, as you pan and zoom in and out.

Next to the coordinate display you will find the *Scale* display. It shows the scale of the map view. If you zoom in or out, QGIS shows you the current scale. There is a scale selector, which allows you to choose among *predefined and custom scales* to assign to the map view.

To the right of the scale display you can define a current clockwise rotation for your map view in degrees.

On the right side of the status bar, there is a small checkbox which can be used to temporarily prevent layers being rendered to the map view (see section *Rendering*).

To the right of the render functions, you find the Current CRS: icon with the EPSG code of the current project CRS. Clicking on this lets you *Enable 'on the fly' CRS transformation* properties for the current project and apply another CRS to the map view.

Finally, the Messages button opens the Log Messages Panel which informs you on underlying process (QGIS startup, plugins loading, processing tools...)

### Порада: Calculating the Correct Scale of Your Map Canvas

When you start QGIS, the default CRS is WGS 84 (epsg 4326) and units are degrees. This means that QGIS will interpret any coordinate in your layer as specified in degrees. To get correct scale values, you can either manually change this setting, e.g. to meters, in the General tab under  $Project \rightarrow Project$ 

Properties, or you can use the Current CRS: icon seen above. In the latter case, the units are set to what the project projection specifies (e.g., +units=us-ft).

Note that CRS choice on startup can be set in  $Settings \rightarrow Options \rightarrow CRS$ .

# **General Tools**

# 8.1 Keyboard shortcuts

QGIS provides default keyboard shortcuts for many features. You can find them in section Menu Bar. Additionally, the menu option  $Settings \rightarrow Configure$  Shortcuts... allows you to change the default keyboard shortcuts and add new keyboard shortcuts to QGIS features.

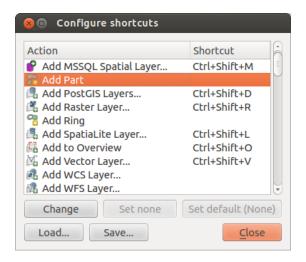


Рис. 8.1: Define shortcut options

Configuration is very simple. Just select a feature from the list and click on :

- [Change] and press the new combination you want to assign as new shortcut
- [Set none] to clear any assigned shortcut
- or [Set default] to backup the shortcut to its original and default value.

Once you have finished your configuration, you can save it as an XML file and load it to another QGIS installation.

# 8.2 Context help

When you need help on a specific topic, you can access context help via the [Help] button available in most dialogs — please note that third-party plugins can point to dedicated web pages.

# 8.3 Rendering

By default, QGIS renders all visible layers whenever the map canvas is refreshed. The events that trigger a refresh of the map canvas include:

- Adding a layer
- Panning or zooming
- Resizing the QGIS window
- Changing the visibility of a layer or layers

QGIS allows you to control the rendering process in a number of ways.

## 8.3.1 Scale Dependent Rendering

Scale-dependent rendering allows you to specify the minimum and maximum scales at which a layer will be visible. To set scale-dependent rendering, open the *Properties* dialog by double-clicking on the layer in the legend. On the *General* tab, click on the Scale dependent visibility checkbox to activate the feature, then set the minimum and maximum scale values.

You can determine the scale values by first zooming to the level you want to use and noting the scale value in the QGIS status bar.

## 8.3.2 Controlling Map Rendering

Map rendering can be controlled in various ways, as described below.

### Suspending Rendering

To suspend rendering, click the  $\[ \]$  Render checkbox in the lower right corner of the status bar. When the  $\[ \]$  Render checkbox is not checked, QGIS does not redraw the canvas in response to any of the events described in section Rendering. Examples of when you might want to suspend rendering include:

- Adding many layers and symbolizing them prior to drawing
- Adding one or more large layers and setting scale dependency before drawing
- Adding one or more large layers and zooming to a specific view before drawing
- Any combination of the above

Checking the Render checkbox enables rendering and causes an immediate refresh of the map canvas.

## **Setting Layer Add Option**

You can set an option to always load new layers without drawing them. This means the layer will be added to the map, but its visibility checkbox in the legend will be unchecked by default. To set this option, choose menu option  $Settings \to Options$  and click on the Rendering tab. Uncheck the M By default new layers added to the map should be displayed checkbox. Any layer subsequently added to the map will be off (invisible) by default.

### Stopping Rendering

To stop the map drawing, press the ESC key. This will halt the refresh of the map canvas and leave the map partially drawn. It may take a bit of time between pressing ESC and the time the map drawing is halted.

Примітка: It is currently not possible to stop rendering — this was disabled in the Qt4 port because of User Interface (UI) problems and crashes.

## Influence Rendering Quality

QGIS has an option to influence the rendering quality of the map. Choose menu option  $Settings \rightarrow Options$ , click on the Rendering tab and select or deselect  $Make\ lines\ appear\ less\ jagged\ at\ the\ expense\ of\ some\ drawing\ performance.$ 

#### Speed-up rendering

There are some settings that allow you to improve rendering speed. Open the QGIS options dialog using  $Settings \rightarrow Options$ , go to the Rendering tab and select or deselect the following checkboxes:

- We render caching where possible to speed up redraws
- Max cores to use.
- The map renders in the background onto a separate image and each Map Update interval, the content from this (off-screen) image will be taken to update the visible screen representation. However, if rendering finishes faster than this duration, it will be shown instantaneously.
- With Enable Feature simplification by default for newly added layers, you simplify features' geometry (less nodes) and as a result, they quickly display. Be aware that you can also face rendering inconsistencies.

## 8.4 Color Selector

The select color dialog will appear whenever you push the Border licenstate of the Use native color chooser dialogs parameter checkbox in  $Settings \rightarrow Options \rightarrow General$  menu. When checked, the color dialog used is the one of the OS being used. Otherwise, QGIS custom color chooser is used.

This dialog has four different tabs which allow you to select colors by color ramp, color wheel, color swatches or color picker (not available under X).

Whatever method you use, the selected color is always described through color sliders for HSV (Hue, Saturation, Value) and RGB (Red, Green, Blue) values. There is also an *opacity* slider to set transparency level. On the lower left part of the dialog you can see a comparison between the *current* and the *new* color you are presently selecting and on the lower right part you have the option to add the color you just tweaked into a color slot button.

## Порада: Dynamically change the color with the live-updating option

Check the *Use live-updating color chooser dialogs* option in the General Settings to have the color applied to your items as you change color parameters in the QGIS custom color chooser dialog.

8.4. Color Selector 37

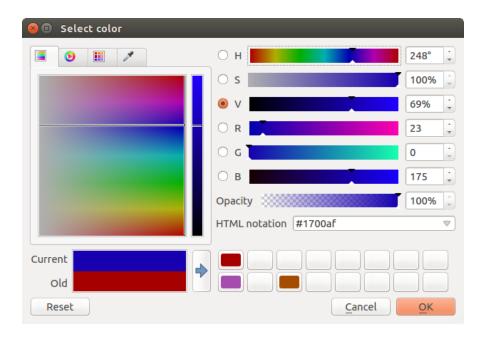


Рис. 8.2: Color selector ramp tab

With color ramp or with color wheel, you can browse to all possible color combinations. There are other possibilities though. By using color swatches you can choose from a preselected list. This selected list is populated with one of three methods:

- Recent colors,
- $Standard\ colors$ , a user-defined list of colors set under Settings o Options o Colors menu
- or Project colors, a user-defined list of colors set under Project  $\rightarrow$  Project Properties  $\rightarrow$  Default Styles.

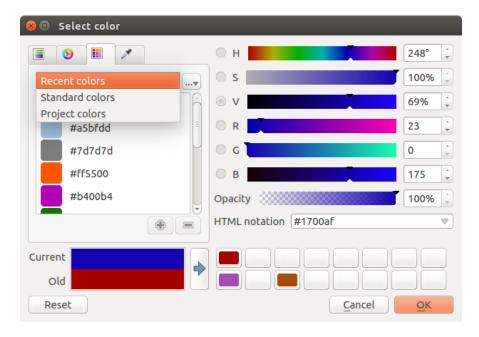


Рис. 8.3: Color selector switcher tab

Another option is to use the color picker which allows you to sample a color from under your mouse pointer at any part of QGIS or even from another application by pressing the space bar. Please note that the color picker is OS dependent and is currently not supported by OSX.

### Порада: quick color picker + copy/paste colors

You can quickly choose from *Recent colors*, from *Standard colors* or simply *copy* or *paste* a color by clicking the drop-down arrow that follows the Border color box.



Рис. 8.4: Quick color selector menu

# 8.5 Blending Modes

QGIS offers different options for special rendering effects with these tools that you may previously only know from graphics programs. Blending modes can be applied on layers, on features but also on print composer items:

- Normal: This is the standard blend mode, which uses the alpha channel of the top pixel to blend with the pixel beneath it. The colors aren't mixed.
- Lighten: This selects the maximum of each component from the foreground and background pixels. Be aware that the results tend to be jagged and harsh.
- Screen: Light pixels from the source are painted over the destination, while dark pixels are not. This mode is most useful for mixing the texture of one item with another item (e.g., you can use a hillshade to texture another layer).
- **Dodge**: Dodge will brighten and saturate underlying pixels based on the lightness of the top pixel. So, brighter top pixels cause the saturation and brightness of the underlying pixels to increase. This works best if the top pixels aren't too bright; otherwise the effect is too extreme.
- Addition: This blend mode simply adds pixel values of one item with the other. In case of values above one (in the case of RGB), white is displayed. This mode is suitable for highlighting features.
- **Darken**: This creates a resultant pixel that retains the smallest components of the foreground and background pixels. Like lighten, the results tend to be jagged and harsh.
- Multiply: Here, the numbers for each pixel of the top item are multiplied with the corresponding pixels for the bottom item. The results are darker pictures.
- Burn: Darker colors in the top item cause the underlying items to darken. Burn can be used to tweak and colorise underlying layers.
- Overlay: This mode combines the multiply and screen blending modes. In the resulting picture, light parts become lighter and dark parts become darker.
- Soft light: This is very similar to overlay, but instead of using multiply/screen it uses color burn/dodge. This is supposed to emulate shining a soft light onto an image.
- Hard light: Hard light is also very similar to the overlay mode. It's supposed to emulate projecting a very intense light onto an image.

- Difference: Difference subtracts the top pixel from the bottom pixel, or the other way around, to always get a positive value. Blending with black produces no change, as the difference with all colors is zero.
- **Subtract**: This blend mode simply subtracts pixel values of one item from the other. In case of negative values, black is displayed.

# 8.6 Zooming and Panning

QGIS provides tools to zoom and pan to your area of interest.

Apart from using the pan and pan and pan are zoom-in / pan icons on the toolbar with the mouse, navigating can also be done with the mouse wheel, spacebar and the arrow keys.

## 8.6.1 Zooming and panning with the mouse wheel

You can press the mouse wheel to pan inside of the main window, and you can roll the mouse wheel to zoom in and out on the map. For zooming, place the mouse cursor inside the map area and roll it forward (away from you) to zoom in and backwards (towards you) to zoom out. The mouse cursor position will be the center of the zoomed area of interest. You can customize the behavior of the mouse wheel zoom using the  $Map\ tools$  tab under the  $Settings \rightarrow Options$  menu.

# 8.6.2 Panning with the arrow keys

Panning the map is possible with the arrow keys. Place the mouse cursor inside the map area, and click on the right arrow key to pan east, left arrow key to pan west, up arrow key to pan north, and down arrow key to pan south.

You can also use the space bar to temporarily cause mouse movements to pan the map. The PgUp and PgDown keys on your keyboard will cause the map display to zoom in or out.

# 8.7 Measuring

QGIS provides four means of measuring geometries:

- the interactive measurement tools —,
- measuring in the Field Calculator,
- derived measures in the *Identify features* tool,
- and a vector analysis tool:  $Vector o Geometry\ Tools o Export/Add\ Geometry\ Columns$

Measuring works within projected coordinate systems (e.g., UTM) and unprojected data. The first three measuring tools behave equally to global project settings:

If "on the fly" CRS transformation is enabled, the default measurement metric is - different from most other GIS - ellipsoidal, using the ellipsoid defined in  $File \to Project\ properties \to General$ . This is true both when geographic and projected coordinate systems are defined for the project. If you want to calculate the projected / planimetric area or distance using cartesian maths, the measurement ellipsoid has to be set to "None / Planimetric" ( $File \to Project\ properties \to CRS$ ). However, with a geographic (= unprojected) CRS defined for the data and project, area and distance measurement will be ellipsoidal. If "on the fly" CRS transformation is disabled, the measurement metric is planimetric when the project coordinate system is projected and ellipsoidal when the project coordinate system is unprojected / geographic.

However, neither the identify tool nor the field calculator will transform your data to the project CRS before measuring. If you want to achieve this, you have to use the vector analysis tool:  $Vector \rightarrow Geometry$   $Tools \rightarrow Export/Add$  Geometry Columns. Here, measurement is by default planimetric except if you choose the ellipsoidal measure.

## 8.7.1 Measure length, areas and angles interactive

All measuring modules use the snapping settings from the digitizing module. This is useful, if you want to measure along lines or areas in vector layers.

To select a measuring tool, click on and select the tool you want to use.

By default, Measure Line: QGIS measures real distances between given points according to a defined ellipsoid. You can define a rubberband color and your preferred measurement units (meters or feet) and angle units (degrees, radians and gon) in the menu option  $Settings \to Options \to Map\ Tools$ . The tool then allows you to click points on the map. Each segment length, as well as the total, shows up in the measure window. To stop measuring, click your right mouse button. Note that you can interactively change the measurement units in the measurement dialog. It overrides the  $Preferred\ measurement\ units$  in the options. There is an info section in the dialog that shows which CRS settings are being used during measurement calculations.

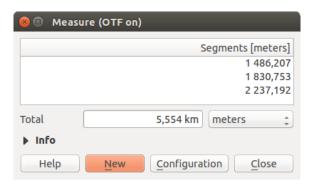


Рис. 8.5: Measure Distance

Measure Area: Areas can also be measured. In the measure window, the accumulated area size appears. In addition, the measuring tool will snap to the currently selected layer, provided that layer has its snapping tolerance set (see section Setting the Snapping Tolerance and Search Radius). So, if you want to measure exactly along a line feature, or around a polygon feature, first set its snapping tolerance, then select the layer. Now, when using the measuring tools, each mouse click (within the tolerance setting) will snap to that layer.



Рис. 8.6: Measure Area

Measure Angle: You can also measure angles. The cursor becomes cross-shaped. Click to draw the first segment of the angle you wish to measure, then move the cursor to draw the desired angle. The measure is displayed in a pop-up dialog.

8.7. Measuring 41



Рис. 8.7: Measure Angle

# 8.8 Select and deselect features

The QGIS toolbar provides several tools to select features in the map canvas. To select one or several features, just click on and select your tool:

- Select Features by area or single click to select feature(s) either by simple click or by rectangle
- Select Features by Polygon
- Select Features by Freehand
- Select Features by Radius

To deselect all selected features, click on Deselect Features from All Layers.

Select features using an expression allows user to select features using expression dialog. See *Expressions* chapter for some example.

Users can save selected features into a New Memory Vector Layer or a New Vector Layer using  $Edit \rightarrow Copy\ Features$  and  $Edit \rightarrow Paste\ Features\ as$  in the wanted format.

# 8.9 Data defined override setup

Beside many options in the vector layer properties dialog or settings in the print composer, you can find a Data defined override icon. Thanks to expressions based on layer attributes or item settings, prebuild or custom functions and variables, this tool allows you to set dynamic value for the concerned parameter. When enabled, the value returned by this widget is applied to the parameter regardless its normal value (checkbox, textbox, slider...).

Clicking the Data defined override icon shows:

- a Description ... that indicates if it is enabled, which input expected, valid input type and the current definition,
- an entry to list the Field type available,
- an entry to list the Variable available,
- Edit ... button to create or edit the expression to use,
- Paste and Copy buttons,
- Clear button to remove the setup.

Порада: When the data-defined override option is setup correctly the icon is yellow or  $\mathbf{E}$ ; if it is broken, the icon is red or  $\mathbf{E}$ .

Parameters that can be used with data-defined tools are:

42

- Style and symbols parameters
- Labels parameters
- Composer parameters

# 8.10 Identify features

The Identify tool allows you to interact with the map canvas and get information on features in a pop-up window. To identify features, use  $View \to Identify$  features or press Ctrl + Shift + I, or click the Identify features icon on the Attributes toolbar.

QGIS offers two ways to identify features with the \( \bigcircle{\chi} \) Identify features tool:

- left click will identify features according to the mode set in the *Identify results* panel
- right click will fetch all the snapped features from all the visible layers. This will open a context menu, allowing the user to choose more precisely the features to identify.

If you click on feature(s), the *Identify results* dialog will list information about the clicked feature(s). The default view is a tree view where the first item is the name of the layer and its children are its identified feature(s). Each feature is described by the name of a field along with its value. This field is the one set in  $Properties \rightarrow Display$ . Then follows all the other information about the feature.

This window can be customized to display custom fields, but by default it will display three kinds of information:

- Actions: Actions can be added to the identify feature windows. The action is run by clicking on the action label. By default, only one action is added, namely view feature form for editing. You can define more actions in the layer's properties dialog.
- **Derived**: This information is calculated or derived from other information. This includes the feature id, its length or perimeter and area in map units depending on its geometry, the count of spatial parts and the number of the clicked part in case of multi-geometry, the count of vertices in the feature and the number of the closest one to the point clicked. It also reports the X and Y (and Z/M if available) coordinate values of both clicked point and feature closest vertex.
- Data attributes: This is the list of attribute fields and values for the feature that has been clicked.

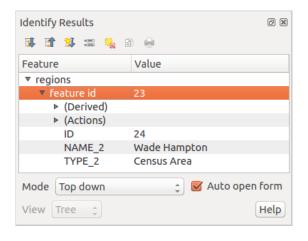


Рис. 8.8: Identify features dialog

At the top of the window, you have seven icons:

- Expand tree
- Collapse tree

- Default behavior to define whether next identified features information should be collapsed or expanded
- View the feature form
- Clear Results
- Copy selected feature to clipboard
- 🍙 🛑 Print selected HTML response

At the bottom of the window, you have the *Mode* and *View* comboboxes. With the *Mode* combobox you can define from which layers features should be identified:

- 'Current layer': only features from the selected layer are identified. The layer may not be visible in the canvas.
- 'Top down, stop at first': for only features from the upper visible layer.
- 'Top down': for all features from the visible layers. The results are shown in the panel.
- and 'Layer selection': opens a context menu where the user selects the layer to identify features from. Operates like a right-click. Only the chosen features will be shown in the result panel.

The *View* can be set as 'Tree', 'Table' or 'Graph'. 'Table' and 'Graph' views can only be set for raster layers.

The identify tool allows you to u auto open a form. If checked, each time a single feature is identified QGIS will open a form showing its attributes. This is a handy way to quickly edit a feature's attributes.

Other functions can be found in the context menu of the identified item. For example, from the context menu you can:

- View the feature form
- Zoom to feature
- Copy feature: Copy all feature geometry and attributes
- Toggle feature selection: Adds identified feature to selection
- Copy attribute value: Copy only the value of the attribute that you click on
- Copy feature attributes: Copy the attributes of the feature
- Clear result: Remove results in the window
- Clear highlights: Remove features highlighted on the map
- Highlight all
- Highlight layer
- Activate layer: Choose a layer to be activated
- Layer properties: Open layer properties window
- Expand all
- Collapse all

## 8.11 Annotation Tools

The Text Annotation tool in the attribute toolbar provides the possibility to place formatted text in a balloon on the QGIS map canvas. Use the Text Annotation tool and click into the map canvas.

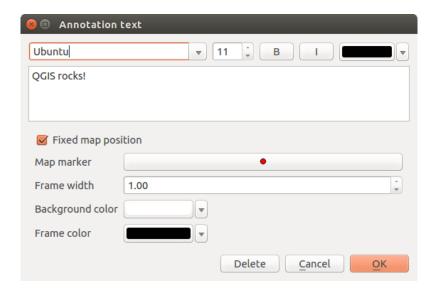


Рис. 8.9: Annotation text dialog

Double clicking on the item opens a dialog with various options. There is the text editor to enter the formatted text and other item settings. For instance, there is the choice of having the item placed on a map position (displayed by a marker symbol) or to have the item on a screen position (not related to the map). The item can be moved by map position (by dragging the map marker) or by moving only the balloon. The icons are part of the GIS theme, and they are used by default in the other themes, too.

The Move Annotation tool allows you to move the annotation on the map canvas.

### 8.11.1 Html annotations

The Html Annotation tools in the attribute toolbar provides the possibility to place the content of an html file in a balloon on the QGIS map canvas. Using the *Html Annotation* tool, click into the map canvas and add the path to the html file into the dialog.

## 8.11.2 SVG annotations

The SVG Annotation tool in the attribute toolbar provides the possibility to place an SVG symbol in a balloon on the QGIS map canvas. Using the SVG Annotation tool, click into the map canvas and add the path to the SVG file into the dialog.

## 8.11.3 Form annotations

Additionally, you can also create your own annotation forms. The Form Annotation tool is useful to display attributes of a vector layer in a customized Qt Designer form (see figure\_custom\_annotation). This is similar to the designer forms for the *Identify features* tool, but displayed in an annotation item. Also see this video https://youtu.be/0pDBuSbQ02o?t=2m25s from Tim Sutton for more information.

**Примітка:** If you press Ctrl+T while an *Annotation* tool is active (move annotation, text annotation, form annotation), the visibility states of the items are inverted.

8.11. Annotation Tools 45

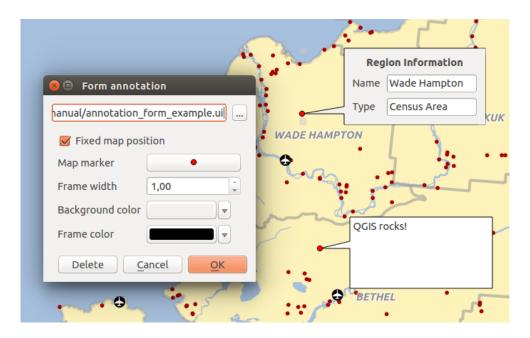


Рис. 8.10: Customized qt designer annotation form

# 8.12 Spatial Bookmarks

Spatial Bookmarks allow you to "bookmark" a geographic location and return to it later. Bookmarks are saved on the computer, meaning that they are available from any project in the same computer.

# 8.12.1 Creating a Bookmark

To create a bookmark:

- 1. Zoom or pan to the area of interest.
- 2. Select the menu option  $View \rightarrow New\ Bookmark$  or press Ctrl-B. The Spatial Bookmark panel opens with the newly created bookmark.
- 3. Enter a descriptive name for the bookmark (up to 255 characters).
- 4. Press Enter to add the bookmark or click elsewhere.

Note that you can have multiple bookmarks with the same name.

## 8.12.2 Working with Bookmarks

To use or manage bookmarks, select the menu option  $View \to Show\ Bookmarks$ . The Spatial Bookmarks panel allows you to:

- Zoom to a Bookmark: select the desired bookmark and then click *Zoom To Bookmark*. You can also zoom to a bookmark by double-clicking on it.
- Delete a Bookmark: select the bookmark and click Delete Bookmark. Confirm your choice.
- Import or Export a bookmark: To share or transfer your bookmarks between computers you can use the *Import/Export Bookmarks* pull down menu in the *Spatial Bookmarks* dialog. All the bookmarks are transferred.

# 8.13 Nesting Projects

If you want to embed content from other project files into your project, you can choose  $Layer \rightarrow Embed$  Layers and Groups.

## 8.13.1 Embedding layers

The following dialog allows you to embed layers from other projects. Here is a small example:

- 1. Press \_\_\_\_\_ to look for a project from the Alaska dataset.
- 2. Select the project file relations.qgs. You can see the content of the project (see figure\_embed\_dialog).
- 3. Press Ctrl and click on the layers airports and regions. Press [OK]. The selected layers are embedded in the map legend and the map view now.

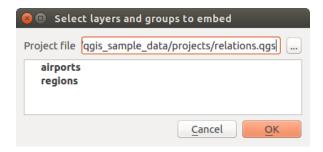


Рис. 8.11: Select layers and groups to embed

While the embedded layers are editable, you can't change their properties like style and labeling.

# 8.13.2 Removing embedded layers

Right-click on the embedded layer and choose Remove.

### 8.14 Decorations

The Decorations of QGIS include the Grid, the Copyright Label, the North Arrow and the Scale Bar. They are used to 'decorate' the map by adding cartographic elements.

### 8.14.1 Grid

Grid allows you to add a coordinate grid and coordinate annotations to the map canvas.

- 1. Select from menu  $View \rightarrow Decorations \rightarrow Grid$ . The dialog starts (see figure \_decorations \_ 1).
- 2. Activate the **Enable** grid checkbox and set grid definitions according to the layers loaded in the map canvas.
- 3. Activate the *Draw annotations* checkbox and set annotation definitions according to the layers loaded in the map canvas.
- 4. Click [Apply] to verify that it looks as expected or [OK] if you're satisfied.

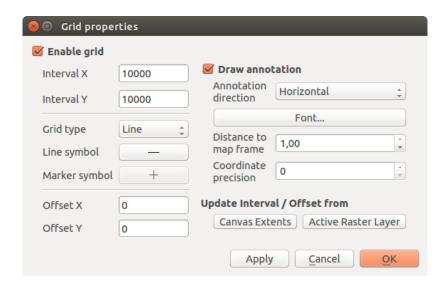


Рис. 8.12: The Grid Dialog

# 8.14.2 Copyright Label

 $\bigcirc$  Copyright label adds a copyright label using the text you prefer to the map.

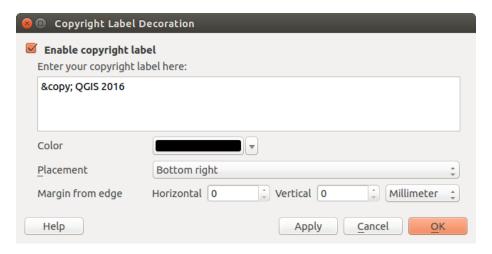


Рис. 8.13: The Copyright Dialog

- 1. Select from menu  $View \rightarrow Decorations \rightarrow Copyright Label$ . The dialog starts (see figure\_decorations\_2).
- 2. Make sure the **Enable Copyright Label** checkbox is checked.
- 3. Enter the text you want to place on the map. You can use HTML as shown in the example.
- 4. Choose the placement of the label from the *Placement* combo box.
- 5. You can refine the placement of the item by setting a Horizontal and/or Vertical Marging from (Canvas) Edge. These values can be a distance in Millimeter or Pixels or set as Percentage of the width or height of the map canvas.
- 6. You can change the color to apply.
- 7. Click [Apply] to verify that it looks as expected or [OK] if you're satisfied.

In the example above, which is the default, QGIS places a copyright symbol followed by the date in the lower right-hand corner of the map canvas.

### 8.14.3 North Arrow

North Arrow places a simple north arrow on the map canvas. Currently, there is only one style available. You can adjust the angle of the arrow or let QGIS set the direction automatically. If you choose to let QGIS determine the direction, it makes its best guess as to how the arrow should be oriented. For placement of the arrow, you have four options, corresponding to the four corners of the map canvas. You can refine the placement of the arrow by setting a Horizontal and/or Vertical Marging from (Canvas) Edge. These values can be a distance in Millimeter or Pixels or set as Percentage of the width or height of the map canvas.

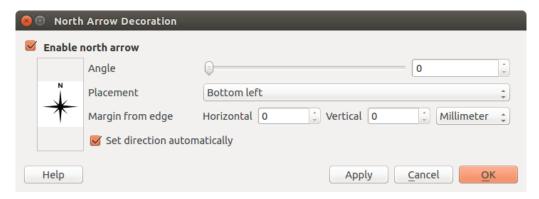


Рис. 8.14: The North Arrow Dialog

### 8.14.4 Scale Bar

Scale Bar adds a simple scale bar to the map canvas. You can control the style and placement, as well as the labelling of the bar.

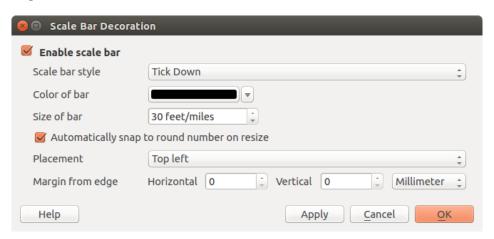


Рис. 8.15: The Scale Bar Dialog

QGIS only supports displaying the scale in the same units as your map frame. So if the units of your layers are in meters, you can't create a scale bar in feet. Likewise, if you are using decimal degrees, you can't create a scale bar to display distance in meters.

To add a scale bar:

- 1. Select from menu  $View \to Decorations \to Scale\ Bar$ . The dialog starts (see figure \_decorations \_4).
- 2. Make sure the Enable scale bar checkbox is checked.

8.14. Decorations 49

- 3. Choose the style from the *Scale bar style* combo box.
- 4. Select the color for the bar *Color of bar* Border or use the default black color.
- 5. Set the Size of bar 1,00 \$
- 6. Optionally, check Automatically snap to round number on resize to display values easy-to-read.
- 7. Choose the placement from the *Placement* combo box.
- 8. You can refine the placement of the item by setting a Horizontal and/or Vertical Marging from (Canvas) Edge. These values can be a distance in Millimeter or Pixels or set as Percentage of the width or height of the map canvas.
- 9. Click [Apply] to verify that it looks as expected or [OK] if you're satisfied.

### Порада: Settings of Decorations

When you save a .qgs project, any changes you have made to Grid, North Arrow, Scale Bar and Copyright will be saved in the project and restored the next time you load the project.

## 8.15 Authentication

QGIS has facility to store/retrieve authentication credentials in a secure manner. Users can securely save credentials into authentication configurations, which are stored in a portable database, can be applied to server or database connections, and safely referenced by their ID tokens in project or settings files. For more information see *Authentication System*.

A master password needs to be set up when initializing the authentication system and its portable database.

# 8.16 Save layer into file

Layers (raster or vector) can be saved in another format with the  $Save\ As...$  feature in the layer contextual menu (by right-clicking in the layer in the layer tree) or in the  $Layer \rightarrow Save\ As...$  menu.

The  $Save\ As$  dialog shows several parameters to change the behaviour when saving the layer. Common parameters (raster and vector) are:

- Format
- Filename
- CRS
- Add save file to map to add the new layer to the canvas
- Extent (possible values are layer, Map view or custom extent)
- Create (for raster), Layer or Custom (for vector) Options which allow you to change some advanced options. Advanced user can see the driver documentation in gdal-ogr documentation.

However, some parameters are specific to raster and vector formats:

- Raster specific parameters:
  - Resolution (horizontal and vertical)
  - Pyramid creation
  - Output mode (raw data or rendered image)
- Vector specific parameters:

- Encoding
- Save only selected features
- Skip attribute creation
- Symbology export: can be used mainly for DXF export and for all file formats who manage OGR feature styles (see note below) as DXF, KML, tab file formats:
  - \* No symbology: default style of the application that reads the data
  - \* Feature symbology: save style with OGR Feature Styles (see note below)
  - \* Symbol Layer symbology: save with OGR Feature Styles (see note below) but export the same geometry multiple times if there are multiple symbology symbol layers used
- Geometry:
  - \* force to multi-geometry,
  - \* add z-dimension,
  - \* add or remove a geometry column with the drop-down list. This is not linked with the current geometry type of the layer. You can add an empty geometry column to an attribute table, remove the geometry column of a spatial layer.

Примітка: OGR Feature Styles are a way to store style directly in the data as a hidden attribute. Only some format can handle this kind of information. KML, DXF and TAB files format are such format. For advanced user, you can read the OGR Feature Styles specification document.

### Примітка: About DXF files

Vector layers can be exported to DXF files using another tool, the *DXF Export* ... in *Project*. The windows allow the user to choose the layer file, the symbology mode (see the note above), the symbology scale, the encoding, the visibility preset and the layers to include in the DXF file.

As an option, you can use the layer title as name if set or Export features intersecting the current map extent.

# 8.17 Use of variables for dynamic content

You can define custom variables for use in expressions. Variables can be defined at the application global level, project level, layer level and composition level. Just like CSS cascading rules, variables can be overwritten - eg, a project level variable will overwrite any application level variables set. You can use these variables to build text strings or other custom expressions using @ character before the variable name. For example in composer creating a label with this content:

```
This map was made using QGIS [% Qqgis_version %]. The project file for this map is: [% Qproject_path %]
```

Will render the label like this:

```
This map was made using QGIS 2.14. The project file for this map is: /gis/qgis-user-conference-2015.qgs
```

You can manage global variables from the  $Settings \rightarrow Options$  menu, and project level variables from Project properties (including adding your own custom variables).

**Примітка:** you can read more information and find examples here Exploring variables in QGIS 2.12, part 1, part 2 and part 3.

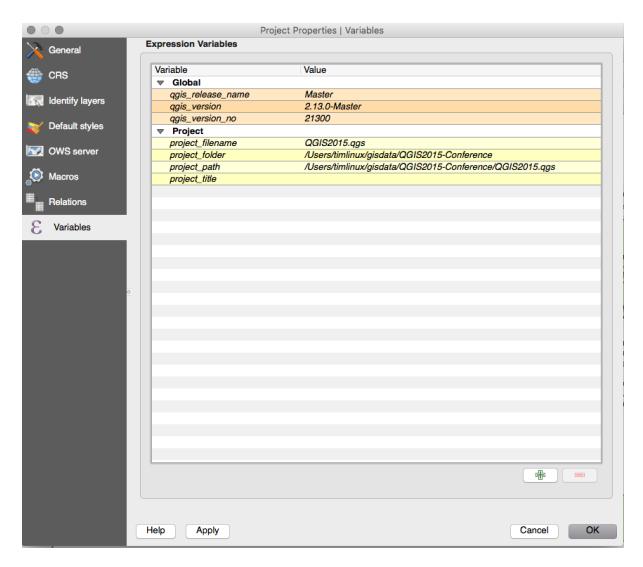


Рис. 8.16: Edit variable at the project level

# **QGIS** Configuration

QGIS is highly configurable through the *Settings* menu. Choose between Project Properties, Options and Customization.

Примітка: QGIS follows desktop guidelines for the location of options and project properties item. Consequently related to the OS you are using, location of some of items described below could be in the *Project* or the *Settings* menu.

# 9.1 Project Properties

In the properties window for the project under  $\triangle$  Settings  $\rightarrow$  Project Properties (kde) or  $\triangle$   $\nearrow$  Project  $\rightarrow$  Project Properties (Gnome, OS X or Windows), you can set project-specific options.

- In the General menu, the general settings let you:
  - give a title to the project beside the project file path
  - choose the color to use for features when they are selected
  - choose the background color: the color to use for the map canvas
  - set whether the path to layers in the project should be saved as absolute (full) or as relative to the project file location. You may prefer relative path when both layers and project files can be moved or shared or if the project is accessed from computers on different platforms.
  - choose to avoid artifacts when project is rendered as map tiles. Note that checking this option can lead to performance degradation.

Calculating areas and distances is a common need in GIS. However, these values are really tied to the underlying projection settings. The **Measurements** frame lets you control these parameters. You can indeed choose:

- the ellipsoid to use: it can be an existing one, a custom one (you'll need to set values of the semi-major and semi-minor axis) or None/Planimetric.
- the units for distance measurements for length and perimeter and the units for area measurements. These settings, which default to the units set in QGIS options but then overrides it for the current project, are used in:
  - \* Attribute table field update bar
  - \* Field calculator calculations
  - \* Identify tool derived length, perimeter and area values
  - \* Default unit shown in measure dialog

The **Coordinate display** allows you to choose and customize the format of units to use to display the mouse coordinate in the status bar and the derived coordinates shown via the identify tool.

Finally, you can define a **project scale** list, which overrides the global predefined scales.

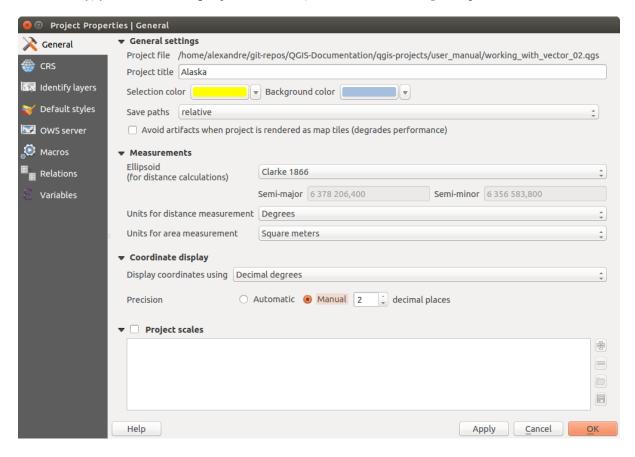


Рис. 9.1: General tab of Project Properties dialog

- The CRS menu enables you to choose the Coordinate Reference System for this project, and to enable on-the-fly re-projection of raster and vector layers when displaying layers from a different CRS.
- With the *Identify layers* menu, you set (or disable) which layers will respond to the *identify tool*. By default, layers are set queryable.
- The *Default Styles* menu lets you control how new layers will be drawn when they do not have an existing .qml style defined. You can also set the default transparency level for new layers and whether symbols should have random colors assigned to them. There is also an additional section where you can define specific colors for the running project. You can find the added colors in the drop down menu of the color dialog window present in each renderer.
- The tab *OWS Server* allows you to define information about the QGIS Server WMS and WFS capabilities, extent and CRS restrictions.
- The *Macros* menu is used to edit Python macros for projects. Currently, only three macros are available: openProject(), saveProject() and closeProject().
- The *Relations* menu is used to define 1:n relations. The relations are defined in the project properties dialog. Once relations exist for a layer, a new user interface element in the form view (e.g. when identifying a feature and opening its form) will list the related entities. This provides a powerful way to express e.g. the inspection history on a length of pipeline or road segment. You can find out more about 1:n relations support in Section *Creating one to many relations*.

```
Project Properties | Macros
                    Python macros
   General
                             from qgis.utils import iface
                             from qgis.gui import QgsMessageBar
  CRS
                          4 - def openProject():
  Identify layers
                                 msgbar = iface.messageBar()
                                 msgbar.PushMessage('WARNING','Project contains sensitive data',
   Default styles
                                                      'Do not publish
                                                     QgsMessageBar.WARNING, 10)
🗾 OWS server
                         10 - def saveProject():
   Macros
                                 pass
                         11
   Relations
                         13 - def closeProject():
                         14
                                 pass
   Variables
                         15
                      Help
                                                                        Apply
                                                                                   Cancel
```

Рис. 9.2: Macro settings in QGIS

# 9.2 Options

Nome basic options for QGIS can be selected using the Options dialog. Select the menu option  $Settings \rightarrow Options$ . The tabs where you can customize your options are described below.

### 9.2.1 General Menu

## Application

- Select the Style (QGIS restart required) and choose between 'Oxygen', 'Windows', 'Motif', 'CDE', 'Plastique' and 'Cleanlooks' ( $\triangle$ ).
- Define the *Icon theme* . Currently only 'default' is possible.
- Define the *Icon size*
- Define the Font. Choose between 
  Qt default and a user-defined font.
- Change the Timeout for timed messages or dialogs .
- 🌌 Hide splash screen at startup
- 🌌 Show tips at startup
- Bold group box titles
- 🌌 QGIS-styled group boxes
- **I** Use native color chooser dialogs
- 🌌 Use live-updating color chooser dialogs
- **Z** Custom side bar style
- **Experimental canvas rotation support (restart required)**

### Project files

9.2. Options 55

- Open project on launch (choose between 'New', 'Most recent' and 'Specific'). When choosing 'Specific' use the to define a project.
- Create new project from default project. You have the possibility to press on Set current project as default or on Reset default. You can browse through your files and define a directory where you find your user-defined project templates. This will be added to Project  $\rightarrow$  New From Template. If you first activate Create new project from default project and then save a project in the project templates folder.
- ullet ullet Prompt to save project and data source changes when required
- Prompt for confirmation when a layer is to be removed
- Warn when opening a project file saved with an older version of QGIS
- Enable macros . This option was created to handle macros that are written to perform an action on project events. You can choose between 'Never', 'Ask', 'For this session only' and 'Always (not recommended)'.

## 9.2.2 System Menu

#### **Environment**

System environment variables can now be viewed, and many configured, in the **Environment** group (see figure\_environment\_variables). This is useful for platforms, such as Mac, where a GUI application does not necessarily inherit the user's shell environment. It's also useful for setting and viewing environment variables for the external tool sets controlled by the Processing toolbox (e.g., SAGA, GRASS), and for turning on debugging output for specific sections of the source code.

• We custom variables (restart required - include separators). You can [Add] and [Remove] variables. Already-defined environment variables are displayed in Current environment variables, and it's possible to filter them by activating Show only QGIS-specific variables.

### Plugin paths

[Add] or [Remove] Path(s) to search for additional C++ plugin libraries

## 9.2.3 Data Sources Menu

#### Feature attributes and table

- Month Open attribute table in a dock window (QGIS restart required)
- Copy geometry in WKT representation from attribute table. When using Copy selected rows to clipboard from the Attribute table dialog, this has the result that the coordinates of points or vertices are also copied to the clipboard.
- Attribute table behavior . There are three possibilities: 'Show all features', 'Show selected features' and 'Show features visible on map'.
- Attribute table row cache 1,00 \$\frac{1}{2}\$. This row cache makes it possible to save the last loaded N attribute rows so that working with the attribute table will be quicker. The cache will be deleted when closing the attribute table.
- Representation for NULL values. Here, you can define a value for data fields containing a NULL value.

### Data source handling

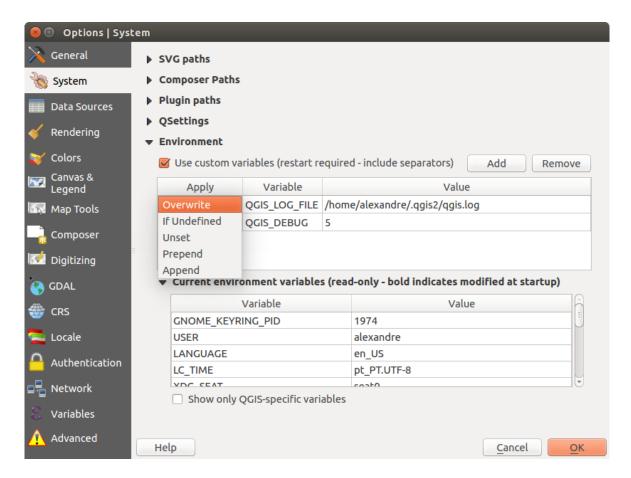


Рис. 9.3: System environment variables in QGIS

9.2. Options 57

- Scan for valid items in the browser dock . You can choose between 'Check extension' and 'Check file contents'.
- Scan for contents of compressed files (.zip) in browser dock . 'No', 'Basic scan' and 'Full scan' are possible.
- Prompt for raster sublayers when opening. Some rasters support sublayers they are called subdatasets in GDAL. An example is netCDF files if there are many netCDF variables, GDAL sees every variable as a subdataset. The option allows you to control how to deal with sublayers when a file with sublayers is opened. You have the following choices:
  - 'Always': Always ask (if there are existing sublayers)
  - 'If needed': Ask if layer has no bands, but has sublayers
  - 'Never': Never prompt, will not load anything
  - 'Load all': Never prompt, but load all sublayers
- Ignore shapefile encoding declaration. If a shapefile has encoding information, this will be ignored by QGIS.
- Madd PostGIS layers with double click and select in extended mode
- Made Add Oracle layers with double click and select in extended mode
- **Execute** expressions on server-side if possible
- Create transaction groups automatically whenever possible (Experimental). When this mode is turned on, all (postgres) layers from the same database are synchronised in their edit state, i.e. when one layer is put into edit state, all are, when one layer is committed or one layer is rolled back, so are the others. Also, instead of buffering edit changes locally, they are directly sent to a transaction in the database which gets committed when the user clicks save layer.

### Hidden Browser Path

This widget lists all the folder you chose to hide from the Browser panel. Removing a folder from the list will make it available in the Browser panel.

## 9.2.4 Rendering Menu

## Rendering behavior

- **Y** By default new layers added to the map should be displayed
- We render caching where possible to speed up redraws
- Market Render layers in parallel using many CPU cores
- Max cores to use
- Map update interval (default to 250 ms)
- **Enable** feature simplification by default for newly added layers
- Simplification threshold
- Simplify on provider side if possible
- Maximum scale at which the layer should be simplified

### Rendering quality

• Make lines appear less jagged at the expense of some drawing performance

#### Rasters

• With RGB band selection, you can define the number for the Red, Green and Blue band.

### $Contrast\ enhancement$

- Single band gray . A single band gray can have 'No stretch', 'Stretch to MinMax', 'Stretch and Clip to MinMax' and also 'Clip to MinMax'.
- Multi band color (byte/band) . Options are 'No stretch', 'Stretch to MinMax', 'Stretch and Clip to MinMax' and 'Clip to MinMax'.
- Multi band color (>byte/band) . Options are 'No stretch', 'Stretch to MinMax', 'Stretch and Clip to MinMax' and 'Clip to MinMax'.
- Limits (minimum/maximum) Options are 'Cumulative pixel count cut', 'Minimum/Maximum', 'Mean +/- standard deviation'.
- Cumulative pixel count cut limits
- Standard deviation multiplier

## Debugging

• Map canvas refresh

### 9.2.5 Colors Menu

This menu allows you to add some custom color that you can find in each color dialog window of the renderers. You will see a set of predefined colors in the tab: you can delete or edit all of them. Moreover you can add the color you want and perform some copy and paste operations. Finally you can export the color set as a gpl file or import them.

### 9.2.6 Canvas and Legend Menu

### Default map appearance (overridden by project properties)

• Define a Selection color and a Background color.

## Layer legend

- Double click action in legend . You can either 'Open layer properties' or 'Open attribute table' with the double click.
- The following Legend item styles are possible:
  - ■ Capitalise layer names
  - − Bold layer names
  - − Bold group names
  - − Display classification attribute names
  - ■ Create raster icons (may be slow)

## 9.2.7 Map tools Menu

This menu offers some options regarding the behavior of the *Identify tool*.

9.2. Options 59

- Search radius for identifying and displaying map tips is a tolerance factor expressed as a percentage of the map width. This means the identify tool will depict results as long as you click within this tolerance.
- *Highlight color* allows you to choose with which color should features being identified are to be highlighted.
- Buffer determines a buffer distance to be rendered from the outline of the identify highlight.
- Minimum width determines how thick should the outline of a highlighted object be.

#### Measure tool

- Define Rubberband color for measure tools
- Define Decimal places
- Keep base unit to not automatically convert large numbers (e.g., meters to kilometers)
- Preferred distance units ('Meters', 'Feet', 'Nautical Miles', 'Degrees' or 'Map Units')
- Preferred area units ('Square meters', 'Square feet', 'Square yards', 'Hectares', 'Map Units' ...)
- Preferred angle units ('Degrees', 'Radians', 'Gon/gradians', 'Minutes of arc' ...)

### Panning and zooming

- Define Mouse wheel action ('Zoom', 'Zoom and recenter', 'Zoom to mouse cursor', 'Nothing')
- Define Zoom factor for wheel mouse

#### Predefined scales

Here, you find a list of predefined scales. With the and buttons you can add or remove your personal scales. You can also import or export scales from/to a .XML file. Note that you still have the possibility to remove your changes and reset to the predefined list.

## 9.2.8 Composer Menu

### Composition defaults

You can define the *Default font* here.

### Grid appearance

- Define the *Grid style* ('Solid', 'Dots', 'Crosses')
- Define the *Grid color*

### Grid and guide defaults

- Define the *Grid spacing* [1,00 \$]
- Define the *Grid offset* 1,00 \$\circ\$ for x and y
- Define the Snap tolerance 1,00 \$

### 9.2.9 Digitizing Menu

### Feature creation

- Suppress attributes pop-up windows after each created feature
- Marke last entered attribute values

• Validate geometries. Editing complex lines and polygons with many nodes can result in very slow rendering. This is because the default validation procedures in QGIS can take a lot of time. To speed up rendering, it is possible to select GEOS geometry validation (starting from GEOS 3.3) or to switch it off. GEOS geometry validation is much faster, but the disadvantage is that only the first geometry problem will be reported.

### Rubberband

• Define Rubberband Line width and Line color

## Snapping

- Moreover Open snapping options in a dock window (QGIS restart required)
- Define Default snap mode ('To vertex', 'To segment', 'To vertex and segment', 'Off')
- Define Default snapping tolerance in map units or pixels
- Define the Search radius for vertex edits in map units or pixels

### Vertex markers

- Show markers only for selected features
- Define vertex Marker style ('Cross' (default), 'Semi transparent circle' or 'None')
- Define vertex Marker size

### Curve offset tool

The next 3 options refer to the Offset Curve tool in Advanced digitizing. Through the various settings, it is possible to influence the shape of the line offset. These options are possible starting from GEOS 3.3.

- Join style
- Quadrant segments
- Miter limit

## 9.2.10 GDAL Menu

GDAL is a data exchange library for raster files. In this tab, you can *Edit create options* and *Edit Pyramids Options* of the raster formats. Define which GDAL driver is to be used for a raster format, as in some cases more than one GDAL driver is available.

### 9.2.11 CRS Menu

### Default CRS for new projects

- Don't enable 'on the fly' reprojection
- • Automatically enable 'on the fly' reprojection if layers have different CRS
- Enable 'on the fly' reprojection by default
- Select a CRS and Always start new projects with this CRS

### CRS for new layers

This area allows you to define the action to take when a new layer is created, or when a layer without a CRS is loaded.

- Prompt for CRS
- Use project CRS
- Use default CRS

9.2. Options 61

#### Default datum transformations

- Mark for datum transformation when no default is defined
- If you have worked with the 'on-the-fly' CRS transformation you can see the result of the transformation in the window below. You can find information about 'Source CRS' and 'Destination CRS' as well as 'Source datum transform' and 'Destination datum transform'.

## 9.2.12 Locale Menu

- W Overwrite system locale and Locale to use instead
- Information about active system locale

#### 9.2.13 Authentication

In the Authentication tab you can set authentication configurations and manage PKI certificates. See Authentication System for more details.

### 9.2.14 Network Menu

#### General

- Define WMS search address, default is http://geopole.org/wms/search?search=\%1\&type=rss
- Define Timeout for network requests (ms) default is 60000
- ullet Define  $Default\ expiration\ period\ for\ WMSC/WMTS\ tiles\ (hours)$  default is 24
- Define Max retry in case of tile request errors
- Define *User-Agent*

## Cache settings

Define the *Directory* and a *Size* for the cache.

- We proxy for web access and define 'Host', 'Port', 'User', and 'Password'.
- Set the *Proxy type* according to your needs.
  - Default Proxy: Proxy is determined based on the application proxy set using
  - Socks5Proxy: Generic proxy for any kind of connection. Supports TCP, UDP, binding to a port (incoming connections) and authentication.
  - *HttpProxy*: Implemented using the "CONNECT" command, supports only outgoing TCP connections; supports authentication.
  - HttpCachingProxy: Implemented using normal HTTP commands, it is useful only in the context of HTTP requests.
  - Ftp Caching Proxy: Implemented using an FTP proxy, it is useful only in the context of FTP requests.

Excluding some URLs can be added to the text box below the proxy settings (see Figure Network Tab).

If you need more detailed information about the different proxy settings, please refer to the manual of the underlying QT library documentation at http://doc.trolltech.com/4.5/qnetworkproxy.html#ProxyType-enum.

### Порада: Using Proxies

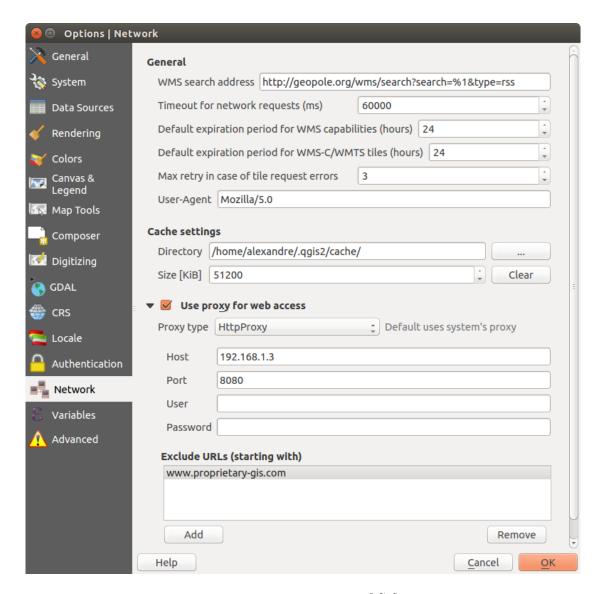


Рис. 9.4: Proxy-settings in QGIS

9.2. Options 63

Using proxies can sometimes be tricky. It is useful to proceed by 'trial and error' with the above proxy types, to check to see if they succeed in your case.

You can modify the options according to your needs. Some of the changes may require a restart of QGIS before they will be effective.

- Description Settings are saved in a text file: \$HOME/.config/QGIS/QGIS2.conf
- X You can find your settings in: \$HOME/Library/Preferences/org.qgis.qgis.plist
- Settings are stored in the registry under: HKEY\CURRENT\_USER\Software\QGIS\qgis

## 9.3 Customization

The customization dialog lets you (de)activate almost every element in the QGIS user interface. This can be very useful if you want to provide your end-users with a 'light' version of QGIS, containing only the icons, menus or panels they need.

Примітка: Before your changes are applied, you need to restart QGIS.

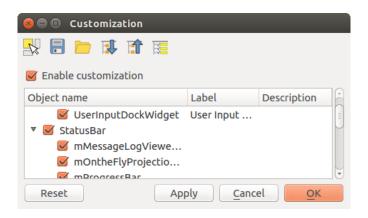


Рис. 9.5: The Customization dialog

The configurable item can be:

- a Menu or some of its sub-menus from the Menu Bar
- a whole **Panel** (see *Panels and Toolbars*)
- the **Status bar** described in *Status Bar* or some of its items
- a **Toolbar**: the whole bar or some of its icons
- or any widget from any dialog in QGIS: label, button, combobox...

With Switch to catching widgets in main application, you can click on an item in QGIS interface that you want to be hidden and QGIS automatically unchecks the corresponding entry in the Customization dialog.

Once you setup your configuration, click [Apply] or [Ok] to validate your changes. This configuration becomes the one used by default by QGIS at the next startup.

The modifications can also be saved in a .ini file using Save To File button. This is a handy way to share a common QGIS interface among multiple users. Just click on Load from File from the destination

computer in order to import the .ini file. You can also run *command line tools* and save various setups for different use cases as well.

# Порада: Easily restore predefined QGIS

The initial QGIS GUI configuration can be restored by one of the methods below:

- unchecking  $\blacksquare$  Enable customization option in the Customization dialog or click the button
- pressing the [Reset] button in the QSettings frame under Settings o Options menu, System tab
- launching QGIS at a command prompt with the following command line qgis --nocustomization
- setting to false the value of  $UI \to Customization \to Enabled$  variable under  $Settings \to Options$  menu, Advanced tab.

In most cases, you need to restart QGIS in order to have the change applied.

9.3. Customization 65

# Working with Projections

QGIS allows users to define a global and project-wide CRS (coordinate reference system) for layers without a pre-defined CRS. It also allows the user to define custom coordinate reference systems and supports on-the-fly (OTF) projection of vector and raster layers. All of these features allow the user to display layers with different CRSs and have them overlay properly.

# 10.1 Overview of Projection Support

QGIS has support for approximately 2,700 known CRSs. Definitions for each CRS are stored in a SQLite database that is installed with QGIS. Normally, you do not need to manipulate the database directly. In fact, doing so may cause projection support to fail. Custom CRSs are stored in a user database. See section Custom Coordinate Reference System for information on managing your custom coordinate reference systems.

The CRSs available in QGIS are based on those defined by the European Petroleum Search Group (EPSG) and the Institut Geographique National de France (IGNF) and are largely abstracted from the spatial reference tables used in GDAL. EPSG identifiers are present in the database and can be used to specify a CRS in QGIS.

In order to use OTF projection, either your data must contain information about its coordinate reference system or you will need to define a global, layer or project-wide CRS. For PostGIS layers, QGIS uses the spatial reference identifier that was specified when the layer was created. For data supported by OGR, QGIS relies on the presence of a recognized means of specifying the CRS. In the case of shapefiles, this means a file containing the well-known text (WKT) specification of the CRS. This projection file has the same base name as the shapefile and a .prj extension. For example, a shapefile named alaska.shp would have a corresponding projection file named alaska.prj.

Whenever you select a new CRS, the layer units will automatically be changed in the *General* tab of the *Project Properties* dialog under the *Project* (Gnome, OS X) or *Settings* (KDE, Windows) menu.

# 10.2 Global Projection Specification

QGIS starts each new project using the global default projection. The global default CRS is EPSG:4326 - WGS 84 (proj=longlat +ellps=WGS84 +datum=WGS84 +no\_defs), and it comes predefined in QGIS. This default can be changed via the [Select...] button in the first section, which is used to define the default coordinate reference system for new projects, as shown in figure\_projection\_1. This choice will be saved for use in subsequent QGIS sessions.

When you use layers that do not have a CRS, you need to define how QGIS responds to these layers. This can be done globally or project-wide in the CRS tab under  $Settings \rightarrow Options$ .

The options shown in figure\_projection\_1 are:

• Prompt for CRS

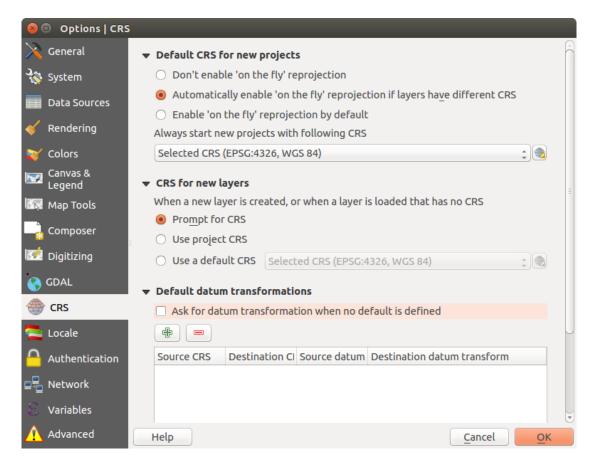


Рис. 10.1: CRS tab in the QGIS Options Dialog

- Use project CRS
- Use default CRS displayed below

If you want to define the coordinate reference system for a certain layer without CRS information, you can also do that in the *General* tab of the raster and vector properties dialog (see *General Menu* for rasters and *General Menu* for vectors). If your layer already has a CRS defined, it will be displayed as shown in *General menu in vector layers properties dialog*.

#### Порада: CRS in the Map Legend

Right-clicking on a layer in the Map Legend (section Layers Panel) provides two CRS shortcuts. Set layer CRS takes you directly to the Coordinate Reference System Selector dialog (see figure\_projection\_2). Set project CRS from Layer redefines the project CRS using the layer's CRS.

# 10.3 Define On The Fly (OTF) Reprojection

QGIS supports OTF reprojection for both raster and vector data. However, OTF is not activated by default. To use OTF projection, you must activate the Enable on the fly CRS transformation checkbox in the CRS tab of the Project Properties dialog.

## There are three ways to do this:

- 1. Select Project Properties from the Project (Gnome, OSX) or Settings (KDE, Windows) menu.
- 2. Click on the CRS status icon in the lower right-hand corner of the status bar.

3. Turn OTF on by default in the CRS tab of the Options dialog by selecting Enable 'on the fly' reprojection by default or Automatically enable 'on the fly' reprojection if layers have different CRS.

If you have already loaded a layer and you want to enable OTF projection, the best practice is to open the CRS tab of the Project Properties dialog, select a CRS, and activate the Enable 'on the Enable 'on the Enable transformation checkbox. The Enable CRS status icon will no longer be greyed out, and all layers will be OTF projected to the CRS shown next to the icon.

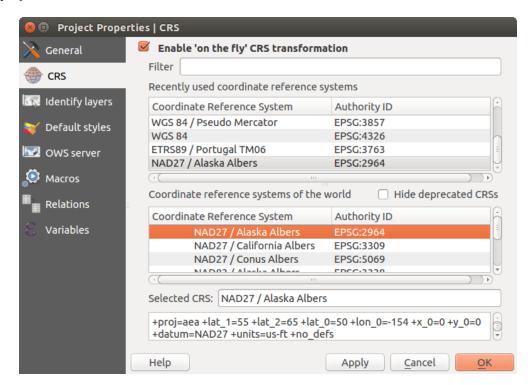


Рис. 10.2: Project Properties Dialog

The CRS tab of the Project Properties dialog contains five important components, as shown in Figure projection 2 and described below:

- 1. Enable 'on the fly' CRS transformation This checkbox is used to enable or disable OTF projection. When off, each layer is drawn using the coordinates as read from the data source, and the components described below are inactive. When on, the coordinates in each layer are projected to the coordinate reference system defined for the map canvas.
- 2. **Filter** If you know the EPSG code, the identifier, or the name for a coordinate reference system, you can use the search feature to find it. Enter the EPSG code, the identifier or the name.
- 3. Recently used coordinate reference systems If you have certain CRSs that you frequently use in your everyday GIS work, these will be displayed in this list. Click on one of these items to select the associated CRS.
- 4. Coordinate reference systems of the world This is a list of all CRSs supported by QGIS, including Geographic, Projected and Custom coordinate reference systems. To define a CRS, select it from the list by expanding the appropriate node and selecting the CRS. The active CRS is preselected.
- 5. **PROJ.4 text** This is the CRS string used by the PROJ.4 projection engine. This text is read-only and provided for informational purposes.

Порада: Project Properties Dialog

If you open the  $Project\ Properties$  dialog from the  $Project\ menu$ , you must click on the CRS tab to view the CRS settings.

Opening the dialog from the CRS status icon will automatically bring the CRS tab to the front.

# 10.4 Custom Coordinate Reference System

If QGIS does not provide the coordinate reference system you need, you can define a custom CRS. To define a CRS, select \*\*Custom CRS... from the Settings menu. Custom CRSs are stored in your QGIS user database. In addition to your custom CRSs, this database also contains your spatial bookmarks and other custom data.

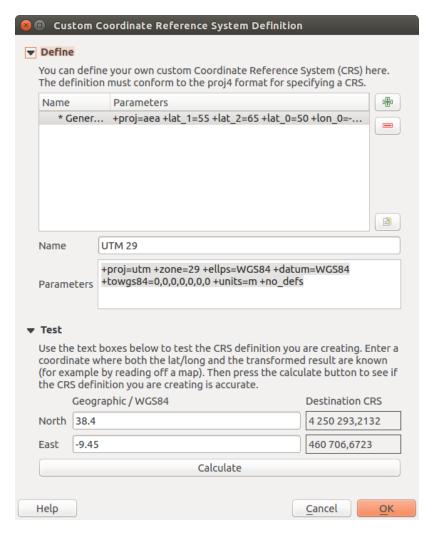


Рис. 10.3: Custom CRS Dialog

Defining a custom CRS in QGIS requires a good understanding of the PROJ.4 projection library. To begin, refer to "Cartographic Projection Procedures for the UNIX Environment - A User's Manual" by Gerald I. Evenden, U.S. Geological Survey Open-File Report 90-284, 1990 (available at ftp://ftp.remotesensing.org/proj/OF90-284.pdf).

This manual describes the use of the proj.4 and related command line utilities. The cartographic parameters used with proj.4 are described in the user manual and are the same as those used by QGIS.

The Custom Coordinate Reference System Definition dialog requires only two parameters to define a user CRS:

- 1. A descriptive name
- 2. The cartographic parameters in PROJ.4 format

To create a new CRS, click the Add new CRS button and enter a descriptive name and the CRS parameters.

Note that the *Parameters* must begin with a +proj= block, to represent the new coordinate reference system.

You can test your CRS parameters to see if they give sane results. To do this, enter known WGS 84 latitude and longitude values in *North* and *East* fields, respectively. Click on [Calculate], and compare the results with the known values in your coordinate reference system.

# 10.5 Default datum transformations

OTF depends on being able to transform data into a 'default CRS', and QGIS uses WGS84. For some CRS there are a number of transforms available. QGIS allows you to define the transformation used otherwise QGIS uses a default transformation.

In the CRS tab under  $Settings \rightarrow \mathcal{P}$  Options you can:

- set QGIS to ask you when it needs define a transformation using Ask for datum transformation when no default is defined
- edit a list of user defaults for transformations.

QGIS asks which transformation to use by opening a dialogue box displaying PROJ.4 text describing the source and destination transforms. Further information may be found by hovering over a transform. User defaults can be saved by selecting Remember selection.

# **QGIS** Browser

- QGIS Browser widget
- QGIS Browser as a standalone application

QGIS Browser is available as a standalone application and as a panel in QGIS Desktop. It lets you easily navigate in your filesystem and manage geodata. You can have access to common vector files (e.g., ESRI shapefiles or MapInfo files), databases (e.g., PostGIS, Oracle, SpatiaLite or MS SQL Spatial) and OWS/WCS|WMS|WFS connections. You can also view your GRASS data (to get the data into QGIS, see *GRASS GIS Integration*).

# 11.1 QGIS Browser widget

To activate QGIS Browser, right-click on QGIS toolbar and check  $\square$  Browser Panel or select it from  $View \rightarrow Panels$  or  $Settings \rightarrow Panels$  (kde). In the Browser panel, you can now browse in your filesystem, databases and web services and get your data into the map view with a simple drag-and-drop or double-click.

You can also open a QGIS project directly from the Browser panel by double-clicking its name or by drag-and-drop into the map view.

At the top of the panel, you find some icons that help you to:

- Add Selected Layers. You can also add data into the map view by selecting Add Layer or Add selected layers in the context menu.
- Refresh the browser tree
- T search for specific data. Enter a search word or wildcard and the browser will filter the tree to only show paths to matching DB tables, filenames or folders other data or folders won't be displayed. See the Browser Panel(2) example on the figure\_browser\_panels. The comparison can be case-sensitive or not. It can also be set to:
  - normal: return any item containing the search text
  - using wildcard(s): fine tune the search using ? and/or \* characters to specify the position of the search text
  - using a regular expression
- Collapse the whole tree
- Tenable and disable properties widget. When toggled on, a new widget is added at the bottom of the panel showing, if applicable, metadatas of the selected item

Right-click an item in the browser tree helps you to:

- in case of file or table, display its metadata or open it in your project. Tables can even be renamed, deleted or truncated
- in case of folder, bookmark it into your favourites, hide it from the browser tree. Hidden folders can be managed from the  $Settings \rightarrow Options \rightarrow Data\ Sources$  tab
- refresh, rename or delete schema.

You can also import files into databases or copy tables from one schema/database to another one with a simple drag-and-drop. There is a second browser panel available to avoid long scrolling while dragging. Just select the file and drag-and-drop from one panel to the other.

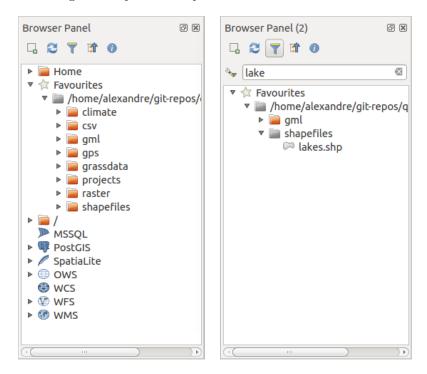


Рис. 11.1: QGIS Browser panels side-by-side

# 11.2 QGIS Browser as a standalone application

It's also possible to run the QGIS Browser as a standalone application. Like the Browser panel, the standalone Browser helps you navigate through your filesystem and manage your geodata. It also helps you preview or create them and open them in a QGIS project by drag-and-drop.

#### Start the QGIS browser

- $\Delta$  Type in "qbrowser" at a command prompt.
- 尽 Start the QGIS Browser using the Start menu or desktop shortcut.
- X The QGIS Browser is available from your Applications folder.

In figure\_browser\_standalone\_metadata, you can see the enhanced functionality of the standalone QGIS Browser. The *Param* tab provides the details of your connection-based datasets, like PostGIS or MSSQL Spatial. The *Metadata* tab contains general information about the file (see *Metadata Menu*). With the *Preview* tab, you can have a look at your files without importing them into your QGIS project. It's also possible to preview the attributes of your files in the *Attributes* tab.

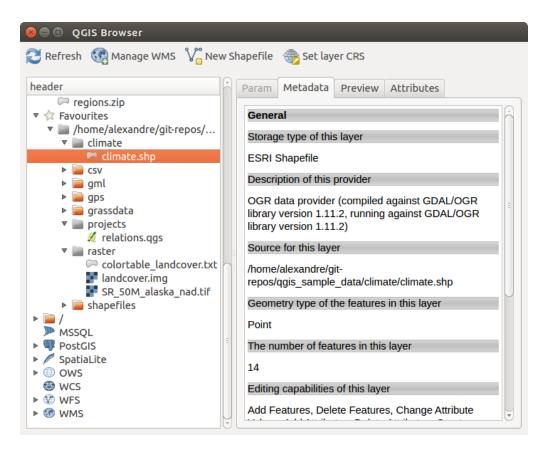


Рис. 11.2: QGIS Browser as a standalone application

# Working with Vector Data

# 12.1 Supported Data Formats

QGIS uses the OGR library to read and write vector data formats, including ESRI shapefiles, MapInfo and MicroStation file formats, AutoCAD DXF, PostGIS, SpatiaLite, Oracle Spatial and MSSQL Spatial databases, and many more. GRASS vector and PostgreSQL support is supplied by native QGIS data provider plugins. Vector data can also be loaded in read mode from zip and gzip archives into QGIS. As of the date of this document, 69 vector formats are supported by the OGR library (see OGR-SOFTWARE-SUITE in *Literature and Web References*). The complete list is available at <a href="http://www.gdal.org/ogr/ogr\_formats.html">http://www.gdal.org/ogr/ogr\_formats.html</a>.

Примітка: Not all of the listed formats may work in QGIS for various reasons. For example, some require external commercial libraries, or the GDAL/OGR installation of your OS may not have been built to support the format you want to use. Only those formats that have been well tested will appear in the list of file types when loading a vector into QGIS. Other untested formats can be loaded by selecting \*.\*.

Working with GRASS vector data is described in Section GRASS GIS Integration.

This section describes how to work with several common formats: ESRI shapefiles, PostGIS layers, SpatiaLite layers, OpenStreetMap vectors, and Comma Separated data (CSV). Many of the features available in QGIS work the same, regardless of the vector data source. This is by design, and it includes the identify, select, labelling and attributes functions.

Примітка: QGIS supports (multi)point, (multi)line, (multi)polygon, CircularString, CompoundCurve, CurvePolygon, MultiCurve, MultiSurface feature types, all with Z and/or M values.

You should note also that some driver doesn't support some of these feature types like CircularString, CompoundCurve, CurvePolygon, MultiCurve, MultiSurface feature type. QGIS will convert them to (multi)polygon feature.

### 12.1.1 Loading a layer from a file

To load a layer from a file (like a Shapefile, a Mapinfo or a dxf layer), click on the toolbar button; or type Ctrl+Shift+V. This will bring up a new window (see figure vector 1).

From the available options check File. Click on [Browse]. That will bring up a standard open file dialog (see figure\_vector\_2), which allows you to navigate the file system and load a shapefile or other supported data source. The selection box Filter allows you to preselect some OGR-supported file formats.

You can also select the encoding for the file if desired.

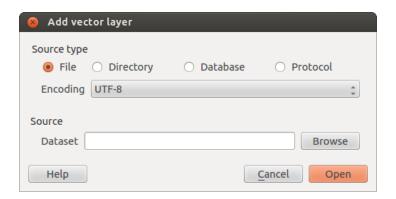


Рис. 12.1: Add Vector Layer Dialog

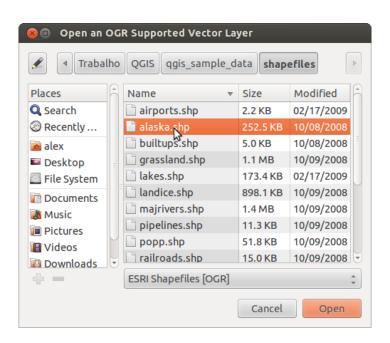


Рис. 12.2: Open an OGR Supported Vector Layer Dialog

Selecting a file from the list and clicking [Open] loads it into QGIS. Figure\_vector\_3 shows QGIS after loading the alaska.shp file.

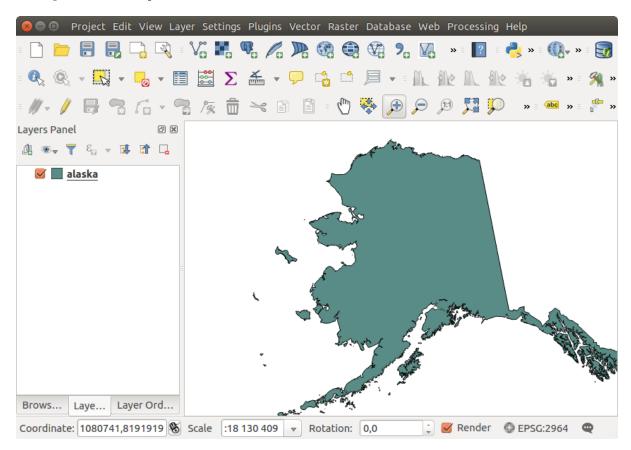


Рис. 12.3: QGIS with Shapefile of Alaska loaded

## Порада: Layer Colors

When you add a layer to the map, it is assigned a random color. When adding more than one layer at a time, different colors are assigned to each layer.

Once a file is loaded, you can zoom around it using the map navigation tools. To change the style of a layer, open the *Layer Properties* dialog by double clicking on the layer name or by right-clicking on the name in the legend and choosing *Properties* from the context menu. See section *Style Menu* for more information on setting symbology of vector layers.

#### Порада: Load layer and project from mounted external drives on OS X

On OS X, portable drives that are mounted beside the primary hard drive do not show up as expected under  $File \rightarrow Open\ Project$ . We are working on a more OSX-native open/save dialog to fix this. As a workaround, you can type /Volumes in the  $File\ name$  box and press Enter. Then you can navigate to external drives and network mounts.

Примітка: DXF files containing several geometry types (point, line and/or polygon), the name of the layer will be made from <filename.dxf> entities < geometry type>.

Примітка: You can also drag and drop the file(s) into the Layers Panel from either the files browser or the QGIS Browser panel. If the layer contains several geometry types, a new windows will ask you to select the sublayer. This often occurs with GPX, Mapinfo or DXF files format.

#### Loading specific directory based layer

To load some specific format like ArcInfo Binary Coverage, UK. National Transfer Format, as well as the raw TIGER format of the US Census Bureau or OpenfileGDB, click on the Add Vector Layer toolbar button or press Ctrl+Shift+V to open the Add Vector Layer dialog. Select Directory as Source type. Change the file type filter Files of type to the format you want to open, for example 'Arc/Info Binary Coverage'. Navigate to the directory that contains the coverage file or the file, and select it.

#### **ESRI Shapefiles**

The ESRI shapefile is still one of the most used vector file format in QGIS. However, this file format has some limitation that some other file format have not (like Geopackage, spatialite). Support is provided by the OGR Simple Feature Library (http://www.gdal.org/ogr/).

A shapefile actually consists of several files. The following three are required:

- 1. .shp file containing the feature geometries
- 2. .dbf file containing the attributes in dBase format
- 3. .shx index file

Shapefiles also can include a file with a .prj suffix, which contains the projection information. While it is very useful to have a projection file, it is not mandatory. A shapefile dataset can contain additional files. For further details, see the ESRI technical specification at http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf.

## Improving Performance for Shapefiles

To improve the performance of drawing a shapefile, you can create a spatial index. A spatial index will improve the speed of both zooming and panning. Spatial indexes used by QGIS have a .qix extension.

Use these steps to create the index:

- Load a shapefile by clicking on the Va Add Vector Layer toolbar button or pressing Ctrl+Shift+V.
- Open the Layer Properties dialog by double-clicking on the shapefile name in the legend or by right-clicking and choosing Properties from the context menu.
- In the General tab, click the [Create Spatial Index] button.

#### Problem loading a shape .prj file

If you load a shapefile with a .prj file and QGIS is not able to read the coordinate reference system from that file, you will need to define the proper projection manually within the *General* tab of the *Layer Properties* dialog of the layer by clicking the [Specify...] button. This is due to the fact that .prj files often do not provide the complete projection parameters as used in QGIS and listed in the *CRS* dialog.

For the same reason, if you create a new shapefile with QGIS, two different projection files are created: a .prj file with limited projection parameters, compatible with ESRI software, and a .qpj file, providing the complete parameters of the used CRS. Whenever QGIS finds a .qpj file, it will be used instead of the .prj.

#### 12.1.2 Delimited Text Files

Tabular data is a very common and widely used format because of its simplicity and readability – data can be viewed and edited even in a plain text editor. A delimited text file is an attribute table with each column separated by a defined character and each row separated by a line break. The first row usually contains the column names. A common type of delimited text file is a CSV (Comma Separated Values), with each column separated by a comma.

Such data files can also contain positional information in two main forms:

- As point coordinates in separate columns
- As well-known text (WKT) representation of geometry

QGIS allows you to load a delimited text file as a layer or ordinal table. But first check that the file meets the following requirements:

- 1. The file must have a delimited header row of field names. This must be the first line in the text file
- 2. The header row must contain field(s) with geometry definition. These field(s) can have any name.
- 3. The X and Y coordinates (if geometry is defined by coordinates) must be specified as numbers. The coordinate system is not important.

As an example of a valid text file, we import the elevation point data file elevp.csv that comes with the QGIS sample dataset (see section  $Sample\ Data$ ):

```
X;Y;ELEV
-300120;7689960;13
-654360;7562040;52
1640;7512840;3
[...]
```

Some items to note about the text file:

- 1. The example text file uses ; (semicolon) as delimiter. Any character can be used to delimit the fields.
- 2. The first row is the header row. It contains the fields X, Y and ELEV.
- 3. No quotes (") are used to delimit text fields.
- 4. The X coordinates are contained in the X field.
- 5. The Y coordinates are contained in the Y field.

#### Others valuable informations for advanced users

Features with curved geometries (CircularString, CurvePolygon and CompoundCurve) are supported. Here are three examples of such geometry types as a delimited text with WKT geometries:

```
Label; WKT_geom
CircularString; CIRCULARSTRING(268 415,227 505,227 406)
CurvePolygon; CURVEPOLYGON(CIRCULARSTRING(1 3, 3 5, 4 7, 7 3, 1 3))
CompoundCurve; COMPOUNDCURVE((5 3, 5 13), CIRCULARSTRING(5 13, 7 15, 9 13), (9 13, 9 3), CIRCULARSTRING(9 3, 7 1, 5 3))
```

Delimited Text supports also Z and M coordinates in geometries:

```
LINESTRINGM(10.0 20.0 30.0, 11.0 21.0 31.0)
```

# Loading a delimited text file

Click the toolbar icon Add Delimited Text Layer in the Manage layers toolbar to open the Create a Layer from a Delimited Text File dialog, as shown in figure delimited text 1.

First, select the file to import (e.g., qgis\_sample\_data/csv/elevp.csv) by clicking on the [Browse] button. Once the file is selected, QGIS attempts to parse the file with the most recently used delimiter. To enable QGIS to properly parse the file, it is important to select the correct delimiter. You can specify a delimiter by activating Custom delimiters, or by activating Regular expression delimiter and entering text into the Expression field. For example, to change the delimiter to tab, use \t (this is a regular expression for the tab character).

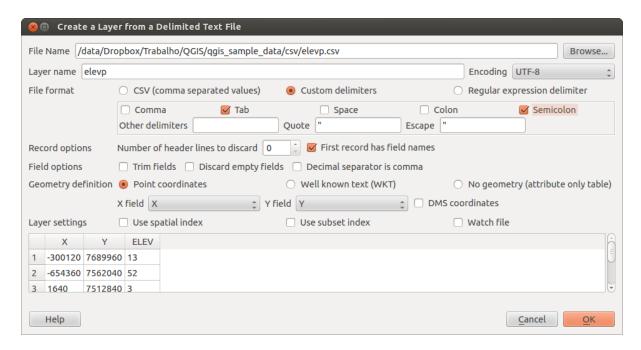


Рис. 12.4: Delimited Text Dialog

Once the file is parsed, set Geometry definition to Point coordinates and choose the X and Y fields from the dropdown lists. If the coordinates are defined as degrees/minutes/seconds, activate the M DMS coordinates checkbox.

Finally, enter a layer name (e.g., elevp), as shown in figure\_delimited\_text\_1. To add the layer to the map, click [OK]. The delimited text file now behaves as any other map layer in QGIS.

There is also a helper option that allows you to trim leading and trailing spaces from fields —  $\square$  Trim fields. Also, it is possible to  $\square$  Discard empty fields. If necessary, you can force a comma to be the decimal separator by activating  $\square$  Decimal separator is comma.

If spatial information is represented by WKT, activate the *Well Known Text* option and select the field with the WKT definition for point, line or polygon objects. If the file contains non-spatial data, activate *No geometry (attribute only table)* and it will be loaded as an ordinal table.

Additionally, you can enable:

- **W** Use spatial index to improve the performance of displaying and spatially selecting features.
- **Use subset index.**
- Watch file to watch for changes to the file by other applications while QGIS is running.

# 12.1.3 OpenStreetMap data

In recent years, the OpenStreetMap project has gained popularity because in many countries no free geodata such as digital road maps are available. The objective of the OSM project is to create a free editable map of the world from GPS data, aerial photography or local knowledge. To support this objective, QGIS provides support for OSM data.

# Loading OpenStreetMap Vectors

QGIS integrates OpenStreetMap import as a core functionality.

- To connect to the OSM server and download data, open the menu  $Vector \rightarrow Openstreetmap \rightarrow Load\ data$ . You can skip this step if you already obtained an .osm XML file using JOSM, Overpass API or any other source.
- The menu  $Vector \rightarrow Openstreet map \rightarrow Import\ topology\ from\ an\ XML\ file\ will\ convert\ your\ .osm$  file into a SpatiaLite database and create a corresponding database connection.
- The menu Vector o Openstreetmap o Export topology to SpatiaLite then allows you to open the database connection, select the type of data you want (points, lines, or polygons) and choose tags to import. This creates a SpatiaLite geometry layer that you can add to your project by clicking on the Add SpatiaLite Layer toolbar button or by selecting the Add SpatiaLite Layer... option from the Layer menu (see section SpatiaLite Layers).

### 12.1.4 PostGIS Layers

PostGIS layers are stored in a PostgreSQL database. The advantages of PostGIS are the spatial indexing, filtering and query capabilities it provides. Using PostGIS, vector functions such as select and identify work more accurately than they do with OGR layers in QGIS.

# **Creating a stored Connection**

The first time you use a PostGIS data source, you must create a connection to the PostgreSQL database that contains the data. Begin by clicking on the Add PostGIS Layer toolbar button, selecting the Add PostGIS Layer... option from the Layer menu, or typing Ctrl+Shift+D. You can also open the Add Vector Layer dialog and select Database. The Add PostGIS Table(s) dialog will be displayed. To access the connection manager, click on the [New] button to display the Create a New PostGIS Connection dialog. The parameters required for a connection are:

- Name: A name for this connection. It can be the same as Database.
- Service: Service parameter to be used alternatively to hostname/port (and potentially database). This can be defined in pg\_service.conf. Check the Service connection file section for more details.
- Host: Name of the database host. This must be a resolvable host name such as would be used to open a telnet connection or ping the host. If the database is on the same computer as QGIS, simply enter 'localhost' here.
- Port: Port number the PostgreSQL database server listens on. The default port is 5432.
- **Database**: Name of the database.
- SSL mode: How the SSL connection will be negotiated with the server. Note that massive speedups in PostGIS layer rendering can be achieved by disabling SSL in the connection editor. The following options are available:
  - Disable: Only try an unencrypted SSL connection.
  - Allow: Try a non-SSL connection. If that fails, try an SSL connection.
  - Prefer (the default): Try an SSL connection. If that fails, try a non-SSL connection.
  - Require: Only try an SSL connection.
- Username: User name used to log in to the database.
- Password: Password used with *Username* to connect to the database.

Optionally, you can activate the following checkboxes:

- **Save** Username
- Save Password

- Only look in the geometry columns table
- Market Don't resolve type of unrestricted columns (GEOMETRY)
- Month of the 'public' schema •
- 🌌 Also list tables with no geometry
- **U**se estimated table metadata

Once all parameters and options are set, you can test the connection by clicking on the [Test Connect] button.

## Порада: Use estimated table metadata to speed up operations

When initializing layers, various queries may be needed to establish the characteristics of the geometries stored in the database table. When the *Use estimated table metadata* option is checked, these queries examine only a sample of the rows and use the table statistics, rather than the entire table. This can drastically speed up operations on large datasets, but may result in incorrect characterization of layers (eg. the feature count of filtered layers will not be accurately determined) and may even cause strange behaviour in case columns that are supposed to be unique actually are not.

#### Loading a PostGIS Layer

Once you have one or more connections defined, you can load layers from the PostgreSQL database. Of course, this requires having data in PostgreSQL. See section *Importing Data into PostgreSQL* for a discussion on importing data into the database.

To load a layer from PostGIS, perform the following steps:

- If the Add PostGIS layers dialog is not already open, selecting the Add PostGIS Layer... option from the Layer menu or typing Ctrl+Shift+D opens the dialog.
- Choose the connection from the drop-down list and click [Connect].
- Select or unselect Also list tables with no geometry.
- Optionally, use some Search Options to define which features to load from the layer, or use the [Build query] button to start the Query builder dialog.
- Find the layer(s) you wish to add in the list of available layers.
- Select it by clicking on it. You can select multiple layers by holding down the Shift key while clicking. See section *Query Builder* for information on using the PostgreSQL Query Builder to further define the layer.
- Click on the [Add] button to add the layer to the map.

## Порада: PostGIS Layers

Normally, a PostGIS layer is defined by an entry in the geometry\_columns table. From version 0.9.0 on, QGIS can load layers that do not have an entry in the geometry\_columns table. This includes both tables and views. Defining a spatial view provides a powerful means to visualize your data. Refer to your PostgreSQL manual for information on creating views.

#### Service connection file

The service connection file allows PostgreSQL connection parameters to be associated with a single service name. That service name can then be specified by a client and the associated settings will be

used.

It's called .pg\_service.conf under \*nix systems (GNU/Linux, macOS etc.) and pg\_service.conf on Windows.

The service file looks like:

[water\_service] host=192.168.0.45 port=5433 dbname=gisdb user=paul password=paulspass

[wastewater\_service] host=dbserver.com dbname=water user=waterpass

**Πρимітка:** There are two services in the above example: water\_service and wastewater\_service. You can use these to connect from QGIS, pgAdmin etc. by specifying only the name of the service you want to connect to (without the enclosing brackets). If you want to use the service with psql you need to do something like export PGSERVICE=water\_service before doing your psql commands.

Примітка: You can find all the parameters here

Примітка: If you don't want to save the passwords in the service file you can use the .pg pass option.

On \*nix operating systems (GNU/Linux, macOS etc.) you can save the .pg\_service.conf file in the user's home directory and the PostgreSQL clients will automatically be aware of it. For example, if the logged user is web, .pg\_service.conf should be saved in the /home/web/ directory in order to directly work (without specifying any other environment variables).

You can specify the location of the service file by creating a PGSERVICEFILE environment variable (e.g. run the export PGSERVICEFILE=/home/web/.pg\_service.conf command under your \*nix OS to temporarily set the PGSERVICEFILE variable)

You can also make the service file available system-wide (all users) either by placing it at pg\_config --sysconfdir''\*\*/.pg\_service.conf\*\* or by adding the ''PGSYSCONFDIR environment variable to specify the directory containing the service file. If service definitions with the same name exist in the user and the system file, the user file takes precedence.

Попередження: There are some caveats under Windows:

- The service file should be saved as pg\_service.conf and not as .pg\_service.conf.
- The service file should be saved in Unix format in order to work. One way to do it is to open it with Notepad++ and Edit -> EOL Conversion -> UNIX Format -> File save.
- After adding an environment variable you may also need to restart the computer.

# Some details about PostgreSQL layers

This section contains some details on how QGIS accesses PostgreSQL layers. Most of the time, QGIS should simply provide you with a list of database tables that can be loaded, and it will load them on request. However, if you have trouble loading a PostgreSQL table into QGIS, the information below may help you understand any QGIS messages and give you direction on changing the PostgreSQL table or view definition to allow QGIS to load it.

QGIS requires that PostgreSQL layers contain a column that can be used as a unique key for the layer. For tables, this usually means that the table needs a primary key, or a column with a unique constraint on it. In QGIS, this column needs to be of type int4 (an integer of size 4 bytes). Alternatively, the ctid

column can be used as primary key. If a table lacks these items, the oid column will be used instead. Performance will be improved if the column is indexed (note that primary keys are automatically indexed in PostgreSQL).

If the PostgreSQL layer is a view, the same requirement exists, but views do not have primary keys or columns with unique constraints on them. You have to define a primary key field (has to be integer) in the QGIS dialog before you can load the view. If a suitable column does not exist in the view, QGIS will not load the layer. If this occurs, the solution is to alter the view so that it does include a suitable column (a type of integer and either a primary key or with a unique constraint, preferably indexed).

QGIS offers a checkbox **Select at id** that is activated by default. This option gets the ids without the attributes which is faster in most cases. It can make sense to disable this option when you use expensive views.

#### Порада: Backup of PostGIS database with layers saved by QGIS

If you want to make a backup of your PostGIS database using the pg\_dump and pg\_restore commands, and the default layer styles as saved by QGIS fail to restore afterwards, you need to set the XML option to DOCUMENT and the restore will work.

QGIS allows to filter features already on server side. Check the Execute expressions on postgres server-side if possible (Experimental) checkbox to do so. Only supported expressions will be sent to the database. Expressions using unsupported operators or functions will gracefully fallback to local evaluation.

# 12.1.5 Importing Data into PostgreSQL

Data can be imported into PostgreSQL/PostGIS using several tools, including the DB Manager plugin and the command line tools shp2pgsql and ogr2ogr.

# **DB** Manager

QGIS comes with a core plugin named  $^{\text{DB Manager}}$ . It can be used to load shapefiles and other data formats, and it includes support for schemas. See section DB Manager Plugin for more information.

## shp2pgsql

PostGIS includes an utility called **shp2pgsql** that can be used to import shapefiles into a PostGIS-enabled database. For example, to import a shapefile named lakes.shp into a PostgreSQL database named gis\_data, use the following command:

```
shp2pgsql -s 2964 lakes.shp lakes_new | psql gis_data
```

This creates a new layer named lakes\_new in the gis\_data database. The new layer will have a spatial reference identifier (SRID) of 2964. See section Working with Projections for more information on spatial reference systems and projections.

#### Порада: Exporting datasets from PostGIS

Like the import tool **shp2pgsql**, there is also a tool to export PostGIS datasets as shapefiles: **pgsql2shp**. This is shipped within your PostGIS distribution.

# ogr2ogr

Besides **shp2pgsql** and **DB Manager**, there is another tool for feeding geodata in PostGIS: **ogr2ogr**. This is part of your GDAL installation.

To import a shapefile into PostGIS, do the following:

```
ogr2ogr -f "PostgreSQL" PG:"dbname=postgis host=myhost.de user=postgres password=topsecret" alaska.shp
```

This will import the shapefile alaska.shp into the PostGIS database postgis using the user postgres with the password topsecret on host server myhost.de.

Note that OGR must be built with PostgreSQL to support PostGIS. You can verify this by typing (in

```
ogrinfo --formats | grep -i post
```

If you prefer to use PostgreSQL's **COPY** command instead of the default **INSERT INTO** method, you can export the following environment variable (at least available on  $\Delta$  and X):

```
export PG_USE_COPY=YES
```

ogr2ogr does not create spatial indexes like shp2pgsl does. You need to create them manually, using the normal SQL command CREATE INDEX afterwards as an extra step (as described in the next section *Improving Performance*).

#### **Improving Performance**

Retrieving features from a PostgreSQL database can be time-consuming, especially over a network. You can improve the drawing performance of PostgreSQL layers by ensuring that a PostGIS spatial index exists on each layer in the database. PostGIS supports creation of a GiST (Generalized Search Tree) index to speed up spatial searches of the data (GiST index information is taken from the PostGIS documentation available at http://postgis.net).

Порада: You can use the DBManager to create an index to your layer. You should first select the layer and click on Table > Edit table, go to Indexes tab and click on [Add spatial index].

```
The syntax for creating a GiST index is:
```

```
CREATE INDEX [indexname] ON [tablename]
  USING GIST ( [geometryfield] GIST_GEOMETRY_OPS );
```

Note that for large tables, creating the index can take a long time. Once the index is created, you should perform a VACUUM ANALYZE. See the PostGIS documentation (POSTGIS-PROJECT *Literature and Web References*) for more information.

The following is an example of creating a GiST index:

```
gsherman@madison:~/current$ psql gis_data
Welcome to psql 8.3.0, the PostgreSQL interactive terminal.
```

# 12.1.6 Vector layers crossing 180° longitude

Many GIS packages don't wrap vector maps with a geographic reference system (lat/lon) crossing the 180 degrees longitude line (http://postgis.refractions.net/documentation/manual-2.0/ST\_Shift\_Longitude.html). As result, if we open such a map in QGIS, we will see two far, distinct locations, that should appear near each other. In Figure\_vector\_4, the tiny point on the far left of the map canvas (Chatham Islands) should be within the grid, to the right of the New Zealand main islands.



Рис. 12.5: Map in lat/lon crossing the 180° longitude line

A work-around is to transform the longitude values using PostGIS and the  $ST\_Shift\_Longitude$  function. This function reads every point/vertex in every component of every feature in a geometry, and if the longitude coordinate is  $<0^{\circ}$ , it adds  $360^{\circ}$  to it. The result is a  $0^{\circ}$  -  $360^{\circ}$  version of the data to be plotted in a  $180^{\circ}$ -centric map.

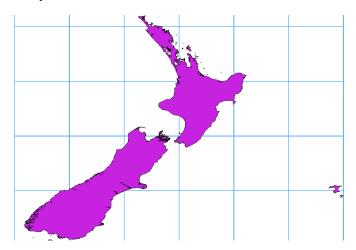


Рис. 12.6: Crossing 180° longitude applying the ST Shift Longitude function

### Usage

- Import data into PostGIS (Importing Data into PostgreSQL) using, for example, the DB Manager plugin.
- Use the PostGIS command line interface to issue the following command (in this example, "TABLE" is the actual name of your PostGIS table): gis\_data=# update TABLE set the\_geom=ST\_Shift\_Longitude(the\_geom);
- If everything went well, you should receive a confirmation about the number of features that were updated. Then you'll be able to load the map and see the difference (Figure vector 5).

# 12.1.7 SpatiaLite Layers

The first time you load data from a SpatiaLite database, begin by clicking on the Add SpatiaLite Layer toolbar button, or by selecting the Add SpatiaLite Layer... option from the Layer

menu, or by typing Ctrl+Shift+L. This will bring up a window that will allow you either to connect to a SpatiaLite database already known to QGIS, which you can choose from the drop-down menu, or to define a new connection to a new database. To define a new connection, click on [New] and use the file browser to point to your SpatiaLite database, which is a file with a .sqlite extension.

If you want to save a vector layer to SpatiaLite format, you can do this by right clicking the layer in the legend. Then, click on Save~as..., define the name of the output file, and select 'SpatiaLite' as format and the CRS. Also, you can select 'SQLite' as format and then add SPATIALITE=YES in the OGR data source creation option field. This tells OGR to create a SpatiaLite database. See also http://www.gdal.org/ogr/drv sqlite.html.

QGIS also supports editable views in SpatiaLite.

#### Creating a new SpatiaLite layer

If you want to create a new SpatiaLite layer, please refer to section Creating a new SpatiaLite layer.

#### Порада: SpatiaLite data management Plugins

For SpatiaLite data management, you can also use several Python plugins: QSpatiaLite, SpatiaLite Manager or *DB Manager* (core plugin, recommended). If necessary, they can be downloaded and installed with the Plugin Installer.

# 12.1.8 MSSQL Spatial Layers

QGIS also provides native MS SQL support. The first time you load MSSQL Spatial data, begin by clicking on the Add MSSQL Spatial Layer toolbar button or by selecting the Add MSSQL Spatial Layer... option from the Layer menu, or by typing Ctrl+Shift+M.

#### 12.1.9 Oracle Spatial Layers

The spatial features in Oracle Spatial aid users in managing geographic and location data in a native type within an Oracle database. QGIS now has support for such layers.

#### Creating a stored Connection

The first time you use an Oracle Spatial data source, you must create a connection to the database that contains the data. Begin by clicking on the Add Oracle Spatial Layer toolbar button, selecting the Add Oracle Spatial Layer... option from the Layer menu, or typing Ctrl+Shift+0. To access the connection manager, click on the [New] button to display the Create a New Oracle Spatial Connection dialog. The parameters required for a connection are:

- Name: A name for this connection. It can be the same as Database
- Database: SID or SERVICE NAME of the Oracle instance.
- Host: Name of the database host. This must be a resolvable host name such as would be used to open a telnet connection or ping the host. If the database is on the same computer as QGIS, simply enter 'localhost' here.
- Port: Port number the Oracle database server listens on. The default port is 1521.
- Username: Username used to login to the database.
- Password: Password used with *Username* to connect to the database.

Optionally, you can activate following checkboxes:

- Save Username Indicates whether to save the database username in the connection configuration.
- Save Password Indicates whether to save the database password in the connection settings.
- Only look in meta data table Restricts the displayed tables to those that are in the all sdo geom metadata view. This can speed up the initial display of spatial tables.
- Month of the order of the search of the search of the search to tables that are owned by the user.
- Also list tables with no geometry Indicates that tables without geometry should also be listed by default.
- We estimated table statistics for the layer metadata When the layer is set up, various metadata are required for the Oracle table. This includes information such as the table row count, geometry type and spatial extents of the data in the geometry column. If the table contains a large number of rows, determining this metadata can be time-consuming. By activating this option, the following fast table metadata operations are done: Row count is determined from all\_tables.num\_rows. Table extents are always determined with the SDO\_TUNE.EXTENTS\_OF function, even if a layer filter is applied. Table geometry is determined from the first 100 non-null geometry rows in the table.
- Monly existing geometry types Only list the existing geometry types and don't offer to add others.

Попередження: In the Authentication tab, saving username and password will keep unprotected credentials in the connection configuration. Those credentials will be visible if, for instance, you shared the project file with someone. Therefore, it's advisable to save your credentials in a Authentication configuration instead (configurations tab). See Authentication System for more details.

Once all parameters and options are set, you can test the connection by clicking on the **[Test Connect]** button.

#### Порада: QGIS User Settings and Security

Depending on your computing environment, storing passwords in your QGIS settings may be a security risk. Passwords are saved in clear text in the system configuration and in the project files! Your customized settings for QGIS are stored based on the operating system:

- $\Delta$  The settings are stored in your home directory in ~/.qgis2.
- 2 The settings are stored in the registry.

# Loading an Oracle Spatial Layer

Once you have one or more connections defined, you can load layers from the Oracle database. Of course, this requires having data in Oracle.

To load a layer from Oracle Spatial, perform the following steps:

- If the Add Oracle Spatial layers dialog is not already open, click on the Add Oracle Spatial Layer toolbar button.
- Choose the connection from the drop-down list and click [Connect].
- Select or unselect Also list tables with no geometry.
- Optionally, use some Search Options to define which features to load from the layer or use the [Build query] button to start the Query builder dialog.

- Find the layer(s) you wish to add in the list of available layers.
- Select it by clicking on it. You can select multiple layers by holding down the Shift key while clicking. See section *Query Builder* for information on using the Oracle Query Builder to further define the layer.
- Click on the [Add] button to add the layer to the map.

#### Порада: Oracle Spatial Layers

Normally, an Oracle Spatial layer is defined by an entry in the USER SDO METADATA table.

# 12.2 The Symbol Library

## 12.2.1 The Style Manager

The Symbol Library is the place where users can manage and create generic symbols to be used in several QGIS projects. You can open it with the  $Settings \rightarrow Style\ Manager$  or from the  $Style\ tab$  in the vector layer's Properties. It allows users to:

- create, edit and remove symbols
- organize symbols in custom groups
- export and import symbols.

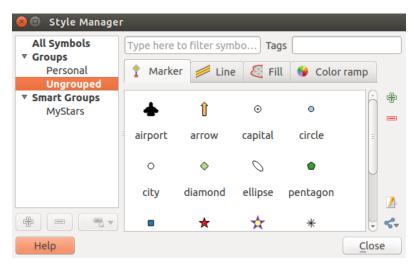


Рис. 12.7: The Style Manager

# Groups and smart groups

You can organize symbols into different categories. These categories, listed in the panel at the left, can be static (called **Group**) or dynamic (named **Smart Group**). A group is smart when its symbols are dynamically fetched according to conditions set. See figure\_symbol\_2:

To create a group, right click on an existing group or on the main **Groups** directory in the left of the dialog. You can also select a group and click the Add Group button. The new group will be a sub-group of the selected one.

Create **Smart Group** is similar to creating group, but instead select **Smart Groups**. The dialog box allows user to choose the expression to select symbols in order to appear in the smart group (contains some tags, member of a group, have a string in its name, etc.). Any symbol that satisfies the entered condition(s) is automatically added to the smart group.



Рис. 12.8: Creating a Smart Group

To remove a group or a smart group, right click on the group and select *Remove Group* or select it and push Remove Group button.

Unlike the smart groups that automatically fetch their belonged symbols, simple groups are filled by the user. To add a symbol into a group, you can either right click on a symbol, choose *Apply Group* and then the group name. There is a second way to add several symbols into a group: just select the group, click and choose *Group Symbols*. All symbols display a checkbox that allows you to add the symbol into the selected groups. When selection is finished, you can click the same button, and choose *Finish* 

All the symbols that are not placed under a custom group belong to a default group named **Ungrouped**.

### Add, Edit, Remove Symbol

Grouping.

Selecting a group returns in the right panel, if applicable, the list of symbols of the group (including its subgroups). These symbols are organized in four different tabs:

- Marker for point symbols
- Line for linear symbols
- Fill for surface symbols
- and Color Ramp

To delete a symbol you no longer need, just select it and click Remove item (also available through right-click). The symbol will be deleted from the local symbols database.

The symbol list can be modified by adding new symbols with Add item button or modifying existing ones with Edit item. See The Symbol Selector for further information.

### Share symbols

The Share item tool, at the right bottom of the Style Library dialog, offers options to easily share symbols with others: users can indeed export their symbols and import symbols to their library.

# **Exporting symbols**

You can export the selected symbols to PNG, SVG or XML file formats. Exporting to PNG or SVG (both not available for color ramp symbols) creates a file for each selected symbol, and the SVG folder can be added to SVG Paths in  $Settings \rightarrow Options$  to e.g. share these symbols on a network. The XML format generates a single file containing all the selected symbols. This file can then be imported in another user's style library.

#### Importing symbols

You can extend your symbols library by importing new symbols. Just select \( \sigma \) Import from the drop-down list at the right bottom of the dialog. In the new dialog, you'll need to:

- indicate the source of the symbols (it can be a .xml file on the disk or an url),
- give the name of the group under which the symbols will be put
- select the symbols you want to add to your library
- and press **Import**.

Note that import and export options are also available through right-click.

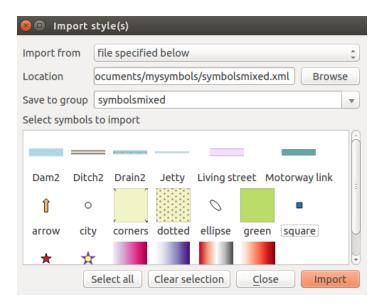


Рис. 12.9: Importing symbols

#### Color Ramp

The Color ramp tab in the Style Manager presents different types of color ramps you can use to style layers.

To create a custom color ramp, activate the Color ramp tab and click the Add item button. The button reveals a drop-down list to choose the ramp type: Gradient, Random, colorBrewer, or cpt-city.

The first three have options for number of steps and/or multiple stops in the color ramp. You can use the Invert option while classifying the data with a color ramp. See figure\_symbol\_4 for an example of custom color ramp and figure\_symbol\_4a for the cpt-city dialog.

The cpt-city option opens a new dialog with hundreds of themes included 'out of the box'.

# 12.2.2 The symbol Selector

The Symbol selector is the main dialog to design a symbol. You can create or edit Marker, Line or Fill Symbols.

For each kind of symbols, you will find always the same dialog structure:

- at the top left side a dynamic symbol representation, updated as soon as symbol properties evolve
- under the symbol representation, the symbol tree shows symbol layers that are combined afterwards to shape a new global symbol. A symbol can consist of several *Symbol layers*. Settings will be shown later in this chapter.

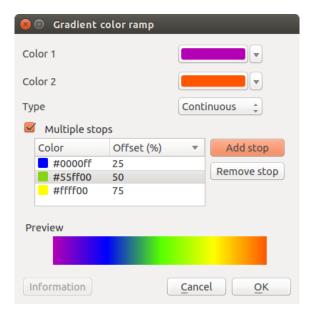


Рис. 12.10: Example of custom gradient color ramp with multiple stops



Рис. 12.11: cpt-city dialog with hundreds of color ramps

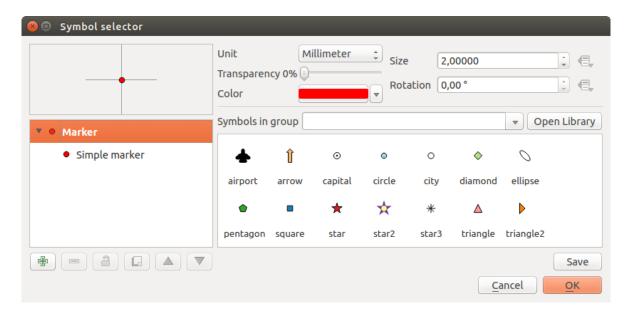


Рис. 12.12: Designing a Marker symbol

- at the right you can setup some parameters that apply to the global symbol:
  - unit: it can be millimeter, pixel or map unit
  - transparency
  - color: when this parameter is changed by the user, its value is echoed to all unlocked subsymbols color
  - size and rotation for marker symbol
  - width for line symbol

Note that the *Data-defined override* button beside the last layer-related parameters is inactive until the symbol is applied to a layer. Once the symbol is connected to a layer, this button offers access to the *size assistant* dialog which helps to create proportional or multivariate analysis rendering.

• under these parameters are displayed items of the symbols library you can choose from. This list of symbols can be filtered by selecting a group in the drop-down list just above.

According to the level selected in the symbol tree, you'll get enabled different tools at the bottom of the dialog to :

- 🗗 add new symbol layer: you can imbricate as many symbols as you want
- remove the selected symbol layer
- lock colors of symbol layer: a locked color stays unchanged when user changes the color at the global (or upper) symbol level
- La duplicate a (group of) symbol layer(s)
- move up or down the symbol layer
- apply *special effects* to the symbol layer
- save the designed symbol into your symbol library
- or choose in the Advanced drop-down list, to clip features to canvas extent.

Порада: Note that once you have set the size in the lower levels of the Symbol layers dialog, the size of

the whole symbol can be changed with the Size (for marker symbol) or the Width (for line symbol) menu in the first level again. The size of the lower levels changes accordingly, while the size ratio is maintained.

More detailed settings can be made when clicking on the lower level in the Symbol tree. You can change each *Symbol layers* properties and according to the symbol type, you get different settings.

#### Marker Symbols

Marker symbols have several symbol layer types:

- Ellipse marker
- Font marker
- Simple marker (default)
- SVG marker
- Vector Field marker

For each marker symbol, you can set the following properties:

- Symbol layer type: You have the option to use Ellipse markers, Font markers, Simple markers, SVG markers and Vector Field markers.
- colors
- Size
- Outline style
- Outline width
- $\bullet$  Angle
- Offset X, Y: You can shift the symbol in the x- or y-direction.
- Anchor point
- Data defined properties ...

#### Line Symbols

Line marker symbols have only two symbol layer types:

- Marker line
- Simple line (default)

The default symbol layer type draws a simple line whereas the other display a marker point regularly on the line. You can choose different location: vertex, last and first vertex, interval, central point or on every curve point. Marker line can have offset along the line or offset line. Finally, *rotation* allows you to change the orientation of the symbol.

The following settings are available:

- colour
- Pen width
- Offset
- Pen style
- Join style
- Cap style
- **U**se custom dash pattern

- Dash pattern unit
- Data defined properties ...

#### Polygon Symbols

Polygon marker symbols have also several symbol layer types:

- Centroid fill
- Gradient fill
- Line pattern fill
- Point pattern fill
- Raster image fill
- SVG fill
- Shapeburst fill
- Simple fill (default)
- Outline: Marker line (same as line marker)
- Outline: simple line (same as line marker)

The following settings are available:

- Colors for the border and the fill.
- Fill style
- Border style
- Border width
- Offset X, Y
- Data defined properties ...

Using the color combo box, you can drag and drop color for one color button to another button, copypaste color, pick color from somewhere, choose a color from the palette or from recent or standard color. The combo box allows you to fill in the feature with transparency. You can also just click the button to open the palette dialog. Note that you can import color from some external software like GIMP.

With the 'Raster image fill' you can fill polygons with a tiled raster image. Options include (data defined) file name, opacity, image size (in pixels, mm or map units), coordinate mode (feature or view) and rotation.

'Gradient Fill' Symbol layer type allows you to select between a Two color and Color ramp setting. You can use the Feature centroid as Referencepoint. All fills 'Gradient Fill' Symbol layer type is also available through the Symbol menu of the Categorized and Graduated Renderer and through the Rule properties menu of the Rule-based renderer.

Other possibility is to choose a 'shapeburst fill' which is a buffered gradient fill, where a gradient is drawn from the boundary of a polygon towards the polygon's centre. Configurable parameters include distance from the boundary to shade, use of color ramps or simple two color gradients, optional blurring of the fill and offsets.

It is possible to only draw polygon borders inside the polygon. Using 'Outline: Simple line' select *Draw line only inside polygon*.

**Note:** When geometry type is polygon, you can choose to disable the automatic clipping of lines/polygons to the canvas extent. In some cases this clipping results in unfavourable symbology (eg centroid fills where the centroid must always be the actual feature's centroid).

# 12.3 The Vector Properties Dialog

The Layer Properties dialog for a vector layer provides general settings to manage appearance of layer features in the map (symbology, labeling, diagrams), interaction with the mouse (actions, map tips, form design). It also provides information about the layer.

To access the *Layer Properties* dialog, double-click on a layer in the legend or right-click on the layer and select *Properties* from the pop-up menu.

#### Порада: Switch quickly between different layer representations

Using the  $Styles \to Add$  combobox at the bottom of the Layer Properties dialog, you can save as many combinations of layer properties settings (symbology, labeling, diagram, fields form, actions...) as you want. Then, simply switch between styles from the context menu of the layer in Layers Panel to automatically get different representations of your data.

#### 12.3.1 General Menu



Use this menu to make general settings for the vector layer. There are several options available:

### Layer Info

- Change the display name of the layer in displayed as
- ullet Define the Layer source of the vector layer
- Define the Data source encoding to define provider-specific options and to be able to read the file

#### Coordinate Reference System

- Specify the coordinate reference system. Here, you can view or change the projection of the specific vector layer.
- Create a Spatial Index (only for OGR-supported formats)
- Update Extents information for a layer
- View or change the projection of the specific vector layer, clicking on Specify ...

#### Scale dependent visibility

You can set the *Maximum (inclusive)* and *Minimum (exclusive)* scale, defining a range of scale in which features will be visible. Out of this range, they are hidden. The Set to current canvas scale button helps you use the current map canvas scale as boundary of the range visibility.

# Query Builder

Under the **Provider Feature Filter** frame, the Query Builder allows you to define a subset of the features in the layer using a SQL-like WHERE clause and to display the result in the main window. As long as the query is active, only the features corresponding to its result are available in the project. The query result can be saved as a new vector layer.

The **Query Builder** is accessible through the eponym term at the bottom of the *General* menu in the Layer Properties. Under *Feature subset*, click on the **[Query Builder]** button to open the *Query builder*. For example, if you have a regions layer with a TYPE\_2 field, you could select only regions that

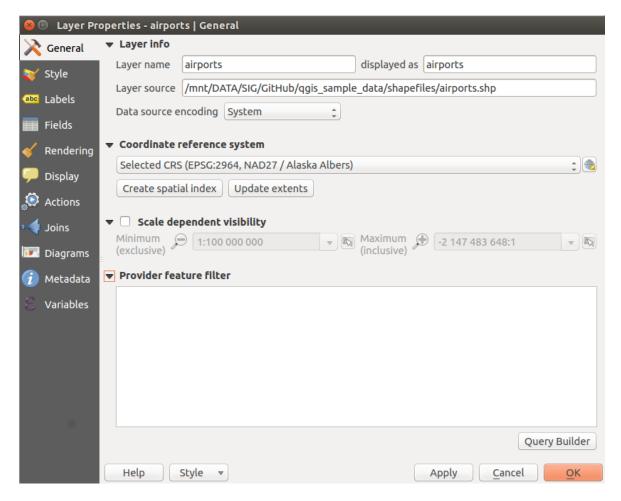


Рис. 12.13: General menu in vector layers properties dialog

are borough in the *Provider specific filter expression* box of the Query Builder. Figure\_vector\_general\_2 shows an example of the Query Builder populated with the regions.shp layer from the QGIS sample data. The Fields, Values and Operators sections help you to construct the SQL-like query.

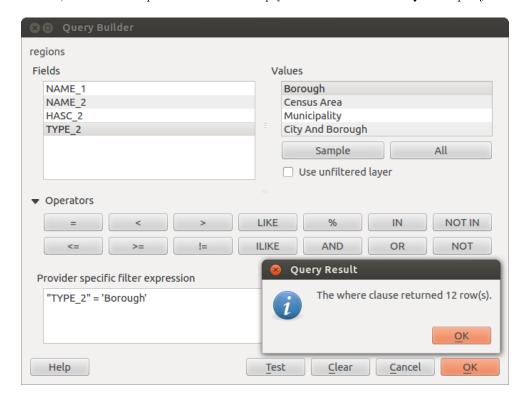


Рис. 12.14: Query Builder

The Fields list contains all attribute columns of the attribute table to be searched. To add an attribute column to the SQL WHERE clause field, double click its name in the Fields list. Generally, you can use the various fields, values and operators to construct the query, or you can just type it into the SQL box.

The Values list lists the values of an attribute table. To list all possible values of an attribute, select the attribute in the Fields list and click the [all] button. To list the first 25 unique values of an attribute column, select the attribute column in the Fields list and click the [Sample] button. To add a value to the SQL WHERE clause field, double click its name in the Values list.

The **Operators section** contains all usable operators. To add an operator to the SQL WHERE clause field, click the appropriate button. Relational operators (= , > , ...), string comparison operator (LIKE), and logical operators (AND, OR, ...) are available.

The [Test] button shows a message box with the number of features satisfying the current query, which is useful in the process of query construction. The [Clear] button clears the text in the SQL WHERE clause text field. The [OK] button closes the window and selects the features satisfying the query. The [Cancel] button closes the window without changing the current selection.

QGIS treats the resulting subset acts as if it where the entire layer. For example if you applied the filter above for 'Borough', you can not display, query, save or edit Anchorage, because that is a 'Municipality' and therefore not part of the subset.

The only exception is that unless your layer is part of a database, using a subset will prevent you from editing the layer.

# 12.3.2 Style Menu

The Style menu provides you with a comprehensive tool for rendering and symbolizing your vector data. You can use tools that are common to all vector data, as well as special symbolizing tools that were

designed for the different kinds of vector data. However all types share the following dialog structure: in the upper part, you have a widget that helps you prepare the classification and the symbol to use for features and at the bottom the  $Layer\ rendering\ widget$ .

#### Порада: Export vector symbology

You have the option to export vector symbology from QGIS into Google \*.kml, \*.dxf and MapInfo \*.tab files. Just open the right mouse menu of the layer and click on  $Save\ As...$  to specify the name of the output file and its format. In the dialog, use the  $Symbology\ export$  menu to save the symbology either as  $Feature\ symbology\ o$  or as  $Symbol\ layer\ symbology\ o$ . If you have used symbol layers, it is recommended to use the second setting.

#### Features rendering

The renderer is responsible for drawing a feature together with the correct symbol. Regardless layer geometry type, there are four common types of renderers: single symbol, categorized, graduated and rule-based. For point layers, there are a point displacement and a heatmap renderers available while polygon layers can also be rendered with the inverted renderer.

There is no continuous color renderer, because it is in fact only a special case of the graduated renderer. The categorized and graduated renderers can be created by specifying a symbol and a color rampthey will set the colors for symbols appropriately. For each data type (points, lines and polygons), vector symbol layer types are available. Depending on the chosen renderer, the dialog provides different additional sections.

**Примітка:** If you change the renderer type when setting the style of a vector layer the settings you made for the symbol will be maintained. Be aware that this procedure only works for one change. If you repeat changing the renderer type the settings for the symbol will get lost.

#### Single Symbol Renderer

The Single Symbol Renderer is used to render all features of the layer using a single user-defined symbol. See The symbol Selector for further information about symbol representation.

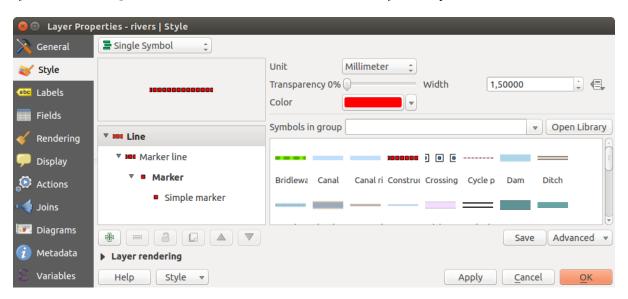


Рис. 12.15: Single symbol line properties

Порада: edit symbol directly from layer panel

If in your **Layers Panel** you have layers with categories defined through categorized, graduated or rule-based style mode, you can quickly change the fill color of the symbol of the categories by right-clicking on a category and choose the color you prefer from a color wheel menu. Right-clicking on a category will also give you access to the options **Hide all items**, **Show all items and Edit symbol**.

#### Categorized Renderer

The Categorized Renderer is used to render all features from a layer, using an user-defined symbol whose aspect reflects the value of a selected feature's attribute. The Categorized menu allows you to select:

- The attribute (using the Column listbox or the E... Set column expression function, see Expressions chapter)
- The symbol (using the *The symbol Selector* dialog) which will be used as default for each class
- The range of colors (using the Color ramp listbox) from which color applied to the symbol is selected

Then click on Classify button to create classes from the distinct value of the attribute column. Each class can be disabled unchecking the checkbox at the left of the class name.

To change symbol, value and/or label of the class, just double click on the item you want to change.

Right-click shows a contextual menu to Copy/Paste, Change color, Change transparency, Change output unit, Change symbol width.

The example in figure\_symbology\_2 shows the category rendering dialog used for the rivers layer of the QGIS sample dataset.

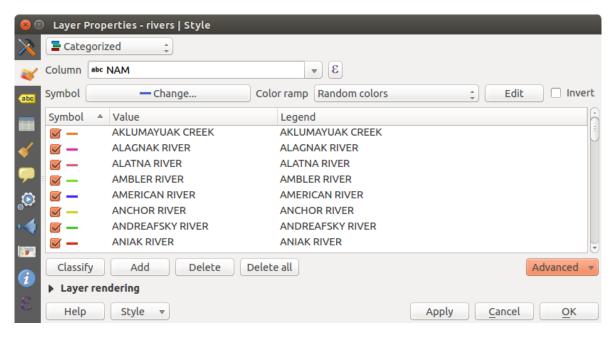


Рис. 12.16: Categorized Symbolizing options

## Порада: Select and change multiple symbols

The Symbology allows you to select multiple symbols and right click to change color, transparency, size, or width of selected entries.

### Порада: Match categories to symbol name

In the [Advanced] menu, under the classes, you can choose one of the two first actions to match symbol name to a category name in your classification. *Matched to saved symbols* match category name with a symbol name from your *Style Manager. Match to symbols from file* match category name to a symbol name from an external file.

#### **Graduated Renderer**

The Graduated Renderer is used to render all the features from a layer, using an user-defined symbol whose color or size reflects the assignment of a selected feature's attribute to a class.

Like the Categorized Renderer, the Graduated Renderer allows you to define rotation and size scale from specified columns.

Also, analogous to the Categorized Renderer, it allows you to select:

- The attribute (using the Column listbox or the E. Set column expression function)
- The symbol (using the Symbol selector dialog)
- The legend format and the precision
- The method to use to change the symbol: color or size
- The colors (using the color Ramp list) if the color method is selected
- The size (using the size domain and its unit

Then you can use the Histogram tab which shows an interactive histogram of the values from the assigned field or expression. Class breaks can be moved or added using the histogram widget.

**Примітка:** You can use Statistical Summary panel to get more information on your vector layer. See *Statistical Summary Panel*.

Back to the Classes tab, you can specify the number of classes and also the mode for classifying features within the classes (using the Mode list). The available modes are:

- Equal Interval: each class has the same size (e.g. values from 0 to 16 and 4 classes, each class has a size of 4);
- Quantile: each class will have the same number of element inside (the idea of a boxplot);
- Natural Breaks (Jenks): the variance within each class is minimal while the variance between classes is maximal;
- Standard Deviation: classes are built depending on the standard deviation of the values;
- Pretty Breaks: Computes a sequence of about n+1 equally spaced nice values which cover the range of the values in x. The values are chosen so that they are 1, 2 or 5 times a power of 10. (based on pretty from the R statistical environment http://astrostatistics.psu.edu/datasets/R/html/base/html/pretty.html)

The listbox in the center part of the *Style* menu lists the classes together with their ranges, labels and symbols that will be rendered.

Click on **Classify** button to create classes using the chosen mode. Each classes can be disabled unchecking the checkbox at the left of the class name.

To change symbol, value and/or label of the class, just double click on the item you want to change.

Right-click shows a contextual menu to Copy/Paste, Change color, Change transparency, Change output unit, Change symbol width.

The example in figure\_symbology\_3 shows the graduated rendering dialog for the rivers layer of the QGIS sample dataset.

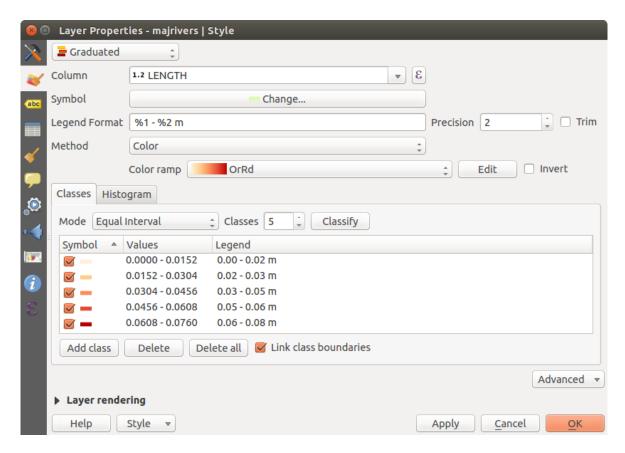


Рис. 12.17: Graduated Symbolizing options

## Порада: Thematic maps using an expression

Categorized and graduated thematic maps can be created using the result of an expression. In the properties dialog for vector layers, the attribute chooser is extended with a E--- Set column expression function. So you don't need to write the classification attribute to a new column in your attribute table if you want the classification attribute to be a composite of multiple fields, or a formula of some sort.

# Proportional Symbol and Multivariate Analysis

Proportional Symbol and Multivariate Analysis are not rendering types available from the Style rendering drop-down list. However with the **Size Assistant** options applied over any of the previous rendering options, QGIS allows you to display your point and line data with such representation. **Creating proportional symbol** 

Proportional rendering is done by first applying to the layer the Single Symbol Renderer. Once you set the symbol, at the upper level of the symbol tree, the Data-defined override button available beside Size or Width options (for point or line layers respectively) provides tool to create proportional symbology for the layer. An assistant is moreover accessible through the menu to help you define size expression.

The assistant lets you define:

- The attribute to represent, using the Field listbox or the \( \mathcal{E}\_{--} \) Set column expression function (see \( Expressions \))
- the scale method of representation which can be 'Flannery', 'Surface' or 'Radius'
- The minimum and maximum size of the symbol

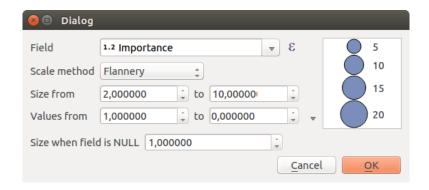


Рис. 12.18: Varying size assistant

- The range of values to represent: The down pointing arrow helps you fill automatically these fields with the minimum (or zero) and maximum values returned by the chosen attribute or the expression applied to your data.
- An unique size to represent NULL values.

To the right side of the dialog, you can preview the features representation within a live-update widget. This representation is added to the layer tree in the layer legend and is also used to shape the layer representation in the print composer legend item.

The values presented in the varying size assistant above will set the size 'Data-defined override' with:

coalesce(scale\_exp(Importance, 1, 20, 2, 10, 0.57), 1)

### Creating multivariate analysis

A multivariate analysis rendering helps you evaluate the relationship between two or more variables e.g., one can be represented by a color ramp while the other is represented by a size.

The simplest way to create multivariate analysis in QGIS is to first apply a categorized or graduated rendering on a layer, using the same type of symbol for all the classes. Then, clicking on the symbol [Change] button above the classification frame, you get the *The symbol Selector* dialog from which, as seen above, you can activate and set the *size assistant* option either on size (for point layer) or width (for line layer).

Like the proportional symbol, the size-related symbol is added to the layer tree, at the top of the categorized or graduated classes symbols. And both representation are also available in the print composer legend item.

## Rule-based rendering

The Rule-based Renderer is used to render all the features from a layer, using rule-based symbols whose aspect reflects the assignment of a selected feature's attribute to a class. The rules are based on SQL statements. The dialog allows rule grouping by filter or scale, and you can decide if you want to enable symbol levels or use only the first-matched rule.

To create a rule, activate an existing row by double-clicking on it, or click on '+' and click on the new rule. In the *Rule properties* dialog, you can define a label for the rule. Press the button to open the expression string builder. In the **Function List**, click on *Fields and Values* to view all attributes of the attribute table to be searched. To add an attribute to the field calculator **Expression** field, double click on its name in the *Fields and Values* list. Generally, you can use the various fields, values and functions to construct the calculation expression, or you can just type it into the box (see *Expressions*). You can create a new rule by copying and pasting an existing rule with the right mouse button. You can also use the 'ELSE' rule that will be run if none of the other rules on that level matches. Since QGIS 2.8 the rules appear in a tree hierarchy in the map legend. Just double-click the rules in the map legend and the

Style menu of the layer properties appears showing the rule that is the background for the symbol in the tree.

The example in figure\_symbology\_5 shows the rule-based rendering dialog for the rivers layer of the QGIS sample dataset.

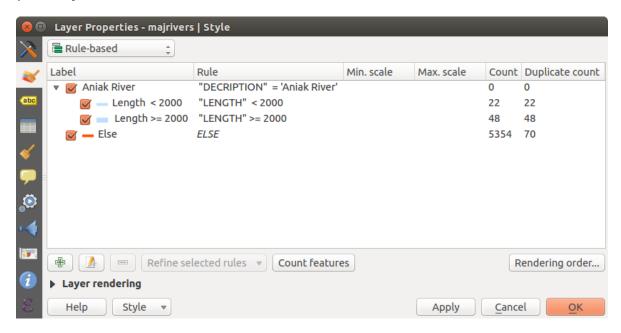


Рис. 12.19: Rule-based Symbolizing options

### Point displacement

The Point Displacement renderer works to visualize all features of a point layer, even if they have the same location. To do this, the symbols of the points are placed on a displacement circle around one center symbol or on several concentric circles.

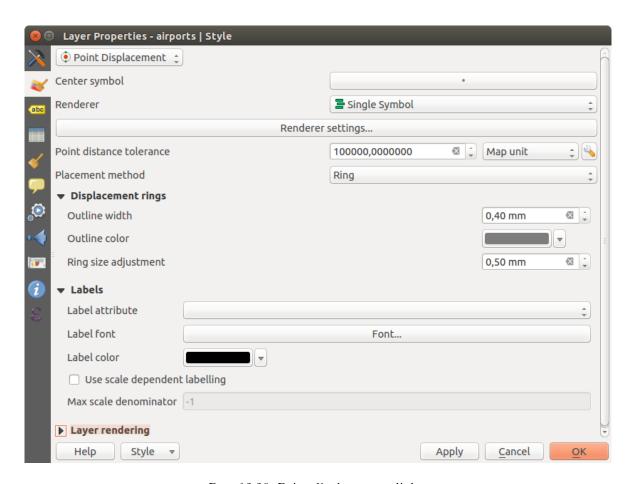
Примітка: You can still render features with other renderer like Single symbol, Graduated, Categorized or Rule-Based renderer using the *Renderer* drop-down list then the *Renderer Settings...* button.

# Inverted Polygon

The Inverted Polygon renderer allows user to define a symbol to fill in outside of the layer's polygons. As above you can select subrenderers, namely Single symbol, Graduated, Categorized, Rule-Based or 2.5 D renderer.

## Heatmap

With the Heatmap renderer you can create live dynamic heatmaps for (multi)point layers. You can specify the heatmap radius in pixels, mm or map units, choose and edit a color ramp for the heatmap style and use a slider for selecting a trade-off between render speed and quality. You can also define a maximum value limit and give a weight to points using a field or an expression. When adding or removing a feature the heatmap renderer updates the heatmap style automatically.



 ${\bf Puc.}$ 12.20: Point displacement dialog

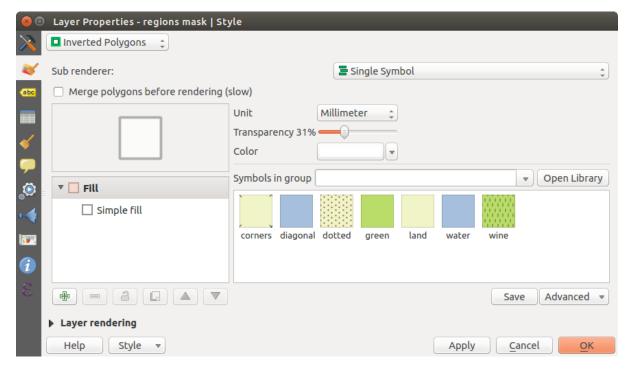


Рис. 12.21: Inverted Polygon dialog

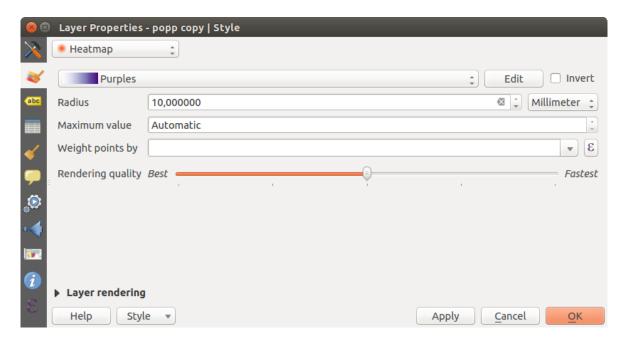


Рис. 12.22: Heatmap dialog

### 2.5 D

Using the 2.5 D renderer it's possible to create a 2.5 D effect on your layer's features. You start by choosing a *Height* value (in map units). For that you can use a fixed value, one of your layer's fields, or an expression. You also need to choose an *Angle* (in degrees) to recreate the viewer position (0° means west, growing in counter clock wise). Use advanced configuration options to set the *Roof Color* and *Wall Color*. If you would like to simulate solar radiation on the features walls, make sure to check the Shade walls based on aspect option. You can also simulate a shadow by setting a Color and Size (in map units).

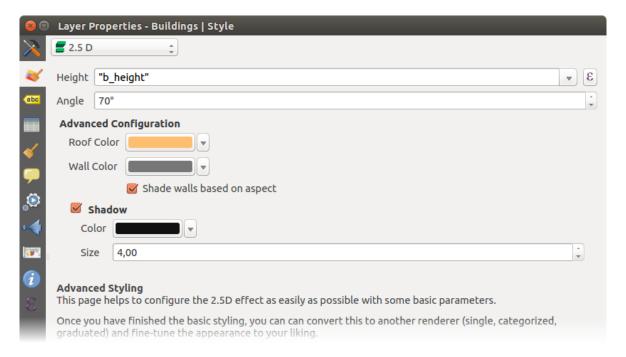


Рис. 12.23: 2.5 D dialog

# Порада: Using 2.5 D effect with other renderers

Once you have finished setting the basic style on the 2.5 D renderer, you can convert this to another renderer (single, categorized, graduated). The 2.5 D effects will be kept and all other renderer specific options will be available for you to fine tune them (this way you can have for example categorized symbols with a nice 2.5 D representation or add some extra styling to your 2.5 D symbols). To make sure that the shadow and the "building" itself do not interfere with other nearby features, you may need to enable Symbols Levels ( $Advanced \rightarrow Symbol\ levels...$ ). The 2.5 D height and angle values are saved in the layer's variables, so you can edit it afterwards in the variables tab of the layer's properties dialog.

## Layer rendering

From the Style tab, you can also set some options that invariabily act on all features of the layer:

- Layer transparency: You can make the underlying layer in the map canvas visible with this tool. Use the slider to adapt the visibility of your vector layer to your needs. You can also make a precise definition of the percentage of visibility in the the menu beside the slider.
- Layer blending mode and Feature blending mode: You can achieve special rendering effects with these tools that you may previously only know from graphics programs. The pixels of your overlaying and underlaying layers are mixed through the settings described in Blending Modes.
- Apply paint effects on all the layer features with the Draw Effects button.
- Control feature rendering order allows you, using features attributes, to define the z-order in which they shall be rendered. Activate the checkbox and click on the button beside. You then get the Define Order dialog in which you:
  - choose a field or build an expression to apply to the layer features
  - set in which order the fetched features should be sorted, i.e. if you choose **Ascending** order, the features with lower value are rendered under those with upper value.
  - define when features returning NULL value should be rendered: **first** or **last**.

You can add several rules of ordering. The first rule is applied to all the features in the layer, z-ordering them according to the value returned. Then, for each group of features with the same value (including those with NULL value) and thus same z-level, the next rule is applied to sort its items among them. And so on...

Once the *Define Order* dialog is applied, a summary of the expression(s) used to control the layer rendering is retranscribed in the textbox beside  $\square$  Control feature rendering order option.



Рис. 12.24: Layer rendering options

### Other Settings

### Symbols levels

For renderers that allow stacked symbol layers (only heatmap doesn't) there is an option to control the rendering order of each symbol's levels.

For most of the renderers, you can access the Symbols levels option by clicking the [Advanced] button below the saved symbols list and choosing Symbol levels. For the Rule-based rendering the option is directly available through [Symbols levels] button, while for Point displacement renderer the same button is inside the Rendering settings dialog.

To activate symbols levels, select the Enable symbol levels. Each row will show up a small sample of the combined symbol, its label and the individual symbols layer divided into columns with a number next to it. The numbers represent the rendering order level in which the symbol layer will be drawn. Lower values levels are drawn first, staying at the bottom, while higher values are drawn last, on top of the others.

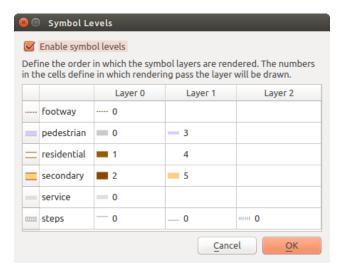


Рис. 12.25: Symbol levels dialog

Примітка: If symbols levels are deactivated, the complete symbols will be drawn according to their respective features order. Overlapping symbols will simply obfuscate to other below. Besides, similar symbols won't "merge" with each other.

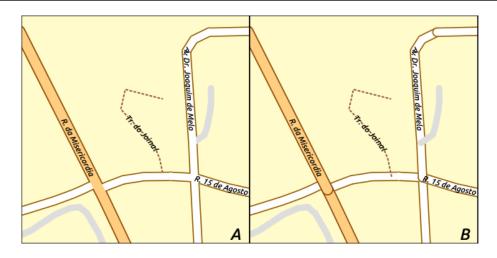


Рис. 12.26: Symbol levels activated (A) and deactivated (B) difference

#### Draw effects

In order to improve layer rendering and avoid (or at least reduce) the resort to other software for final rendering of maps, QGIS provides another powerful functionality: the Draw Effects options, which adds paint effects for customizing the visualization of vector layers.

The option is available in the Layer Properties -> Style dialog, under the Layer rendering group (applying to the whole layer) or in symbol layer properties (applying to corresponding features). You can combine both usage.

Paint effects can be activated by checking the *Draw effects* option and clicking the Customize effects button, that will open the *Effect Properties* Dialog (see figure\_effects\_1). The following effect types, with custom options are available:

• Source: Draws the feature's original style according to the configuration of the layer's properties. The transparency of its style can be adjusted.

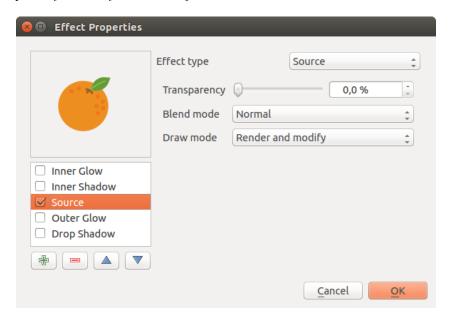


Рис. 12.27: Draw Effects: Source dialog

- Blur: Adds a blur effect on the vector layer. The options that someone can change are the Blur type (Stack or Gaussian blur), the strength and transparency of the blur effect.
- Colorize: This effect can be used to make a version of the style using one single hue. The base will always be a grayscale version of the symbol and you can use the Grayscale to select how to create it (options are: 'lightness', 'luminosity' and 'average'). If Colorise is selected, it will be possible to mix another color and choose how strong it should be. You can also control the Brightness, contrast and saturation levels of the resulting symbol.
- **Drop Shadow:** Using this effect adds a shadow on the feature, which looks like adding an extra dimension. This effect can be customized by changing the *offset* degrees and radius, determining where the shadow shifts towards to and the proximity to the source object. *Drop Shadow* also has the option to change the blur radius, the transparency and the color of the effect.
- Inner Shadow: This effect is similar to the *Drop Shadow* effect, but it adds the shadow effect on the inside of the edges of the feature. The available options for customization are the same as the *Drop Shadow* effect.
- Inner Glow: Adds a glow effect inside the feature. This effect can be customized by adjusting the *spread* (width) of the glow, or the *Blur radius*. The latter specifies the proximity from the edge of

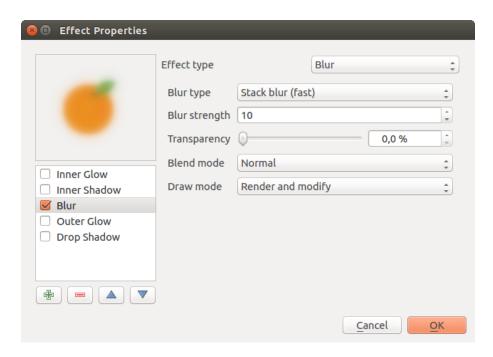


Рис. 12.28: Draw Effects: Blur dialog

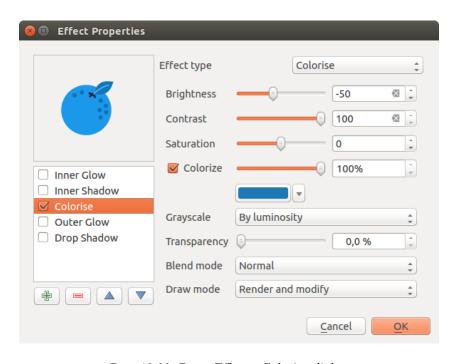


Рис. 12.29: Draw Effects: Colorize dialog

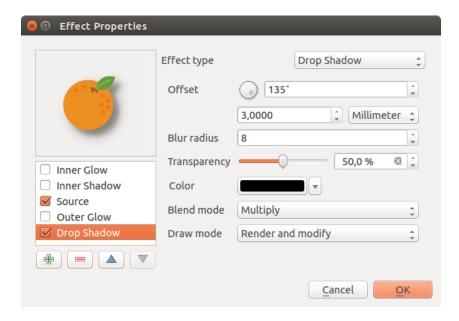


Рис. 12.30: Draw Effects: Drop Shadow dialog

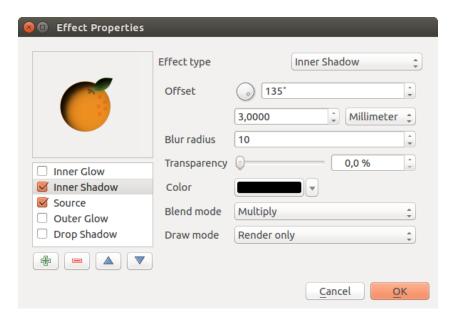


Рис. 12.31: Draw Effects: Inner Shadow dialog

the feature where you want any blurring to happen. Additionally, there are options to customize the color of the glow, with a single color or a color ramp.

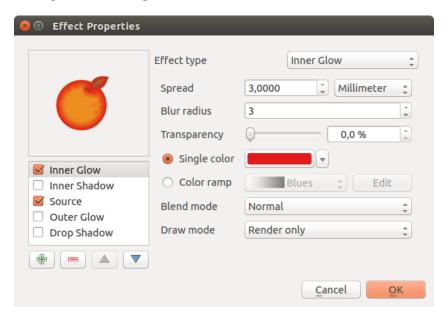


Рис. 12.32: Draw Effects: Inner Glow dialog

• Outer Glow: This effect is similar to the *Inner Glow* effect, but it adds the glow effect on the outside of the edges of the feature. The available options for customization are the same as the *Inner Glow* effect.

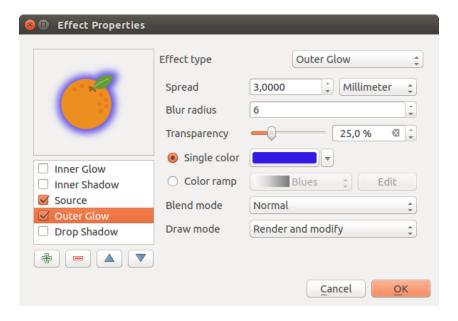


Рис. 12.33: Draw Effects: Outer Glow dialog

- Transform: Adds the possibility of transforming the shape of the symbol. The first options available for customization are the *Reflect horizontal* and *Reflect vertical*, which actually create a reflection on the horizontal and/or vertical axes. The 4 other options are:
  - Shear: slants the feature along the x and/or y axis
  - Scale: enlarges or minimizes the feature along the x and/or y axis by the given percentage
  - Rotation: turns the feature around its center point

**Effect Properties** Effect type Transform Reflect horizontal Reflect vertical ☑ 🗘 0,00 Shear X.Y 1.00 100,0% 100,0% Scale X.Y Rotation 0,00° ☐ Inner Glow Millimeter Translate X,Y 0,000 ÷ 0,000 Inner Shadow Draw mode Render and modify **\*** Outer Glow □ Drop Shadow Cancel

 and Translate changes the position of the item based on a distance given on the x and/or the y axis.

Рис. 12.34: Draw Effects: Transform dialog

There are some common options available for all draw effect types. *Transparency* and *Blend mode* options work similar to the ones described in *Layer rendering* and can be used in all draw effects except for the transform one.

One or more draw effects can used at the same time. You activate/deactivate an effect using its checkbox in the effects list. You can change the selected effect type by using the Effect type option. You can reorder the effects using Move up and Move down buttons, and also add/remove effects using the Add effect and Remove effect buttons.

There is also a Draw mode option available for every draw effect, and you can choose whether to render and/or to modify the symbol. Effects render from top to bottom.'Render only' mode means that the effect will be visible while the 'Modify only' mode means that the effect will not be visible but the changes that it applies will be passed to the next effect (the one immediately below). The 'Render and Modify' mode will make the effect visible and pass any changes to the next effect. If the effect is in the top of the effects list or if the immediately above effect is not in modify mode, then it will use the original source symbol from the layers properties (similar to source).

## 12.3.3 Labels Menu

The Labels core application provides smart labeling for vector point, line and polygon layers, and only requires a few parameters. This application also supports on-the-fly transformed layers. The following menus are used to configure the labeling of vector layers:

- Text
- Formatting
- Buffer
- Background
- Shadow
- Placement

### • Rendering

To label a layer start QGIS and load a vector layer. Activate the layer in the legend and click on the Layer Labeling Options icon in the QGIS toolbar menu or activate the Labels tab in the layer properties dialog.

The first step is to choose the labeling method from the drop-down list. There are four options available:

- No labels
- Show labels for this layer
- Rule-based labeling
- and Discourage other labels from covering features in this layer: allows to set a layer as just an obstacle for other layer's labels without rendering any labels of its own.

Select the Show labels for this layer option and then select an attribute column to use for labeling from the Label with drop-down list. Click  $\varepsilon_{--}$  if you want to define labels based on expressions - See Define labels based on expressions.

The following steps describe simple labeling without using the *Data defined override* functions, which are situated next to the drop-down menus - see *Using data-defined override for labeling* for an use-case.

#### Text menu

You can define the text style in the *Text* menu (see Figure\_labels\_1). Use the *Type case* option to influence the text rendering. You have the possibility to render the text 'All uppercase', 'All lowercase' or 'Capitalize first letter'. Use the *Blending Modes* to create effects known from graphics programs.

### Formatting menu

In the Formatting menu, you can define a character for a line break in the labels with the 'Wrap on character' function. You can format the Line Height and the alignment. For the latter typical values are available plus Follow label placement. When set to this mode, text alignment for labels will be dependent on the final placement of the label relative to the point. E.g., if the label is placed to the left of the point then the label will be right aligned, and if it is placed to the right of the point then the label will be left aligned.

For line vector layers you can include line directions symbols. There are options specifying the type of symbol and the symbol placement.

Use the Formatted numbers option to format the numbers in an attribute table. Here, decimal places may be inserted. If you enable this option, three decimal places are initially set by default.

# Buffer menu

To create a buffer, just activate the Draw text buffer checkbox in the Buffer menu. The buffer color is variable. Here, you can also use blend modes. If the color buffer's fill checkbox is activated, it will interact with partially transparent text and give mixed color transparency results. Turning off the buffer fill fixes that issue (except where the interior aspect of the buffer's stroke intersects with the text's fill) and also allows you to make outlined text.

# Background menu

In the *Background* menu, you can define with *Size X* and *Size Y* the shape of your background. Use *Size type* to insert an additional 'Buffer' into your background. The buffer size is set by default here. The background then consists of the buffer plus the background in *Size X* and *Size Y*. You can set a *Rotation* where you can choose between 'Sync with label', 'Offset of label' and 'Fixed'. Using 'Offset of

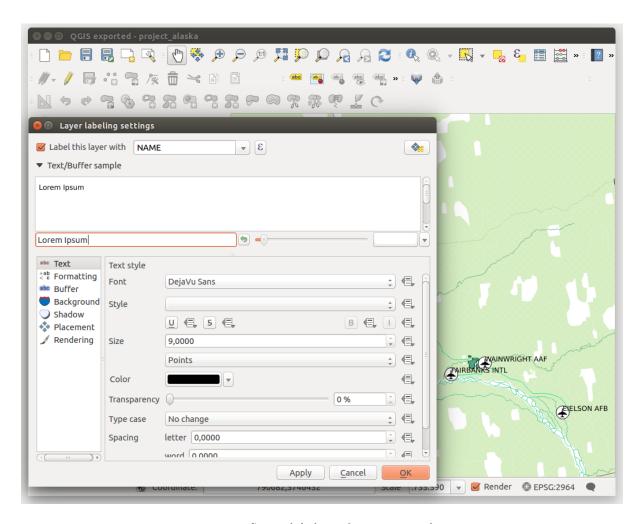


Рис. 12.35: Smart labeling of vector point layers

label' and 'Fixed', you can rotate the background. Define an  $Offset\ X,Y$  with X and Y values, and the background will be shifted. When applying  $Radius\ X,Y$ , the background gets rounded corners. Again, it is possible to mix the background with the underlying layers in the map canvas using the  $Blend\ mode$  (see  $Blending\ Modes$ ).

#### Shadow menu

Use the Shadow menu for a user-defined Drop shadow. The drawing of the background is very variable. Choose between 'Lowest label component', 'Text', 'Buffer' and 'Background'. The Offset angle depends on the orientation of the label. If you choose the Word global shadow checkbox, then the zero point of the angle is always oriented to the north and doesn't depend on the orientation of the label. You can influence the appearance of the shadow with the Blur radius. The higher the number, the softer the shadows. The appearance of the drop shadow can also be altered by choosing a blend mode.

#### Placement menu

Choose the *Placement* menu for configuring label placement and labeling priority. Note that the placement options differ according to the type of vector layer, namely point, line or polygon.

### Placement for point layers

With the Cartographic placement mode, point labels are generated with best visual relationship with the point feature, following ideal cartographic placement rules. Labels can be placed at a set Distance either from the point feature itself or from the bounds of the symbol used to represent the feature. The latter option is especially useful when the symbol size isn't fixed, e.g. if it's set by a data defined size or when using different symbols in a categorized renderer.

By default, placements are prioritised in the following order:

- 1. top right
- 2. top left
- 3. bottom right
- 4. bottom left
- 5. middle right
- 6. middle left
- 7. top, slightly right
- 8. bottom, slightly left.

Placement priority can however be customized or set for an individual feature using a data defined list of prioritised positions. This also allows only certain placements to be used, so e.g. for coastal features you can prevent labels being placed over the land.

The Around point setting places the label in an equal radius (set in Distance) circle around the feature. The placement of the label can even be constrained using the Quadrant option.

In the Offset from point placement, labels are placed at a fixed offset from the point feature. You can select the Quadrant in which to place your label. You are also able to set the X and Y offset distances between the points and their labels and can alter the angle of the label placement with the Rotation setting. Thus, placement in a selected quadrant with a defined rotation is possible.

### Placement for line layers

Label options for line layers include Parallel, Curved or Horizontal. For the Parallel and Curved options, you can set the position to Above line, Months On line and Below line. It's possible to select several options at once. In that case, QGIS will look for the optimal label position. For Parallel and curved placement you can also use the line orientation for the position of the label. Additionally, you can define a Maximum angle between curved characters when selecting the Curved option (see Figure\_labels\_2).

For all three placement options you can set up a minimum distance for repeating labels. The distance can be in mm or in map units.

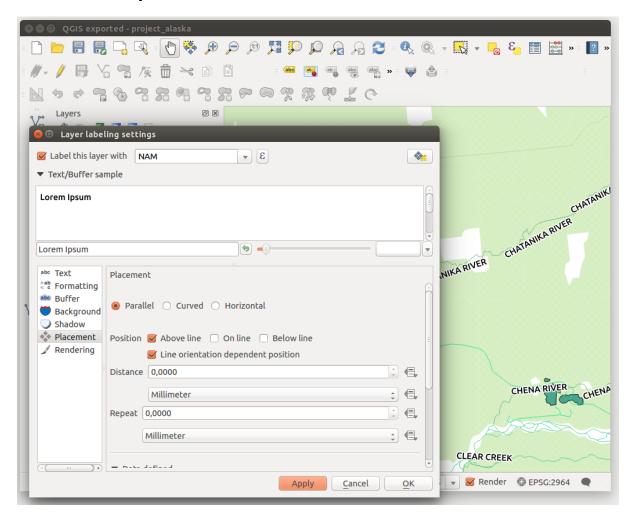


Рис. 12.36: Smart labeling of vector line layers

# Placement for polygon layers

You can choose one of the following options for placing labels in polygons: Offset from centroid, Horizontal (slow), Around centroid, Free and Using perimeter.

In the Offset from centroid settings you can specify if the centroid is of the visible polygon or whole polygon. That means that either the centroid is used for the polygon you can see on the map or the centroid is determined for the whole polygon, no matter if you can see the whole feature on the map. You can place your label within a specific quadrant, and define offset and rotation. The Around

centroid setting places the label at a specified distance around the centroid. Again, you can define visible polygon or whole polygon for the centroid.

With the Using perimeter settings, you can define a position and a distance for the label. For the position, Above line, On line, Below line and Line orientation dependent position are possible. You can specify the distance between the label and the polygon outline, as well as the repeat interval for the label.

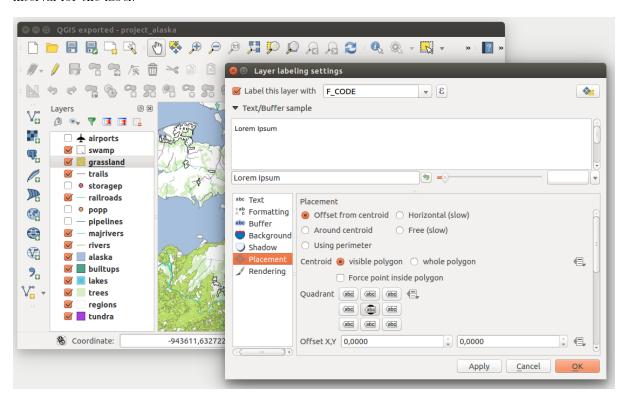


Рис. 12.37: Smart labeling of vector polygon layers

In the *priority* section you can define the priority with which labels are rendered for all three vector layer types (point, line, polygon). This placement option interact with labels of the other vector layers in the map canvas. If there are labels from different layers in the same location, the label with the higher priority will be displayed and the others will be left out.

# Rendering menu

In the *Rendering* menu, you can tune when the labels can be rendered and their interaction with other labels and features.

Under Label options, you find the scale-based and the Pixel size-based visibility settings.

The Label z-index determines the order in which labels are rendered, as well in relation with other feature labels in the layer (using data-defined override expression), as with labels from other layers. Labels with a higher z-index are rendered on top of labels (from any layer) with lower z-index.

Additionally, the logic has been tweaked so that if 2 labels have matching z-indexes, then:

- if they are from the same layer, the smaller label will be drawn above the larger label
- if they are from different layers, the labels will be drawn in the same order as their layers themselves (ie respecting the order set in the map legend).

Note that this setting doesn't make labels to be drawn below the features from other layers, it just controls the order in which labels are drawn on top of all the layer's features.

While rendering labels and in order to display readable labels, QGIS automatically evaluates the position of the labels and can hide some of them in case of collision. You can however choose to Show all labels for this layer (including colliding labels) in order to manually fix their placement.

With data-defined expressions in *Show label* and *Always Show* you can fine tune which labels should be rendered.

Under Feature options, you can choose to label every part of a multi-part feature and limit the number of features to be labeled. Both line and polygon layers offer the option to set a minimum size for the features to be labeled, using Suppress labeling of features smaller than. For polygon features, you can also filter the labels to show according to whether they completely fit within the feature or not. For line features, you can choose to Merge connected lines to avoid duplicate labels, rendering a quite airy map in conjunction with the Distance or Repeat options in Placement tab.

From the *Obstacles* frame, you can manage the covering relation between labels and features. Activate the *Discourage labels from covering features* option to decide whether features of the layer should act as obstacles for any label (including labels from other features in the same layer). An obstacle is a feature QGIS tries as far as possible to not place labels over. Instead of the whole layer, you can define a subset of features to use as obstacles, using the data-defined override control next to the option.

The priority control slider for obstacles allows you to make labels prefer to overlap features from certain layers rather than others. A **Low weight** obstacle priority means that features of the layer are less considered as obstacles and thus more likely to be covered by labels. This priority can also be data-defined, so that within the same layer, certain features are more likely to be covered than others.

For polygon layers, you can choose the type of obstacle features could be by minimising the labels placement:

- over the feature's interior: avoids placing labels over interior of polygon (prefers placing labels totally outside or just slightly inside polygon)
- or **over the feature's boundary**: avoids placing labels over boundary of polygon (prefers placing labels outside or completely inside the polygon). It can be e.g. useful for regional boundary layers, where the features cover an entire area. In this case it's impossible to avoid placing labels within these features, and it looks much better to avoid placing them over the boundaries between features.

### Define labels based on expressions

QGIS allows to use expressions to label features. Just click the E... icon in the Labels menu of the properties dialog. In figure\_labels\_4 you see a sample expression to label the alaska regions with name and area size, based on the field 'NAME\_2', some descriptive text and the function \$area in combination with format\_number() to make it look nicer.

Expression based labeling is easy to work with. All you have to take care of is that:

- you need to combine all elements (strings, fields and functions) with a string concatenation function such as concat, + or ||. Be aware that in some situations (null or numeric value involved) not all of these tools will fit your need
- strings are written in 'single quotes'
- fields are written in "double quotes" or without any quote.

Let's have a look at some examples:

```
# label based on two fields 'name' and 'place' with a comma as separator
"name" || ', ' || "place"

-> John Smith, Paris
# label based on two fields 'name' and 'place' with other texts
```

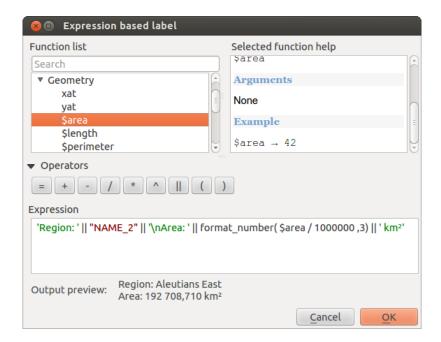


Рис. 12.38: Using expressions for labeling

```
'My name is ' + "name" + 'and I live in ' + "place"
 'My name is ' \mid \mid "name" \mid \mid 'and I live in ' \mid \mid "place"
 concat('My name is ', name, ' and I live in ', "place")
 -> My name is John Smith and I live in Paris
 # label based on two fields 'name' and 'place' with other texts
 # combining different concatenation functions
 concat('My name is ', name, ' and I live in ' | | place)
 -> My name is John Smith and I live in Paris
                               # if the field 'place' is NULL
 -> My name is John Smith
 # multi-line label based on two fields 'name' and 'place' with a descriptive text
 concat('My name is ', "name", '\n' , 'I live in ' , "place")
 -> My name is John Smith
    I live in Paris
 # label based on a field and the $area function
 # to show the place name and its rounded area size in a converted unit.
 'The area of ' \mid \mid "place" \mid \mid ' has a size of ' \mid \mid round(\frac{area}{10000}) \mid \mid ' ha'
 -> The area of Paris has a size of 10500 ha
 # create a CASE ELSE condition. If the population value in field
 # population is <= 50000 it is a town, otherwise a city.
 concat('This place is a ', CASE WHEN "population <= 50000" THEN 'town' ELSE 'city' END)</pre>
-> This place is a town
```

As you can see in the expression builder, you have hundreds of functions available to create simple and very complex expressions to label your data in QGIS. See *Expressions* chapter for more information and examples on expressions.

### Using data-defined override for labeling

With the data-defined override functions, the settings for the labeling are overridden by entries in the attribute table. You can activate and deactivate the function with the right-mouse button. Hover over the symbol and you see the information about the data-defined override, including the current definition

field. We now describe an example using the data-defined override function for the  $^{\bullet\bullet}$  Move label function (see figure labels 5).

- 1. Import lakes.shp from the QGIS sample dataset.
- 2. Double-click the layer to open the Layer Properties. Click on Labels and Placement. Select Offset from centroid.
- 3. Look for the *Data defined* entries. Click the licon to define the field type for the *Coordinate*. Choose 'xlabel' for X and 'ylabel' for Y. The icons are now highlighted in yellow.
- 4. Zoom into a lake.
- 5. Set editable the layer using the Toggle Editing button.
- 6. Go to the Label toolbar and click the icon. Now you can shift the label manually to another position (see figure\_labels\_6). The new position of the label is saved in the 'xlabel' and 'ylabel' columns of the attribute table.

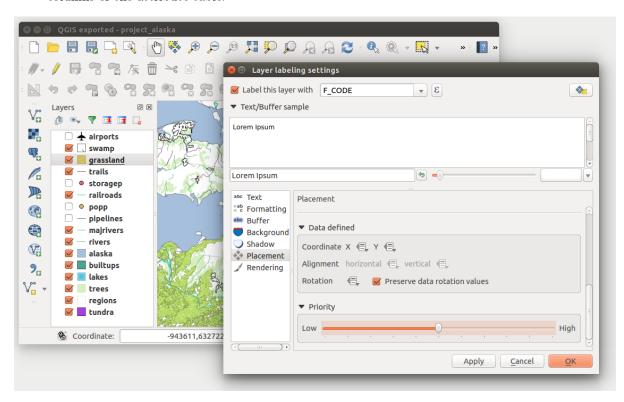


Рис. 12.39: Labeling of vector polygon layers with data-defined override

### Rule-based labeling

With Rule-based labeling multiple label configurations can be defined and applied selectively on the base of expression filters, as in *Rule-based rendering*.

Rules can be set selecting the corresponding option at the top of the Labels panel (see figure\_labels\_7).

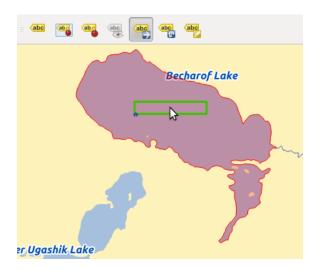
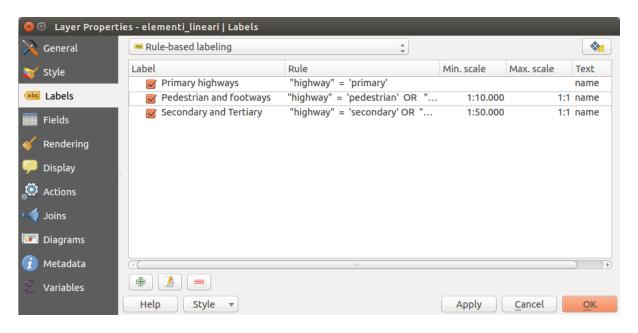
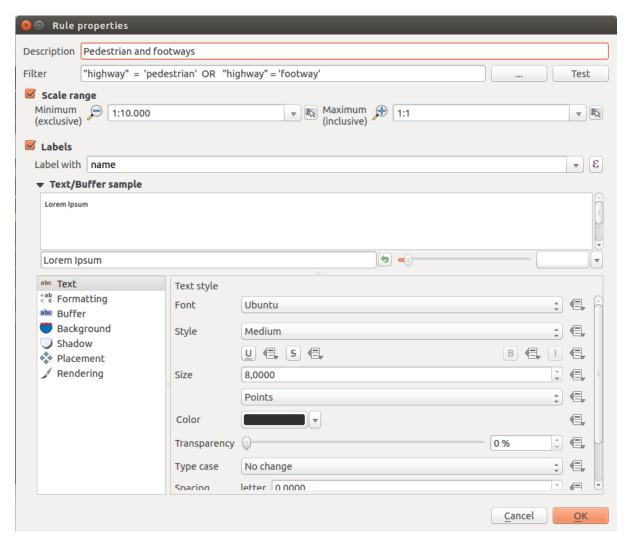


Рис. 12.40: Move labels



 $\mbox{Puc.}\ 12.41\mbox{:}\ \mbox{Rule based labeling panel}$ 

To create a rule, activate an existing row by double-clicking on it, or click on '+' and click on the new rule. Within the panel you can set the filter expression and the related label configurations.



Pис. 12.42: Rule settings

# 12.3.4 Fields Menu

Within the *Fields* menu, the field attributes of the selected dataset can be manipulated. The buttons

New Column and Louise Column can be used when the dataset is in Editing mode.

### Edit Widget

Within the *Fields* menu, you also find an **edit widget** column. This column can be used to define values or a range of values that are allowed to be added to the specific attribute table column. If you click on the **[edit widget]** button, a dialog opens, where you can define different widgets. These widgets are:

- Checkbox: Displays a checkbox, and you can define what attribute is added to the column when the checkbox is activated or not.
- Classification: Displays a combo box with the values used for classification, if you have chosen 'unique value' as legend type in the *Style* menu of the properties dialog.
- Color: Displays a color button allowing user to choose a color from the color dialog window.

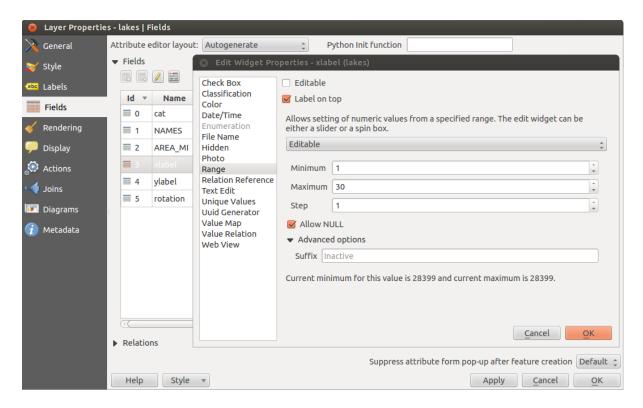


Рис. 12.43: Dialog to select an edit widget for an attribute column

- Date/Time: Displays a line field which can open a calendar widget to enter a date, a time or both. Column type must be text. You can select a custom format, pop-up a calendar, etc.
- Enumeration: Opens a combo box with values that can be used within the columns type. This is currently only supported by the PostgreSQL provider.
- File name: Simplifies the selection by adding a file chooser dialog.
- Hidden: A hidden attribute column is invisible. The user is not able to see its contents.
- Photo: Field contains a filename for a picture. The width and height of the field can be defined.
- Range: Allows you to set numeric values from a specific range. The edit widget can be either a slider or a spin box.
- **Relation Reference**: This widget lets you embed the feature form of the referenced layer on the feature form of the actual layer. See *Creating one to many relations*.
- Text edit (default): This opens a text edit field that allows simple text or multiple lines to be used. If you choose multiple lines you can also choose html content.
- Unique values: You can select one of the values already used in the attribute table. If 'Editable' is activated, a line edit is shown with autocompletion support, otherwise a combo box is used.
- UUID Generator: Generates a read-only UUID (Universally Unique Identifiers) field, if empty.
- Value map: A combo box with predefined items. The value is stored in the attribute, the description is shown in the combo box. You can define values manually or load them from a layer or a CSV file.
- Value Relation: Offers values from a related table in a combobox. You can select layer, key column and value column. Several options are available to change the standard behaviours: allow null value, order by value, allow multiple selections and use of autocompleter. The forms will display either a drop-down list or a line edit field when completer checkbox is enabled.
- Webview: Field contains a URL. The width and height of the field is variable.

Примітка: QGIS has an advanced 'hidden' option to define your own field widget using python and add it to this impressive list of widgets. It is tricky but it is very well explained in following excellent blog that explains how to create a real time validation widget that can be used like described widgets. See http://blog.vitu.ch/10142013-1847/write-your-own-qgis-form-elements

# Порада: Relative Path in widgets

If the path which is selected with the file browser is located in the same directory as the .qgs project file or below, paths are converted to relative paths. This increases portability of a qgs project with multimedia information attached. This is enabled only for File Name, Photo and Web View at this moment.

With the **Attribute editor layout**, you can now define built-in forms (see figure\_fields\_2). This is useful for data entry jobs or to identify objects using the option auto open form when you have objects with many attributes. You can create an editor with several tabs and named groups to present the attribute fields.

Choose 'Drag and drop designer' and an attribute column. Use the icon to create a category to insert a tab or a named group (see figure\_fields\_3). When creating a new category, QGIS will insert a new tab or named group for the category in the built-in form. The next step will be to assign the relevant fields to a selected category with the icon. You can create more categories and use the same fields again. Other options in the dialog are 'Autogenerate' and 'Provide ui-file'.

- 'Autogenerate' just creates editors for all fields and tabulates them.
- The 'Provide ui-file' option allows you to use complex dialogs made with the Qt-Designer. Using a UI-file allows a great deal of freedom in creating a dialog. For detailed information, see <a href="http://nathanw.net/2011/09/05/qgis-tips-custom-feature-forms-with-python-logic/">http://nathanw.net/2011/09/05/qgis-tips-custom-feature-forms-with-python-logic/</a>.

QGIS dialogs can have a Python function that is called when the dialog is opened. Use this function to add extra logic to your dialogs. The form code can be specified in three different ways:

- load from the environment (for example in startup.py or from a plugin)
- load from an external file, a file chooser will appear in that case to allow you to select a Python file from your filesystem
- load from inline code, a Python editor will appear where you can directly type your form code

In all cases you must enter the name of the function that will be called (open in the example below).

An example is (in module MyForms.py):

```
def open(dialog,layer,feature):
    geom = feature.geometry()
    control = dialog.findChild(QWidged,"My line edit")
```

Reference in Python Init Function like so: open

## 12.3.5 Joins Menu

The Joins menu allows you to join a loaded attribute table to a loaded vector layer. After clicking the Add vector join dialog appears. As key columns, you have to define a join layer you want to connect with the target vector layer. Then, you have to specify the join field that is common to both the join layer and the target layer. Now you can also specify a subset of fields from the joined layer based on the checkbox Choose which fields are joined. As a result of the join, all information from the join layer and the target layer are displayed in the attribute table of the target layer as joined information. If you specified a subset of fields only these fields are displayed in the attribute table of the target layer.

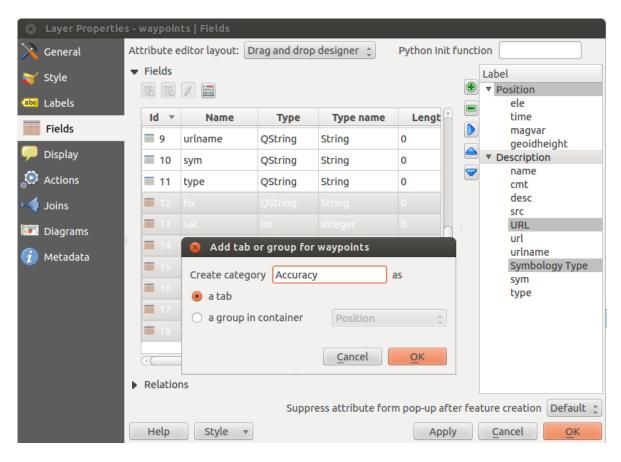


Рис. 12.44: Dialog to create categories with the Attribute editor layout

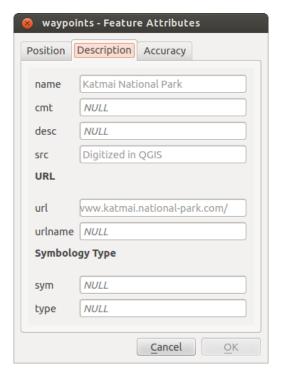


Рис. 12.45: Resulting built-in form with tabs and named groups

QGIS currently has support for joining non-spatial table formats supported by OGR (e.g., CSV, DBF and Excel), delimited text and the PostgreSQL provider (see figure joins 1).

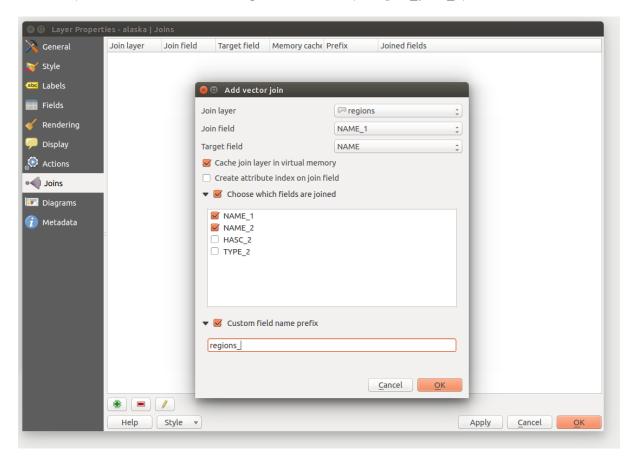


Рис. 12.46: Join an attribute table to an existing vector layer

Additionally, the add vector join dialog allows you to:

- South Cache join layer in virtual memory
- Market Create attribute index on the join field
- Market Choose which fields are joined
- Create a Custom field name prefix

# 12.3.6 Diagrams Menu

The Diagrams menu allows you to add a graphic overlay to a vector layer (see figure diagrams 1).

The current core implementation of diagrams provides support for:

- pie charts, a circular statistical graphic divided into slices to illustrate numerical proportion. The arc length of each slice is proportional to the quantity it represents,
- text diagrams, a horizontaly divided circle showing statistics values inside
- $\bullet$  and **histograms**.

For each type of diagram, the menu is divided into five tabs:

## **Attributes**

Attributes defines which variables to display in the diagram. Use add item button to select the desired fields into the 'Assigned Attributes' panel. Generated attributes with Expressions can also be used.

You can move up and down any row with click and drag, sorting how atributes are displayed. You can also change the label in the 'Legend' column or the attibute color by double-clicking the item.

This label is the default text displayed in the legend of the print composer or of the layer tree.

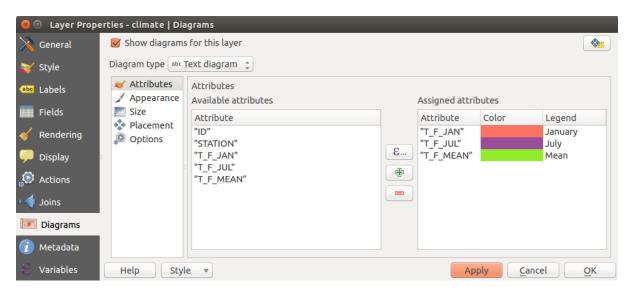


Рис. 12.47: Vector properties dialog with diagram menu

## **Appearance**

Appearance defines how the diagram looks like. It provides general settings that do not interfere with the statistic values such as:

- the graphic transparency, its outline width and color
- the width of the bar in case of histogram
- the circle background color in case of text diagram, and the font used for texts
- the orientation of the left line of the first slice represented in pie chart. Note that slices are displayed clockwise.

In this menu, you can also manage the diagram visibility:

- by removing diagrams that overlap others or Show all diagrams even if they overlap each other
- by setting the scale visibility

# Size

Size is the main tab to set how the selected statistics are represented. The diagram size units can be 'Map Units' or 'Millimeters'. You can use:

- Fixed size, an unique size to represent the graphic of all the features, except when displaying histogram
- or Scaled size, based on an expression using layer attributes.

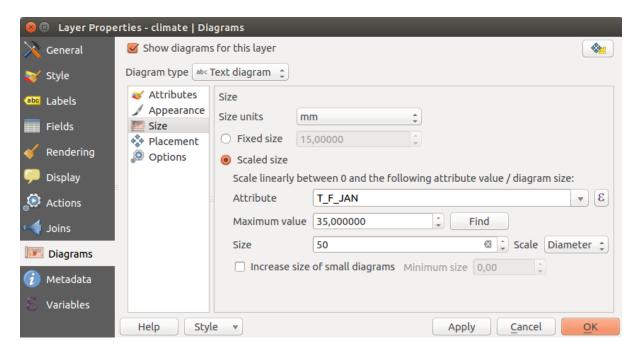


Рис. 12.48: Vector properties dialog with diagram menu, Size tab

#### **Placement**

*Placement* helps to define diagram position. According to the layer geometry type, it offers different options for the placement:

- 'Over the point' or 'Around the point' for point geometry. The latter variable requires a radius to follow
- 'Over the line' or 'Around the line' for line geometry. Like point feature, the last variable requires a distance to respect and user can specify the diagram placement relative to the feature ('above', 'on' and/or 'below' the line) It's possible to select several options at once. In that case, QGIS will look for the optimal position of the diagram. Remember that here you can also use the line orientation for the position of the diagram.
- 'Over the centroid', 'Around the centroid' (with a distance set), 'Perimeter' and anywhere 'Inside polygon' are the options for polygon features.

The diagram can also be placed using feature data by filling the X and Y fields with an attribute of the feature.

The placement of the diagrams can interact with the labeling, so you can detect and solve position conflicts between diagrams and labels by setting the **Priority** slider or the **z-index** value.

# **Options**

The *Options* tab has settings only in case of histogram. You can choose whether the bar orientation should be 'Up', 'Down', 'Right' and 'Left'.

# Порада: Switch quickly between diagrams

Given that almost all the settings above are common to the different types of diagram, when designing your diagram, you can easily change the diagram type and check which one is more appropriate to your data without any loss.

### Case Study

We will demonstrate an example and overlay on the Alaska boundary layer a text diagram showing temperature data from a climate vector layer. Both vector layers are part of the QGIS sample dataset (see section  $Sample\ Data$ ).

- 1. First, click on the Load Vector icon, browse to the QGIS sample dataset folder, and load the two vector shape layers alaska.shp and climate.shp.
- 2. Double click the climate layer in the map legend to open the Layer Properties dialog.
- 3. Click on the *Diagrams* menu, activate Show diagrams for this layer, and from the *Diagram type* combo box, select 'Text diagram'.
- 4. In the *Appearance* tab, we choose a light blue as background color, and in the *Size* tab, we set a fixed size to 18 mm.
- 5. In the Position tab, placement could be set to 'Around Point'.
- 6. In the diagram, we want to display the values of the three columns T\_F\_JAN, T\_F\_JUL and T\_F\_MEAN. So, in the *Attributes* tab first select T\_F\_JAN and click the button, then repeat with T\_F\_JUL and finally T\_F\_MEAN.
- 7. Now click [Apply] to display the diagram in the QGIS main window.
- 8. You can adapt the chart size in the Size tab. Activate the Size and set the size of the diagrams on the basis of the maximum value of an attribute and the Size option. If the diagrams appear too small on the screen, you can activate the Increase size of small diagrams checkbox and define the minimum size of the diagrams.
- 9. Change the attribute colors by double clicking on the color values in the Assigned attributes field. Figure diagrams 3 gives an idea of the result.
- 10. Finally, click [Ok].

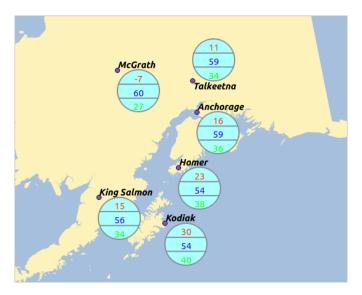


Рис. 12.49: Diagram from temperature data overlayed on a map

Remember that in the *Position* tab, a *Data defined position* of the diagrams is possible. Here, you can use attributes to define the position of the diagram. You can also set a scale-dependent visibility in the *Appearance* tab.

The size and the attributes can also be an expression. Use the  $\varepsilon_{--}$  button to add an expression. See *Expressions* chapter for more information and example.

## 12.3.7 Actions Menu

QGIS provides the ability to perform an action based on the attributes of a feature. This can be used to perform any number of actions, for example, running a program with arguments built from the attributes of a feature or passing parameters to a web reporting tool.

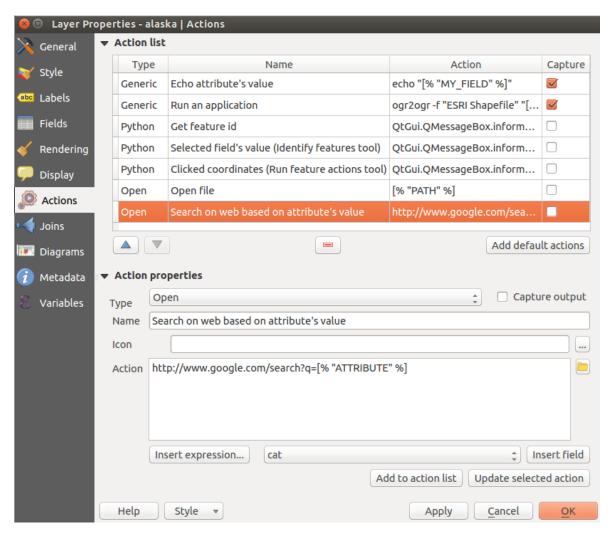


Рис. 12.50: Overview action dialog with some sample actions

Actions are useful when you frequently want to run an external application or view a web page based on one or more values in your vector layer. They are divided into six types and can be used like this:

- Generic, Mac, Windows and Unix actions start an external process.
- Python actions execute a Python expression.
- Generic and Python actions are visible everywhere.
- Mac, Windows and Unix actions are visible only on the respective platform (i.e., you can define three 'Edit' actions to open an editor and the users can only see and execute the one 'Edit' action for their platform to run the editor).

There are several examples included in the dialog. You can load them by clicking on [Add default actions]. One example is performing a search based on an attribute value. This concept is used in the following discussion.

### **Defining Actions**

Attribute actions are defined from the vector Layer Properties dialog. To define an action, open the vector Layer Properties dialog and click on the Actions menu. Go to the Action properties. Select 'Generic' as type and provide a descriptive name for the action. The action itself must contain the name of the application that will be executed when the action is invoked. You can add one or more attribute field values as arguments to the application. When the action is invoked, any set of characters that start with a % followed by the name of a field will be replaced by the value of that field. The special characters %% will be replaced by the value of the field that was selected from the identify results or attribute table (see using \_actions below). Double quote marks can be used to group text into a single argument to the program, script or command. Double quotes will be ignored if preceded by a backslash.

If you have field names that are substrings of other field names (e.g., col1 and col10), you should indicate that by surrounding the field name (and the % character) with square brackets (e.g., [%col10]). This will prevent the %col10 field name from being mistaken for the %col1 field name with a 0 on the end. The brackets will be removed by QGIS when it substitutes in the value of the field. If you want the substituted field to be surrounded by square brackets, use a second set like this: [[%col10]].

Using the *Identify Features* tool, you can open the *Identify Results* dialog. It includes a *(Derived)* item that contains information relevant to the layer type. The values in this item can be accessed in a similar way to the other fields by proceeding the derived field name with (Derived).. For example, a point layer has an X and Y field, and the values of these fields can be used in the action with %(Derived).X and %(Derived).Y. The derived attributes are only available from the *Identify Results* dialog box, not the *Attribute Table* dialog box.

Two example actions are shown below:

- konqueror http://www.google.com/search?q=%nam
- konqueror http://www.google.com/search?q=%%

In the first example, the web browser konqueror is invoked and passed a URL to open. The URL performs a Google search on the value of the nam field from our vector layer. Note that the application or script called by the action must be in the path, or you must provide the full path. To be certain, we could rewrite the first example as: /opt/kde3/bin/konqueror http://www.google.com/search?q=%nam. This will ensure that the konqueror application will be executed when the action is invoked.

The second example uses the %% notation, which does not rely on a particular field for its value. When the action is invoked, the %% will be replaced by the value of the selected field in the identify results or attribute table.

### **Using Actions**

Actions can be invoked from either the *Identify Results* dialog, an *Attribute Table* dialog or from *Run Feature Action* (recall that these dialogs can be opened by clicking or Identify Features or Copen Attribute Table or Run Feature Action). To invoke an action, right click on the record and choose the action from the pop-up menu. Actions are listed in the popup menu by the name you assigned when defining the action. Click on the action you wish to invoke.

If you are invoking an action that uses the %% notation, right-click on the field value in the *Identify Results* dialog or the *Attribute Table* dialog that you wish to pass to the application or script.

Here is another example that pulls data out of a vector layer and inserts it into a file using bash and the echo command (so it will only work on  $\Delta$  or perhaps X). The layer in question has fields for a species name taxon\_name, latitude lat and longitude long. We would like to be able to make a spatial selection of localities and export these field values to a text file for the selected record (shown in yellow in the QGIS map area). Here is the action to achieve this:

bash -c "echo \"%taxon\_name %lat %long\" >> /tmp/species\_localities.txt"

After selecting a few localities and running the action on each one, opening the output file will show something like this:

As an exercise, we can create an action that does a Google search on the lakes layer. First, we need to determine the URL required to perform a search on a keyword. This is easily done by just going to Google and doing a simple search, then grabbing the URL from the address bar in your browser. From this little effort, we see that the format is <a href="http://google.com/search?q=qgis">http://google.com/search?q=qgis</a>, where QGIS is the search term. Armed with this information, we can proceed:

- 1. Make sure the lakes layer is loaded.
- 2. Open the Layer Properties dialog by double-clicking on the layer in the legend, or right-click and choose Properties from the pop-up menu.
- 3. Click on the Actions menu.
- 4. Enter a name for the action, for example Google Search.
- 5. For the action, we need to provide the name of the external program to run. In this case, we can use Firefox. If the program is not in your path, you need to provide the full path.
- 6. Following the name of the external application, add the URL used for doing a Google search, up to but not including the search term: http://google.com/search?q=
- 7. The text in the Action field should now look like this: firefox http://google.com/search?q=
- 8. Click on the drop-down box containing the field names for the lakes layer. It's located just to the left of the [Insert Field] button.
- 9. From the drop-down box, select 'NAMES' and click [Insert Field].
- 10. Your action text now looks like this:

```
firefox http://google.com/search?q=%NAMES
```

11. To finalize the action, click the [Add to action list] button.

This completes the action, and it is ready to use. The final text of the action should look like this:

```
firefox http://google.com/search?q=%NAMES
```

We can now use the action. Close the *Layer Properties* dialog and zoom in to an area of interest. Make sure the lakes layer is active and identify a lake. In the result box you'll now see that our action is visible:

When we click on the action, it brings up Firefox and navigates to the URL <a href="http://www.google.com/search?q=Tustumena">http://www.google.com/search?q=Tustumena</a>. It is also possible to add further attribute fields to the action. Therefore, you can add a + to the end of the action text, select another field and click on [Insert Field]. In this example, there is just no other field available that would make sense to search for.

You can define multiple actions for a layer, and each will show up in the *Identify Results* dialog.

You can also invoke actions from the attribute table by selecting a row and right-clicking, then choosing the action from the pop-up menu.

There are all kinds of uses for actions. For example, if you have a point layer containing locations of images or photos along with a file name, you could create an action to launch a viewer to display the image. You could also use actions to launch web-based reports for an attribute field or combination of fields, specifying them in the same way we did in our Google search example.

We can also make more complex examples, for instance, using **Python** actions.

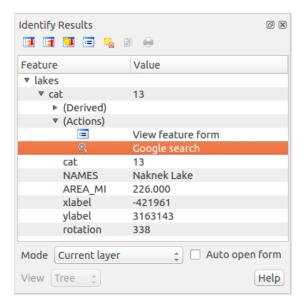


Рис. 12.51: Select feature and choose action

Usually, when we create an action to open a file with an external application, we can use absolute paths, or eventually relative paths. In the second case, the path is relative to the location of the external program executable file. But what about if we need to use relative paths, relative to the selected layer (a file-based one, like a shapefile or SpatiaLite)? The following code will do the trick:

```
command = "firefox"
imagerelpath = "images_test/test_image.jpg"
layer = qgis.utils.iface.activeLayer()
import os.path
layerpath = layer.source() if layer.providerType() == 'ogr'
    else (qgis.core.QgsDataSourceURI(layer.source()).database()
        if layer.providerType() == 'spatialite' else None)
path = os.path.dirname(str(layerpath))
image = os.path.join(path,imagerelpath)
import subprocess
subprocess.Popen( [command, image ] )
```

We just have to remember that the action is one of type *Python* and the *command* and *imagerelpath* variables must be changed to fit our needs.

But what about if the relative path needs to be relative to the (saved) project file? The code of the Python action would be:

```
command="firefox"
imagerelpath="images/test_image.jpg"
projectpath=qgis.core.QgsProject.instance().fileName()
import os.path
path=os.path.dirname(str(projectpath)) if projectpath != '' else None
image=os.path.join(path, imagerelpath)
import subprocess
subprocess.Popen( [command, image ] )
```

Another Python action example is the one that allows us to add new layers to the project. For instance, the following examples will add to the project respectively a vector and a raster. The names of the files to be added to the project and the names to be given to the layers are data driven (*filename* and *layername* are column names of the table of attributes of the vector where the action was created):

```
qgis.utils.iface.addVectorLayer('/yourpath/[% "filename" %].shp',
    '[% "layername" %]', 'ogr')
```

To add a raster (a TIF image in this example), it becomes:

```
qgis.utils.iface.addRasterLayer('/yourpath/[% "filename" %].tif',
    '[% "layername" %]')
```

# 12.3.8 Display Menu

This menu is specifically created for Map Tips. It includes a nice feature: Map Tip display text in HTML. While you can still choose a Field to be displayed when hovering over a feature on the map, it is also possible to insert HTML code that creates a complex display when hovering over a feature. To activate Map Tips, select the menu option  $View \rightarrow Map Tips$ .

Figure Display 1 and 2 show an example of HTML code and how it behaves in map canvas.

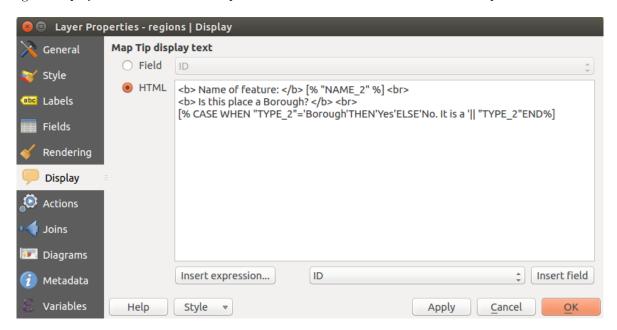


Рис. 12.52: HTML code for map tip



Рис. 12.53: Map tip made with HTML code

# 12.3.9 Rendering Menu

QGIS offers support for on-the-fly feature generalisation. This can improve rendering times when drawing many complex features at small scales. This feature can be enabled or disabled in the layer settings using the Simplify geometry option. There is also a global setting that enables generalisation by default for newly added layers (see section Options).

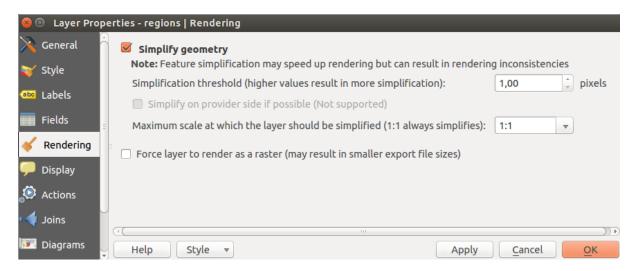


Рис. 12.54: Layer Geometry Simplification dialog

**Примітка:** Feature generalisation may introduce artefacts into your rendered output in some cases. These may include slivers between polygons and inaccurate rendering when using offset-based symbol layers.

While rendering extremely detailed layers (e.g. polygon layers with a huge number of nodes), this can cause composer exports in PDF/SVG format to be huge as all nodes are included in the exported file. This can also make the resultant file very slow to work with/open in other programs.

Checking Force layer to render as raster forces these layers to be rasterised so that the exported files won't have to include all the nodes contained in these layers and the rendering is therefore sped up.

You can also do this by forcing the composer to export as a raster, but that is an all-or-nothing solution, given that the rasterisation is applied to all layers.

### 12.3.10 Metadata Menu

The Metadata menu consists of Description, Attribution, MetadataURL, LegendUrl and Properties sections

In the *Properties* section, you get general information about the layer, including specifics about the type and location, number of features, feature type, and editing capabilities. The *Extents* table provides you with information on the layer extent and the *Layer Spatial Reference System*, which is information about the CRS of the layer. This can provide a quick way to get useful information about the layer.

Additionally, you can add or edit a title and abstract for the layer in the *Description* section. It's also possible to define a *Keyword list* here. These keyword lists can be used in a metadata catalogue. If you want to use a title from an XML metadata file, you have to fill in a link in the *DataUrl* field.

Use Attribution to get attribute data from an XML metadata catalogue.

In *MetadataUrl*, you can define the general path to the XML metadata catalogue. This information will be saved in the QGIS project file for subsequent sessions and will be used for QGIS server.

In the *LegendUrl* section, you can provide the url of a legend image in the url field. You can use the Format drop-down option to apply the appropriate format of the image. Currently png, jpg and jpeg image formats are supported.

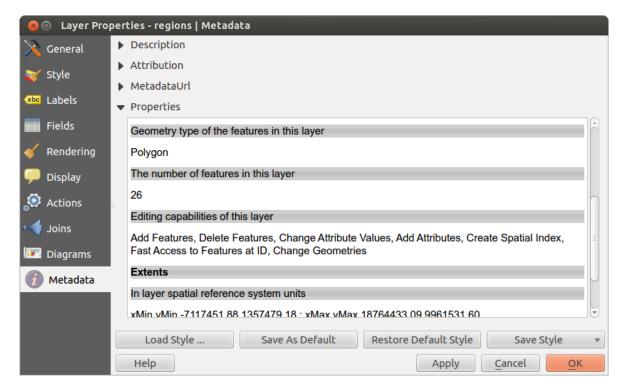


Рис. 12.55: Metadata menu in vector layers properties dialog

## 12.3.11 Save and Share Layer Properties

### **Managing Custom Styles**

When a layer is added to map canvas, QGIS uses by default a random symbol/color to render its features. You can however set a default symbol in  $Project \rightarrow Properties \rightarrow Default \ styles$  that will be applied to each newly added layer according to its geometry type.

But, most of the time, you'd prefer to have a custom and more complex style that can be applied automatically or manually (with less efforts) to the layers. You can achieve this goal using the *Style* combobox at the bottom of the Layer Properties dialog. This combobox provides you with functions to create, load and manage styles.

A style stores any information set in the layer properties dialog to render or interact with the features (including symbology, labeling, action, diagram... settings).

By default, the style applied to a loaded layer is named default. Once you have got the ideal and appropriate rendering for your layer, you can save it by clicking the Style combobox and choose:

- Rename Current: The active style gets renamed and updated with the current options
- Add: A new style is created using the current options.

At the bottom of the Style drop-down list, you see the styles set for the layer and the active one is checked. Once you have more than one style defined for a layer, a **Remove Current** option can help you delete those you no longer want.

Note that each time you validate the layer properties dialog, the active style is updated with the changes you've done.

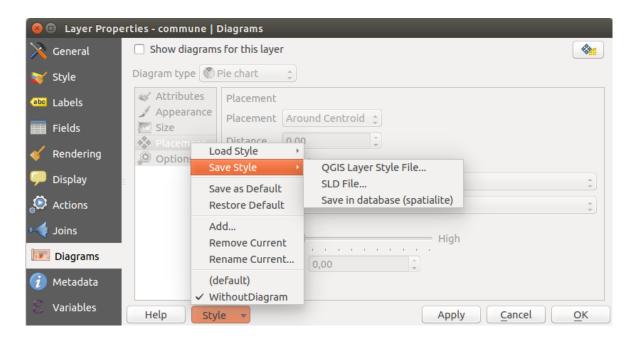


Рис. 12.56: Style combobox options

You can create as many styles as you wish for a layer but only one can be active at a time. Combined to layer visibility preset, this offers a quick and powerful way to manage complex projects with few layers (no need to duplicate any layer in the map legend).

#### Порада: Manage styles from layer context menu

Right-click on the layer in  $Layers\ Panel$  to add, rename or remove layer style. You can also edit feature symbols.

#### Storing Style in a File or a Database

While these styles are saved inside the project and can be copied and pasted from layer to layer in the project, it's also possible to save them outside the project so that they can be loaded in another project. Clicking the  $Style \rightarrow Save Style$  saves the symbol as a QGIS layer style file (.qml) or SLD file (.sld). SLDs can be exported from any type of renderer – single symbol, categorized, graduated or rule-based – but when importing an SLD, either a single symbol or rule-based renderer is created. That means that categorized or graduated styles are converted to rule-based. If you want to preserve those renderers, you have to stick to the QML format. On the other hand, it can be very handy sometimes to have this easy way of converting styles to rule-based.

If the datasource of the layer is a database (PostGIS or Spatialite for example), you can also save your layer style inside a table of the database. Just click on *Save Style* combobox and choose **Save in database** item then fill in the dialog to define a style name, add a description, an ui file if applicable and check if the style is the default style. You can add several style in the database. However each table can have only one default style.

When loading a layer in QGIS, if a default style already exists for this layer, QGIS will load the layer and its style. After you modified the layer style, you can **Save as Default**, creating a new style that becomes the default one or **Restore Default** style if you're not satisfied.

### Порада: Quickly share a layer style within the project

You can also share layer style within a project without importing a file or database style: right-click on the layer in the *Layers Panel* and, from the *Styles* combobox, copy the style of a layer and paste it to a group or a selection of layers: the style is applied to all the layers that are of the same type (vector vs raster) as the original layer and, in case of vector, have the same geometry type (point, line or polygon).

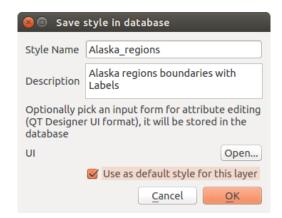


Рис. 12.57: Save Style in database Dialog

# 12.4 Expressions

The Expressions feature is available from many parts in QGIS. It can be accessed using the Expression Builder, the Select By Expression..., the Geometry generator symbol layer option, the Field calculator or the Data defined override tool. Based on layer data and prebuilt or user defined functions, it offers a powerful way to manipulate attribute value, geometry and variables in order to dynamically change the geometry style, the content or position of the label, the value for diagram, the height of a composer item, select some features, create virtual field ...

### Some examples:

• From Field Calculator, calculate a "pop\_density" field using existing "total\_pop" and "area\_km2" fields:

```
"total_pop" / "area_km2"
```

• Update the field "density level" with categories according to the "pop density" values:

```
CASE WHEN "pop_density" < 50 THEN 'Low population density'
WHEN "pop_density" >= 50 and "pop_density" < 150 THEN 'Medium population density'
WHEN "pop_density" >= 150 THEN 'High population density'
END
```

• Apply a categorized style to all the features according to whether their average house price is smaller or higher than 10000€ per square metre:

```
"price_m2" > 10000
```

• Using the "Select By Expression..." tool, select all the features representing areas of "High population density" and whose average house price is higher than 10000€ per square metre:

```
"density_level" = 'High population density' and "price_m2" > 10000
```

Likewise, the previous expression could also be used to define which features should be labeled or shown in the map. Using expressions offers you a lot of possibilities.

The **Expressions** feature offers access to the:

- Expression tab which lists functions to use
- Function Editor tab which helps to create custom functions to use in the expressions.

12.4. Expressions 141

## 12.4.1 Functions List

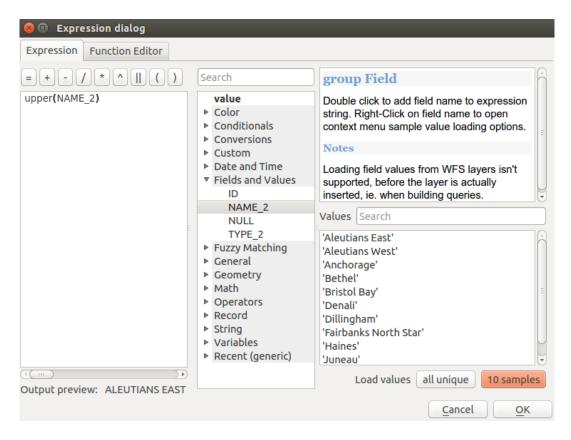


Рис. 12.58: The Expression tab

The **Expression** tab contains functions as well as layer's fields and values. It contains widgets to:

- type expressions using functions and/or fields. A preview of the expression's result is displayed at the bottom of the dialog.
- select the appropriate function among a list. A search box is available to filter the list and quickly find a particular function or field. Double-clicking on the item's name adds it to the expression being written.
- display help for each function selected. When a field is selected, this widget shows a sample of its values. Double-clicking a value adds it to the expression.

To help to quickly find a function, they are organized in groups. In *Operators*, you find mathematical operators. Look in *Math* for mathematical functions. The *Conversions* group contains functions that convert one data type to another. The *String* group provides functions for data strings, such as *Date and Time* handles date and time data. In the *Geometry* group, you find functions for geometry objects. With *Record* group functions, you can add a numeration to your data set while *Fields and Values* group helps view all attributes of the attribute table. The *Customs* group lists the functions created or imported by the user. There are many other groups, listed below.

### **Operators**

This group contains operators (e.g., +, -, \*). Note that for most of the mathematical functions below, if one of the inputs is NULL then the result is NULL.

Function	Description
a + b	Addition of two values (a plus b)
$\begin{vmatrix} a + b \\ a - b \end{vmatrix}$	Subtraction of two values (a minus b).
a * b	Multiplication of two values (a multiplied by b)
	· · · · · · · · · · · · · · · · · ·
a / b	Division of two values (a divided by b)
a % b	Remainder of division of a by b (eg, $7 \% 2 = 1$ , or 2 fits into 7 three times with
a ^ b	remainder 1)
	Power of two values (for example, 2^2=4 or 2^3=8)
a < b	Compares two values and evaluates to 1 if the left value is less than the right value (a is smaller than b)
$a \le b$	Compares two values and evaluates to 1 if the left value is less than or equal to
	the right value
a <> b	Compares two values and evaluates to 1 if they are not equal
a = b	Compares two values and evaluates to 1 if they are equal
a != b	a and b are not equal
a > b	Compares two values and evaluates to 1 if the left value is greater than the right
	value (a is larger than b)
a>=b	Compares two values and evaluates to 1 if the left value is greater than or equal
	to the right value
a~ b	a matches the regular expression b
	Joins two values together into a string. If one of the values is NULL the result
	will be NULL
'\n'	Inserts a new line in a string
LIKE	Returns 1 if the first parameter matches the supplied pattern
ILIKE	Returns 1 if the first parameter matches case-insensitive the supplied pattern (ILIKE can be used instead of LIKE to make the match case-insensitive)
a IS b	Tests whether two values are identical. Returns 1 if a is the same as b
a OR b	Returns 1 when condition a or b is true
a AND b	Returns 1 when condition a and b are true
NOT	Negates a condition
column name	Value of the field column name, take care to not be confused with simple quote,
"column name"	see below
'string'	a string value, take care to not be confused with double quote, see above
NULL	null value
a IS NULL	a has no value
a IS NOT	a has a value
NULL	
a IN	a is below the values listed
(value[,value])	
a NOT IN	a is not below the values listed
(value[,value])	
17	l .

## Some examples:

• Joins a string and a value from a column name:

```
'My feature''s id is: ' || "gid"
```

 $\bullet$  Test if the "description" attribute field starts with the 'Hello' string in the value (note the position of the % character):

"description" LIKE 'Hello%'

## Conditionals

This group contains functions to handle conditional checks in expressions.

12.4. Expressions 143

Function	Description
CASE WHEN THEN	Evaluates an expression and returns a result if true. You can test
END	multiple conditions
CASE WHEN THEN	Evaluates an expression and returns a different result whether it's true
ELSE END	or false. You can test multiple conditions
coalesce	Returns the first non-NULL value from the expression list
if	Tests a condition and returns a different result depending on the
	conditional check
$regexp\_match$	Returns true if any part of a string matches the supplied regular
	expression

## Some example:

• Send back a value if the first condition is true, else another value:

```
CASE WHEN "software" LIKE '%QGIS%' THEN 'QGIS' ELSE 'Other' END
```

## **Mathematical Functions**

This group contains math functions (e.g., square root, sin and cos).

Function	Description
abs	Returns the absolute value of a number
acos	Returns the inverse cosine of a value in radians
asin	Returns the inverse sine of a value in radians
atan	Returns the inverse cosine of a value in radians
atan2(y,x)	Returns the inverse tangent of y/x by using the signs of the two arguments to
	determine the quadrant of the result
azi-	Returns the north-based azimuth as the angle in radians measured clockwise from the
muth(a,b)	vertical on point a to point b
ceil	Rounds a number upwards
clamp	Restricts an input value to a specified range
cos	Returns the cosine of a value in radians
degrees	Converts from radians to degrees
exp	Returns exponential of a value
floor	Rounds a number downwards
ln	Returns the natural logarithm of the passed expression
log	Returns the value of the logarithm of the passed value and base
$\log 10$	Returns the value of the base 10 logarithm of the passed expression
max	Returns the largest value in a set of values
min	Returns the smallest value in a set of values
pi	Returns the value of pi for calculations
radians	Converts from degrees to radians
rand	Returns the random integer within the range specified by the minimum and maximum
	argument (inclusive)
randf	Returns the random float within the range specified by the minimum and maximum
	argument (inclusive)
round	Rounds to number of decimal places
$scale\_exp$	Transforms a given value from an input domain to an output range using an
	exponential curve
scale_linea	r Transforms a given value from an input domain to an output range using linear
	interpolation
$\sin$	Returns the sine of an angle
sqrt	Returns the square root of a value
tan	Returns the tangent of an angle

## **Color Functions**

This group contains functions for manipulating colors.

Function	Description	
$\operatorname{color} \operatorname{\_cmyk}$	Returns a string representation of a color based on its cyan, magenta, yellow and black	
	components	
color_cmyka	Returns a string representation of a color based on its cyan, magenta, yellow, black	
, , ,	and alpha (transparency) components	
$\operatorname{color} \_\operatorname{hsl}$	Returns a string representation of a color based on its hue, saturation, and lightness	
1 11-	attributes	
$\operatorname{color}_{-}\operatorname{hsla}$	Returns a string representation of a color based on its hue, saturation, lightness and alpha (transparency) attributes	
$\operatorname{color} \ \operatorname{hsv}$	Returns a string representation of a color based on its hue, saturation, and value	
color_nsv	attributes	
color hsva	Returns a string representation of a color based on its hue, saturation, value and alpha	
	(transparency) attributes	
color part	Returns a specific component from a color string, eg the red component or alpha	
	component	
$\operatorname{color} \operatorname{rgb}$	Returns a string representation of a color based on its red, green, and blue components	
$\operatorname{color} \operatorname{rgba}$	Returns a string representation of a color based on its red, green, blue, and alpha	
	(transparency) components	
darker	Returns a darker (or lighter) color string	
$_{ m lighter}$	Returns a lighter (or darker) color string	
project_cold	project_color Returns a color from the project's color scheme	
$ramp\_color$	Returns a string representing a color from a color ramp	
$\operatorname{set} \_\operatorname{color} \_\operatorname{p}$	aSets a specific color component for a color string, eg the red component or alpha	
	component	

## Conversions

This group contains functions to convert one data type to another (e.g., string to integer, integer to string).

Function	Description
to_date	Converts a string into a date object
to_datetime	Converts a string into a datetime object
to_int	Converts a string to integer number
to_interval	Converts a string to an interval type (can be used to take days, hours, months, etc. of
	a date)
to real	Converts a string to a real number
to string	Converts number to string
to time	Converts a string into a time object

## **Custom functions**

This group contains functions created by the user. See function  $\_$  editor for more details.

## **Date and Time Functions**

This group contains functions for handling date and time data.

12.4. Expressions 145

Function	Description
age	Returns as an interval the difference between two dates or datetimes
day	Extracts the day from a date or datetime, or the number of days from an interval
day_of_week	Returns a number corresponding to the day of the week for a specified date or
	datetime
hour	Extracts the hour from a datetime or time, or the number of hours from an interval
minute	Extracts the minute from a datetime or time, or the number of minutes from an
	interval
month	Extracts the month part from a date or datetime, or the number of months from an
	interval
now()	Returns current date and time
second	Extracts the second from a datetime or time, or the number of seconds from an
	interval
week	Extracts the week number from a date or datetime, or the number of weeks from an
	interval
year	Extracts the year part from a date or datetime, or the number of years from an
	interval

## Some example:

• Get the month and the year of today in the format "10/2014"

```
month(now()) || ',' || year(now())
```

#### Fields and Values

Contains a list of fields from the layer.

Generally, you can use the various fields, values and functions to construct the calculation expression, or you can just type it into the box.

To display the values of a field, you just click on the appropriate field and choose between *Load top 10 unique values* and *Load all unique values*. On the right side, the **Field Values** list opens with the unique values. At the top of the list, a search box helps filtering the values. To add a value to the expression you are writing, double click its name in the list.

Sample values can also be accessed via right-click. Select the field name from the list, then right-click to access a context menu with options to load sample values from the selected field.

Fields name should be double-quoted in the expression. Values or string should be simple-quoted.

## **Fuzzy Matching Functions**

This group contains functions for fuzzy comparisons between values.

Function	Description
hammi-	Returns the number of characters at corresponding positions within the input
ng_distance	strings where the characters are different
levensheim	Returns the minimum number of character edits (insertions, deletions or
	substitutions) required to change one string to another. Measure the similarity
	between two strings
longest common Retherminghe longest common substring between two strings	
soundex	Returns the Soundex representation of a string

#### **General Functions**

This group contains general assorted functions.

Function	Description
eval	Evaluates an expression which is passed in a string. Useful to expand dynamic
	parameters passed as context variables or fields
layer prope	rteturns a property of a layer or a value of its metadata. It can be layer name, crs,
_	geometry type, feature count
var	Returns the value stored within a specified variable. See variable functions below

## **Geometry Functions**

 $num\_interior\_rings$ 

num\_points

This group contains functions that operate on geometry objects (e.g., length, area).

Function	Description
\$area	Returns the area size of the current feature
\$geometry	Returns the geometry of the current feature (can be used for processing with other functions
\$length	Returns the length of the current line feature
\$perimeter	Returns the perimeter of the current polygon feature
\$x	Returns the x coordinate of the current feature
\$x_at(n)	Returns the x coordinate of the nth node of the current feature's geometry
\$y	Returns the y coordinate of the current feature
\$y_at(n)	Returns the y coordinate of the nth node of the current feature's geometry
area	Returns the area of a geometry polygon feature. Calculations are in the Spatial Reference S
bounds	Returns a geometry which represents the bounding box of an input geometry. Calculations a
bounds height	Returns the height of the bounding box of a geometry. Calculations are in the Spatial Reference
bounds_width	Returns the width of the bounding box of a geometry. Calculations are in the Spatial Refere
buffer	Returns a geometry that represents all points whose distance from this geometry is less than
centroid	Returns the geometric center of a geometry
closest point	Returns the point on a geometry that is closest to a second geometry
combine	Returns the combination of two geometries
contains(a,b)	Returns 1 (true) if and only if no points of b lie in the exterior of a, and at least one point of
convex hull	Returns the convex hull of a geometry (this represents the minimum convex geometry that e
crosses	Returns 1 (true) if the supplied geometries have some, but not all, interior points in common
difference(a,b)	Returns a geometry that represents that part of geometry a that does not intersect with geo
disjoint	Returns 1 (true) if the geometries do not share any space together
distance	Returns the minimum distance (based on spatial ref) between two geometries in projected u
end point	Returns the last node from a geometry
exterior ring	Returns a line string representing the exterior ring of a polygon geometry. If the geometry is
extrude(geom, x, y)	Returns an extruded version of the input (Multi-)Curve or (Multi-)Linestring geometry with
geom_from_gml	Returns a geometry created from a GML representation of geometry
geom from wkt	Returns a geometry created from a well-known text (WKT) representation
geom to wkt	Returns the well-known text (WKT) representation of the geometry without SRID metadata
geometry	Returns a feature's geometry
geometry n	Returns the nth geometry from a geometry collection, or null if the input geometry is not a
interior_ring_n	Returns the geometry of the nth interior ring from a polygon geometry, or null if the geometry
intersection	Returns a geometry that represents the shared portion of two geometries
intersects	Tests whether a geometry intersects another. Returns 1 (true) if the geometries spatially int
intersects_bbox	Tests whether a geometry's bounding box overlaps another geometry's bounding box. Retur
is closed	Returns true if a line string is closed (start and end points are coincident), false if a line stri
length	Returns length of a line geometry feature (or length of a string)
m	Returns the m value of a point geometry
make line	Creates a line geometry from a series of point geometries
make point(x,y,z,m)	Returns a point geometry from x and y values (and optional z and m values)
make point $m(x,y,m)$	Returns a point geometry from x and y coordinates and m values
make polygon	Creates a polygon geometry from an outer ring and optional series of inner ring geometries
nodes to points	Returns a multipoint geometry consisting of every node in the input geometry
num geometries	Returns the number of geometries in a geometry collection, or null if the input geometry is i
= 2	The state of the s

12.4. Expressions 147

Returns the number of vertices in a geometry

Returns the number of interior rings in a polygon or geometry collection, or null if the input

## Some examples:

• Return the x coordinate of the current feature's centroid:

x(\$geometry)

• Send back a value according to feature's area:

CASE WHEN \$area > 10 000 THEN 'Larger' ELSE 'Smaller' END

## **Record Functions**

This group contains functions that operate on record identifiers.

Function	Description
\$currentfeatReturns the current feature being evaluated. This can be used with the 'attribute'	
	function to evaluate attribute values from the current feature.
\$id	Returns the feature id of the current row
\$map	Returns the id of the current map item if the map is being drawn in a composition, or
	"canvas" if the map is being drawn within the main QGIS window
\$rownum	Returns the number of the current row
scale	Returns the current scale of the map canvas
attri-	Returns the value of a specified attribute from a feature.
bute	
get featureReturns the first feature of a layer matching a given attribute value.	
uuid	Generates a Universally Unique Identifier (UUID) for each row. Each UUID is 38
	characters long

## Some examples:

• Return the first feature in layer "LayerA" whose field "id" has the same value as the field "name" of the current feature (a kind of jointure):

```
get_feature( 'layerA', 'id', attribute( $currentfeature, 'name') )
```

• Calculate the area of the joined feature from the previous example:

```
area( geometry( get_feature( 'layerA', 'id', attribute( $currentfeature, 'name') ) ) )
```

## **String Functions**

This group contains functions that operate on strings (e.g., that replace, convert to upper case).

Function	Description	
concat	Concatenates several strings to one	
format	Formats a string using supplied arguments	
format_date	format date Formats a date type or string into a custom string format	
format_nun	format number formatted with the locale separator for thousands (also truncates	
	the number to the number of supplied places)	
left (string,	Returns a substring that contains the n leftmost characters of the string	
n)		
$\operatorname{length}$	Returns length of a string (or length of a line geometry feature)	
lower	converts a string to lower case	
lpad	Returns a string with supplied width padded using the fill character	
regexp_repl	regexp_replaced regular expression replaced	
regexp_subs	stReturns the portion of a string which matches a supplied regular expression	
replace	Returns a string with the supplied string replaced	
ri-	Returns a substring that contains the n rightmost characters of the string	
ght (string,		
n)		
rpad	Returns a string with supplied width padded using the fill character	
strpos	Returns the index of a regular expression in a string	
substr	Returns a part of a string	
title	Converts all words of a string to title case (all words lower case with leading capital	
	letter)	
trim	Removes all leading and trailing white space (spaces, tabs, etc.) from a string	
upper	Converts string a to upper case	
wordwrap	Returns a string wrapped to a maximum/ minimum number of characters	

## **Recent Functions**

This group contains recently used functions. Any expression used in the Expression dialog is added to the list, sorted from the more recent to the less one. This helps to quickly retrieve any previous expression.

#### Variables Functions

This group contains dynamic variables related to the application, the project file and other settings. It means that some functions may not be available according to the context:

- from the Select by expression dialog
- from the Field calculator dialog
- from the layer properties dialog
- from the print composer

To use these functions in an expression, they should be preceded by @ character (e.g, @row\_number). Are concerned:

12.4. Expressions 149

Function	Description
atlas feature	Returns the current atlas feature (as feature object)
atlas featureid	Returns the current atlas feature ID
atlas featurenumber	Returns the number of pages in composition
atlas_filename	Returns the current atlas file name
atlas_geometry	Returns the current atlas feature geometry
atlas_pagename	Returns the current atlas page name
atlas_totalfeatures	Returns the total number of features in atlas
grid_axis	Returns the current grid annotation axis (eg, 'x' for longitude, 'y' for latitude)
grid_number	Returns the current grid annotation value
item_id	Returns the composer item user ID (not necessarily unique)
item_uuid	Returns the composer item unique ID
layer_id	Returns the ID of current layer
layer_name	Returns the name of current layer
layout_dpi	Returns the composition resolution (DPI)
layout_numpages	Returns the number of pages in the composition
layout_pageheight	Returns the composition height in mm
layout_pagewidth	Returns the composition width in mm
map_id	Returns the ID of current map destination. This will be 'canvas' for canvas renders, and the it
map_extent_center	Returns the point feature at the center of the map
map_extent_height	Returns the current height of the map
$map\_extent\_width$	Returns the current width of the map
map_rotation	Returns the current rotation of the map
$map\_scale$	Returns the current scale of the map
$project\_filename$	Returns the filename of current project
project_folder	Returns the folder for current project
$project\_path$	Returns the full path (including file name) of current project
project_title	Returns the title of current project
qgis_os_name	Returns the current Operating system name, eg 'windows', 'linux' or 'osx'
$qgis\_platform$	Returns the QGIS platform, eg 'desktop' or 'server'
qgis_release_name	Returns the current QGIS release name
qgis_version	Returns the current QGIS version string
qgis_version_no	Returns the current QGIS version number
$symbol\_angle$	Returns the angle of the symbol used to render the feature (valid for marker symbols only)
$symbol\_color$	Returns the color of the symbol used to render the feature
user_account_name	Returns the current user's operating system account name
$user\_full\_name$	Returns the current user's operating system user name
row_number	Stores the number of the current row

## 12.4.2 Function Editor

With the Function Editor, you are able to define your own Python custom functions in a comfortable way.

The function editor will create new Python files in .qgis2\python\expressions folder and will auto load all functions defined when starting QGIS. Be aware that new functions are only saved in the expressions folder and not in the project file. If you have a project that uses one of your custom functions you will need to also share the .py file in the expressions folder.

Here's a short example on how to create your own functions:

```
@qgsfunction(args="auto", group='Custom')
def myfunc(value1, value2, feature, parent):
    pass
```

The short example creates a function 'myfunc' that will give you a function with two values. When using the args='auto' function argument the number of function arguments required will be calculated by the number of arguments the function has been defined with in Python (minus 2 - feature, and parent).

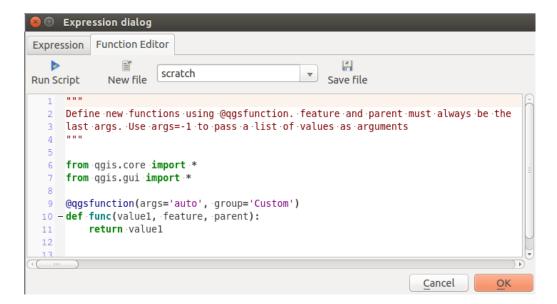


Рис. 12.59: The Function Editor tab

This function then can be used with the following expression:

```
myfunc('test1', 'test2')
```

Your function will be implemented in the Custom functions group of the Expression tab after using the  $Run\ Script$  button.

Further information about creating Python code can be found in the PyQGIS-Developer-Cookbook.

The function editor is not only limited to working with the field calculator, it can be found whenever you work with expressions.

# 12.5 Working with the Attribute Table

The attribute table displays features of a selected layer. Each row in the table represents one map feature, and each column contains a particular piece of information about the feature. Features in the table can be searched, selected, moved or even edited.

To open the attribute table for a vector layer, make the layer active by clicking on it in the map legend area. Then, from the main Layer menu, choose Open Attribute Table. It is also possible to right click on the layer and choose Open Attribute Table from the drop-down menu, and to click on the Open Attribute Table button in the Attributes toolbar.

This will open a new window that displays the feature attributes for the layer (figure\_attributes\_1). The number of features and the number of selected features are shown in the attribute table title.

The buttons at the top of the attribute table window provide the following functionality:

- Toggle editing mode to enable editing functionalities (also with Ctrl+e)
- Save Edits (also with Ctrl+s)
- Reload the table
- Add feature
- Delete selected features (also with Ctrl+d)

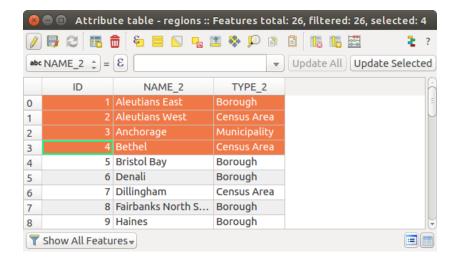


Рис. 12.60: Attribute Table for regions layer

- Select features using an Expression
- $\bullet$  Select all (also with Ctrl+a)
- Invert selection (also with Ctrl+r)
- Unselect all (also with Ctrl+u)
- Move selected to top (also with Ctrl+t)
- Pan map to the selected rows (also with Ctrl+p)
- ullet Zoom map to the selected rows (also with Ctrl+j)
- Copy selected rows to clipboard (also with Ctrl+c)
- Paste from clipboard to a new row (also with Ctrl+v)
- Delete Column for PostGIS layers and for OGR layers with GDAL version >= 1.9 (also with Ctrl+1)
- New Column for PostGIS layers and for OGR layers with GDAL version >= 1.6 (also with Ctrl+w)
- Open field calculator (also with Ctrl+i)

Below these buttons is the Field Calculator bar (enabled only in editing mode), which allows calculations to be quickly applied to either all or selected features attributes in the table. This bar uses the same expressions as the Field Calculator (see Field Calculator).

### Порада: Skip WKT geometry

If you want to use attribute data in external programs (such as Excel), use the Copy selected rows to clipboard button. You can copy the information without vector geometries if you deactivate  $Settings \rightarrow Options \rightarrow$  Data sources menu Copy geometry in WKT representation from attribute table.

## 12.5.1 Selecting features in an attribute table

Each selected row in the attribute table displays the attributes of a selected feature in the layer. If the set of features selected in the main window is changed, the selection is also updated in the attribute table. Likewise, if the set of rows selected in the attribute table is changed, the set of features selected in the main window will be updated.

Rows can be selected by clicking on the row number on the left side of the row. **Multiple rows** can be marked by holding the Ctrl key. A continuous selection can be made by holding the Shift key and clicking on several row headers on the left side of the rows. All rows between the current cursor position and the clicked row are selected. Moving the cursor position in the attribute table, by clicking a cell in the table, does not change the row selection. Changing the selection in the main canvas does not move the cursor position in the attribute table.

The table can be sorted by any column, by clicking on the column header. A small arrow indicates the sort order (downward pointing means descending values from the top row down, upward pointing means ascending values from the top row down).

For a **simple search by attributes** on only one column, choose the Column filter  $\rightarrow$  from the menu in the bottom left corner. Select the field (column) on which the search should be performed from the dropdown menu, and hit the **[Apply]** button. Then, only the matching features are shown in the attribute table.

To make a selection, you have to use the Select features using an Expression icon on top of the attribute table. Select features using an Expression allows you to define a subset of a table using a Function List like in the Field Calculator (see Field Calculator). The query result can then be saved as a new vector layer. For example, if you want to find regions that are boroughs from regions.shp of the QGIS sample data, you have to open the Fields and Values menu and choose the field that you want to query. Double-click the field 'TYPE\_2' and also [Load all unique values]. From the list, choose and double-click 'Borough'. In the Expression field, the following query appears:

```
"TYPE_2" = 'Borough'
```

Here you can also use the Function list  $\rightarrow$  Recent (Selection) to make a selection that you used before. The expression builder remembers the last 20 used expressions.

The matching rows will be selected, and the total number of matching rows will appear in the title bar of the attribute table, as well as in the status bar of the main window. For searches that display only selected features on the map, use the Query Builder described in section Query Builder.

To show selected records only, use *Show Selected Features* from the menu at the bottom left. See next section for more information on filter feature.

The field calculator bar allows you to make calculations on the selected rows only. For example, you can alter the number of the ID field of the layer regions.shp with the expression

TD+5

as shown in figure attributes 1.

## 12.5.2 Filter features

At the bottom of the attribute table, you have a dropdown list of different filter:

- Show All Features;
- Show Selected Features;
- Show Features visible on map;
- Show Edited and New Features;
- Field Filter;

• Advanced filter (Expression);

The first four are self explanatory, the two last are expression filters. Field Filter allows user to choose a column name in the list and add a simple form to the right of the drop-down list to filter with a *like* expression parameter. This filter will create an expression filter as an *Advanced filter*. The last kind of filter will open an expression window, see *Expressions* for more information.

## 12.5.3 Tab/form mode

By default the attribute window displays a table layout. In some case one should prefer to use a form layout to help edit some features more easily.

You can switch to form layout by clicking in the bottom right, on <a> and switch back to table layout with <a> and switch back to table layout with <a> and switch back to table layout switch back to table layout switch solves and switch solves are switched and switch solves and switch solves are switched and switch solves and switch solves are switched and switch solves and switch switch solves are switched and switch solves and switch switch

## 12.5.4 Zoom to feature

To zoom into a feature, without having to select it, right-click on the feature you want to zoom in, within the attribute table, and select *Zoom to feature*.

## 12.5.5 Save selected features as new layer

The selected features can be saved as any OGR-supported vector format and also transformed into another coordinate reference system (CRS). Just open the right mouse menu of the layer and click on Save~as to define the name of the output file, its format and CRS (see section Layers~Panel). To save the selection ensure that the Save~only~selected~features is selected. It is also possible to specify OGR creation options within the dialog.

#### 12.5.6 Paste into new layer

Features that are on the clipboard may be pasted into a new layer. To do this, first make a layer editable. Select some features, copy them to the clipboard, and then paste them into a new layer using  $Edit \rightarrow Paste\ Features\ as\ and\ choosing\ New\ vector\ layer\ or\ New\ memory\ layer.$ 

This applies to features selected and copied within QGIS and also to features from another source defined using well-known text (WKT).

## 12.5.7 Editing attribute values

The Field Calculator button in the attribute table allows you to perform calculations on the basis of existing attribute values or defined functions, for instance, to calculate length or area of geometry features. The results can be written to a new attribute field, a virtual field, or they can be used to update values in an existing field.

A virtual field is a field based on an expression calculated on the fly, meaning that its value is automatically updated as soon as the underlying parameter changes. The expression is set once; you no longer need to recalculate the field each time underlying values change. For example, you may want to use a virtual field if you need area to be evaluated as you digitize features or to automatically calculate a duration between dates that may change (e.g., using now() function).

#### Примітка: Use of Virtual Fields

• Virtual fields are not permanent in the layer attributes, meaning that they're only saved and available in the project file they've been created.

• A field can be set virtual only at its creation and the expression used can't be changed later: you'll need to delete and recreate that field.

The field calculator is available on any layer that supports edit. When you click on the field calculator icon the dialog opens (see figure\_attributes\_2). If the layer is not in edit mode, a warning is displayed and using the field calculator will cause the layer to be put in edit mode before the calculation is made.

The quick field calculation bar on top of the attribute table is only visible if the layer is in edit mode.

In quick field calculation bar, you first select the existing field name then open the expression dialog to create your expression or write it directly in the field then click on [Update All], [Update Selected] or [Update Filtered] button according to your need.

#### Field Calculator

Based on the *Expression Builder* dialog, the field calculator dialog offers a complete interface to define an expression and apply it to an existing or a newly created field. To use the field calculator dialog, you first must select whether you want to only update selected features, create a new attribute field where the results of the calculation will be added or update an existing field.

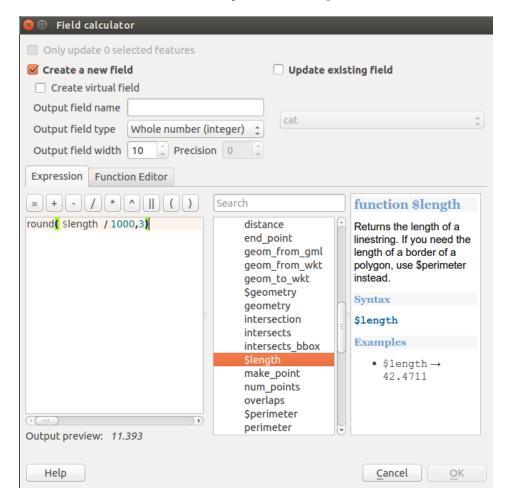


Рис. 12.61: Field Calculator

If you choose to add a new field, you need to enter a field name, a field type (integer, real or string), the total field width, and the field precision (see figure\_attributes\_2). For example, if you choose a field width of 10 and a field precision of 3, it means you have 6 digits before the dot, then the dot and another 3 digits for the precision.

A short example illustrates how field calculator works when using the *Expression* tab. We want to calculate the length in km of the railroads layer from the QGIS sample dataset:

- 1. Load the shapefile railroads.shp in QGIS and press Open Attribute Table.
- 2. Click on Toggle editing mode and open the Field Calculator dialog.
- 3. Select the Create a new field checkbox to save the calculations into a new field.
- 4. Add length as Output field name and real as Output field type, and define Output field width to be 10 and Precision, 3.
- 5. Now double click on function \$length in the *Geometry* group to add it into the Field calculator expression box.
- 6. Complete the expression by typing / 1000 in the Field calculator expression box and click [Ok].
- 7. You can now find a new field length in the attribute table.

## 12.5.8 Working with non spatial attribute tables

QGIS allows you also to load non-spatial tables. This currently includes tables supported by OGR and delimited text, as well as the PostgreSQL, MSSQL and Oracle provider. The tables can be used for field lookups or just generally browsed and edited using the table view. When you load the table, you will see it in the legend field. It can be opened with the

As an example, you can use columns of the non-spatial table to define attribute values, or a range of values that are allowed, to be added to a specific vector layer during digitizing. Have a closer look at the edit widget in section *Fields Menu* to find out more.

## 12.5.9 Conditional formatting of Table Cells

You can enable the conditional formatting panel clicking on  $\blacksquare$  at the top right of the attributes window in table view (not available in form view).

The new panel allows user to add new rules for conditional formatting of field or full row in regard of the expression on field. Adding new rule open a form to define:

• the name of the rule,

other layer attribute table.

- a condition from expression window,
- a preset formatting
- some other parameters to improve, change or setup the formatting:
  - background and text colors,
  - use of icon,
  - bold, italic underline, or strikeout,
  - text field,
  - font.

## 12.5.10 Creating one to many relations

Relations are a technique often used in databases. The concept is, that features (rows) of different layers (tables) can belong to each other.

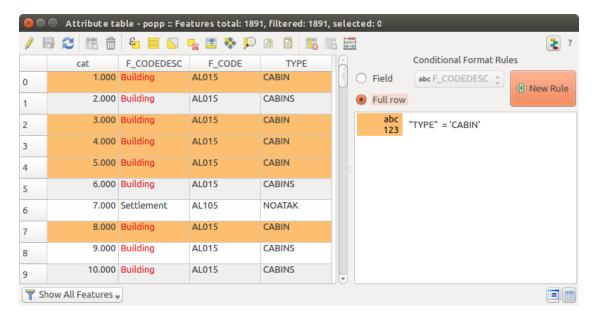


Рис. 12.62: Conditional Formatting of an attribute table

As an example you have a layer with all regions of alaska (polygon) which provides some attributes about its name and region type and a unique id (which acts as primary key).

## Foreign keys

Then you get another point layer or table with information about airports that are located in the regions and you also want to keep track of these. If you want to add them to the region layer, you need to create a one to many relation using foreign keys, because there are several airports in most regions.



Рис. 12.63: Alaska region with airports

In addition to the already existing attributes in the airports attribute table another field fk\_region which acts as a foreign key (if you have a database, you will probably want to define a constraint on it).

This field fk\_region will always contain an id of a region. It can be seen like a pointer to the region it belongs to. And you can design a custom edit form for the editing and QGIS takes care about the setup. It works with different providers (so you can also use it with shape and csv files) and all you have to do is to tell QGIS the relations between your tables.

#### Layers

QGIS makes no difference between a table and a vector layer. Basically, a vector layer is a table with a geometry. So can add your table as a vector layer. To demonstrate you can load the 'region' shapefile (with geometries) and the 'airport' csv table (without geometries) and a foreign key (fk\_region) to the layer region. This means, that each airport belongs to exactly one region while each region can have any number of airports (a typical one to many relation).

#### **Definition (Relation Manager)**

The first thing we are going to do is to let QGIS know about the relations between the layer. This is done in  $Project \rightarrow Project$  Properties. Open the Relations menu and click on Add.

- name is going to be used as a title. It should be a human readable string, describing, what the relation is used for. We will just call say "Airports" in this case.
- referencing layer is the one with the foreign key field on it. In our case this is the airports layer
- referencing field will say, which field points to the other layer so this is fk\_region in this case
- referenced layer is the one with the primary key, pointed to, so here it is the regions layer
- referenced field is the primary key of the referenced layer so it is ID
- id will be used for internal purposes and has to be unique. You may need it to build custom forms once this is supported. If you leave it empty, one will be generated for you but you can assign one yourself to get one that is easier to handle.

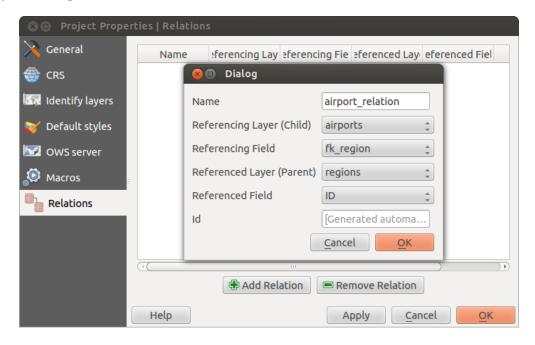


Рис. 12.64: Relation Manager

#### **Forms**

Now that QGIS knows about the relation, it will be used to improve the forms it generates. As we did not change the default form method (autogenerated) it will just add a new widget in our form. So let's select the layer region in the legend and use the identify tool. Depending on your settings, the form might open directly or you will have to choose to open it in the identification dialog under actions.

As you can see, the airports assigned to this particular region are all shown in a table. And there are also some buttons available. Let's review them shortly

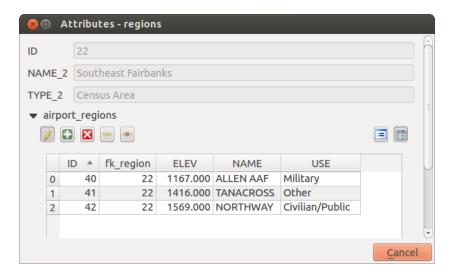


Рис. 12.65: Identification dialog regions with relation to airports

- The button is for toggling the edit mode. Be aware that it toggles the edit mode of the airport layer, although we are in the feature form of a feature from the region layer. But the table is representing features of the airport layer.
- The button will add a new feature to the airport layer. And it will assign the new airport to the current region by default.
- The button will delete the selected airport permanently.
- The "symbol will open a new dialog where you can select any existing airport which will then be assigned to the current region. This may be handy if you created the airport on the wrong region by accident.
- The symbol will unlink the selected airport from the current region, leaving them unassigned (the foreign key is set to NULL) effectively.
- The two buttons to the right switch between table view and form view where the later let's you view all the airports in their respective form.

If you work on the airport table, a new widget type is available which lets you embed the feature form of the referenced region on the feature form of the airports. It can be used when you open the layer properties of the airports table, switch to the *Fields* menu and change the widget type of the foreign key field 'fk region' to Relation Reference.

If you look at the feature dialog now, you will see, that the form of the region is embedded inside the airports form and will even have a combobox, which allows you to assign the current airport to another region.

# 12.6 Editing

QGIS supports various capabilities for editing OGR, SpatiaLite, PostGIS, MSSQL Spatial and Oracle Spatial vector layers and tables.

 $\Pi$ римітка: The procedure for editing GRASS layers is different - see section Digitizing and editing a GRASS vector layer for details.

Порада: Concurrent Edits

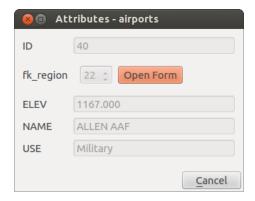


Рис. 12.66: Identification dialog airport with relation to regions

This version of QGIS does not track if somebody else is editing the same feature at the same time as you are. The last person to save its edits wins.

## 12.6.1 Setting the Snapping Tolerance and Search Radius

For an optimal and accurate edit of the vector layer geometries, we need to set an appropriate value of snapping tolerance and search radius for features vertices.

#### Snapping tolerance

Snapping tolerance is the distance QGIS uses to search for the closest vertex and/or segment you are trying to connect to when you set a new vertex or move an existing vertex. If you aren't within the snapping tolerance, QGIS will leave the vertex where you release the mouse button, instead of snapping it to an existing vertex and/or segment. The snapping tolerance setting affects all tools that work with tolerance.

- 1. A general, project-wide snapping tolerance can be defined by choosing Settings → Options..., Digitizing tab. You can select between 'To vertex', 'To segment' or 'To vertex and segment' as default snap mode. You can also define a default snapping tolerance and a search radius for vertex edits. The tolerance can be set either in map units or in pixels. The advantage of choosing pixels is that the snapping tolerance doesn't have to be changed after zoom operations. In our small digitizing project (working with the Alaska dataset), we define the snapping units in feet. Your results may vary, but something on the order of 300 ft at a scale of 1:10000 should be a reasonable setting.
- 2. A layer-based snapping tolerance that overrides the global snapping options can be defined by choosing  $Settings \rightarrow Snapping\ options$ . It enables and adjusts snapping mode and tolerance on a layer basis (see figure\_edit\_1). This dialog offers three different modes to select the layer(s) to snap to:
  - Current layer: only the active layer is used, a convenient way to ensure topology within the layer being edited
  - All layers: a quick and simple setting for all visible layers in the project so that the pointer snaps to all vertices and/or segments. In most cases it is sufficient to use this snapping mode.
  - Advanced: if you need to edit a layer and snap its vertices to another layer, ensure the target layer is checked and increase the snapping tolerance to a greater value. Furthermore, snapping will never occur to a layer that is not checked in the snapping options dialog, regardless of the global snapping tolerance. So be sure to mark the checkbox for those layers that you need to snap to.

Порада: Control the list of layers to snap

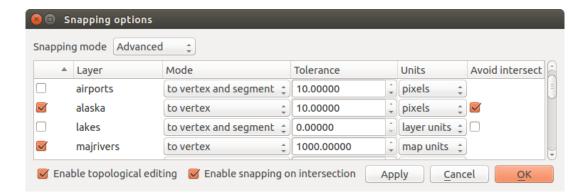


Рис. 12.67: Edit snapping options on a layer basis (Advanced mode)

The *Snapping Options* dialog is by default populated with parameters (mode, tolerance, units) set in the global *Digitizing* tab. To avoid layers being checked by default in the **Advanced** mode and hence set snappable, define the *Default Snap mode* to Off.

Snapping tolerance can be set in pixels or map units (the units of the map view). While in the **Advanced** layer selection mode, it is possible to use a snapping tolerance that refers to layer units, the units of the reprojected layer when 'on-the-fly' CRS transformation is on.

#### Search radius

Search radius is the distance QGIS uses to search for the closest vertex you are trying to select when you click on the map. If you aren't within the search radius, QGIS won't find and select any vertex for editing. Snap tolerance and search radius are set in map units or pixels, so you may find you need to experiment to get them set right. If you specify too big of a tolerance, QGIS may snap to the wrong vertex, especially if you are dealing with a large number of vertices in close proximity. Set search radius too small, and it won't find anything to move.

The search radius for vertex edits in layer units can be defined in the *Digitizing* tab under *Settings*  $\rightarrow$  *Options*. This is the same place where you define the general, project-wide snapping tolerance.

## 12.6.2 Topological editing

Besides layer-based snapping options, you can also define topological functionalities in the Snapping options... dialog in the Settings (or File) menu. Here, you can define M Enable topological editing, and/or for polygon layers, activate the M Avoid Intersections option.

#### Enable topological editing

The option Enable topological editing is for editing and maintaining common boundaries in features mosaics. QGIS 'detects' shared boundary by the features, so you only have to move a common vertex/segment once, and QGIS will take care of updating the neighboring features.

## Avoid intersections of new polygons

A second topological option called Avoid intersections prevents you to draw new features that overlap an existing one. It is for quicker digitizing of adjacent polygons. If you already have one polygon, it is possible with this option to digitize the second one such that both intersect, and QGIS then cuts the second polygon to the boundary of the existing one. The advantage is that you don't have to digitize all vertices of the common boundary.

**Примітка:** If the new geometry is totally covered by existing ones, it gets cleared and the new feature will have no geometry when allowed by the provider, otherwise saving modifications will make QGIS pop-up an error message.

#### Попередження: Use cautiously the Avoid Intersections option

Because the option cuts or clears geometry of any overlaping feature from any polygon layer, do not forget to uncheck this option once you no longer need it otherwise, you can get unexpected geometries.

### **Enable snapping on intersections**

Another option is to use  $Enable\ snapping\ on\ intersection$ . It allows you to snap on an intersection of background layers, even if there's no vertex on the intersection.

## **Geometry Checker**

A core plugin can help the user to find the geometry invalidity. You can find more information on this plugin at *Geometry Checker Plugin*.

## 12.6.3 Digitizing an existing layer

By default, QGIS loads layers read-only. This is a safeguard to avoid accidentally editing a layer if there is a slip of the mouse. However, you can choose to edit any layer as long as the data provider supports it, and the underlying data source is writable (i.e., its files are not read-only).

In general, tools for editing vector layers are divided into a digitizing and an advanced digitizing toolbar, described in section Advanced digitizing. You can select and unselect both under  $Vi-ew \rightarrow Toolbars \rightarrow$ . Using the basic digitizing tools, you can perform the following functions:

Icon	Purpose	Icon	Purpose	
	Current edits		Toggle editing	
0 0	Add Feature: Capture Point	V <sub>®</sub>	Add Feature: Capture Line	
	Add Feature: Capture Polygon		Move Feature	
[ w	Add Circular String	( ×	Add Circular String By Radius	
194	Node Tool	â	Delete Selected	
~	Cut Features		Copy Features	
	Paste Features		Save layer edits	

Table Editing: Vector layer basic editing toolbar

Note that while using any of the digitizing tools, you can still zoom or pan in the map canvas without losing the focus on the tool.

All editing sessions start by choosing the Toggle editing option found in the context menu of a given layer, from the attribute table dialog, the digitizing toolbar or the Edit menu.

Once the layer is in edit mode, additional tool buttons on the editing toolbar will become available and markers will appear at the vertices of all features unless  $Show\ markers\ only\ for\ selected\ features$  option under  $Settings \to Options... \to Digitizing\ menu$  is checked.

## Порада: Save Regularly

Remember to Save Layer Edits regularly. This will also check that your data source can accept all the changes.

### **Adding Features**

You can use the Add Feature, Add Feature or Add Feature icons on the toolbar to add new feature (point, line and polygon) into the current layer.

The next buttons Add circular string or Add circular string by radius allow users to add line or polygon features with a circular geometry.

To create features with these tools, you first digitize the geometry then enter its attributes. To digitize the geometry, left-click on the map area to create the first point of your new feature.

For linear or curved geometries, keep on left-clicking for each additional point you wish to capture or use *automatic tracing* capability to accelerate the digitization. You can switch back and forth between linear *Add feature* tool and curved *Add circular string...* tools to create compound curved geometry. Pressing Delete or Backspace key reverts the last node you add. When you have finished adding points, right-click anywhere on the map area to confirm you have finished entering the geometry of that feature.

### Примітка: Curved geometries are stored as such only in compatible data provider

Although QGIS allows to digitize curved geometries within any editable data format, you need to be using a data provider (e.g. PostGIS, GML or WFS) that supports curves to have features stored as curved, otherwise QGIS segmentizes the circular arcs. The memory layer provider also supports curves.

#### Порада: Customize the digitizing rubber band

While capturing polygon, the by-default red rubber band can hide underlying features or places you'd like to capture a point. This can be fixed by setting a lower opacity (or alpha channel) to the rubber band's  $Fill\ Color\$ in  $Settings \to Options \to Digitizing\$ menu. You can also avoid the use of the rubber band by checking  $Don't\ update\ rubber\ band\ during\ node\ editing$ .

The attribute window will appear, allowing you to enter the information for the new feature. Figure\_edit\_2 shows setting attributes for a fictitious new river in Alaska. However, in the Digitizing menu under the  $Settings \rightarrow Options$  menu, you can also activate:

- Suppress attributes pop-up windows after each created feature to avoid the form opening
- or Reuse last entered attribute values to have fields automatically filled at the opening of the form and just have to type changing values.

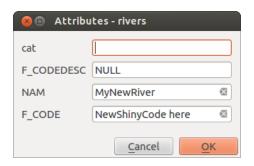


Рис. 12.68: Enter Attribute Values Dialog after digitizing a new vector feature

With the Move Feature(s) icon on the toolbar, you can move existing features.

#### Node Tool

For shapefile-based or MapInfo layers as well as SpatiaLite, PostgreSQL/PostGIS, MSSQL Spatial, and

Oracle Spatial tables, the Node Tool provides manipulation capabilities of feature vertices similar to CAD programs. It is possible to simply select multiple vertices at once and to move, add or delete them altogether. The node tool also works with 'on the fly' projection turned on and supports the topological editing feature. This tool is, unlike other tools in QGIS, persistent, so when some operation is done, selection stays active for this feature and tool.

It is important to set the property  $Settings \rightarrow \$   $Options \rightarrow Digitizing \rightarrow Search \ Radius$ : 1,00  $\diamondsuit$  to a number greater than zero. Otherwise, QGIS will not be able to tell which vertex is being edited and will display a warning.

## Порада: Vertex Markers

The current version of QGIS supports three kinds of vertex markers: 'Semi-transparent circle', 'Cross' and 'None'. To change the marker style, choose \(^{>}\) Options from the Settings menu, click on the Digitizing tab and select the appropriate entry.

#### **Basic operations**

Start by activating the Node Tool and selecting a feature by clicking on it. Red boxes will appear at each vertex of this feature.

- Selecting vertices: You can select vertices by clicking on them one at a time, by clicking on an edge to select the vertices at both ends, or by clicking and dragging a rectangle around some vertices. When a vertex is selected, its color changes to blue. To add more vertices to the current selection, hold down the Ctrl key while clicking. Hold down Ctrl when clicking to toggle the selection state of vertices (vertices that are currently unselected will be selected as usual, but also vertices that are already selected will become unselected).
- Adding vertices: To add a vertex, simply double click near an edge and a new vertex will appear on the edge near to the cursor. Note that the vertex will appear on the edge, not at the cursor position; therefore, it should be moved if necessary.
- Deleting vertices: Select the vertices and click the Delete key. Deleting all the vertices of a feature generates, if compatible with the datasource, a geometryless feature. Note that this doesn't delete the complete feature, just the geometry part; To delete a complete feature use the Delete Selected tool
- Moving vertices: Select all the vertices you want to move, click on a selected vertex or edge and drag in the direction you wish to move. All the selected vertices will move together. If snapping is enabled, the whole selection can jump to the nearest vertex or line.

Each change made with the node tool is stored as a separate entry in the *Undo* dialog. Remember that all operations support topological editing when this is turned on. On-the-fly projection is also supported, and the node tool provides tooltips to identify a vertex by hovering the pointer over it.

## Порада: Move features with precision

The Move Feature tool doesn't currently allow to snap features while moving. Using the Node Tool, select ALL the vertices of the feature, click a vertex, drag and snap it to a target vertex: the whole feature is moved and snapped to the other feature.

#### The Vertex Editor

With activating the *Node Tool* on a feature, QGIS opens the *Vertex Editor* panel listing all the vertices of the feature with their x, y (z, m if applicable) coordinates and r (for the radius, in case of circular geometry). Simply select a row in the table does select the corresponding vertex in the map canvas, and vice versa. Simply change a coordinate in the table and your vertex position is updated. You can also select multiple rows and delete them altogether.

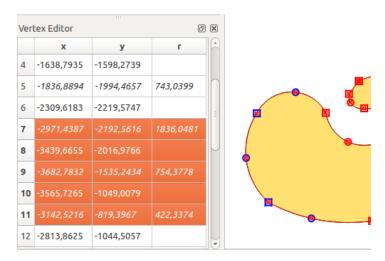


Рис. 12.69: Vertex editor panel showing selected nodes

## **Cutting, Copying and Pasting Features**

Selected features can be cut, copied and pasted between layers in the same QGIS project, as long as destination layers are set to Toggle editing beforehand.

## Порада: Transform polygon into line and vice-versa using copy/paste

Copy a line feature and paste it in a polygon layer: QGIS pastes in the target layer a polygon whose boundary corresponds to the closed geometry of the line feature. This is a quick way to generate different geometries of the same data.

Features can also be pasted to external applications as text. That is, the features are represented in CSV format, with the geometry data appearing in the OGC Well-Known Text (WKT) format. WKT features from outside QGIS can also be pasted to a layer within QGIS.

When would the copy and paste function come in handy? Well, it turns out that you can edit more than one layer at a time and copy/paste features between layers. Why would we want to do this? Say we need to do some work on a new layer but only need one or two lakes, not the 5,000 on our big\_lakes layer. We can create a new layer and use copy/paste to plop the needed lakes into it.

As an example, we will copy some lakes to a new layer:

- 1. Load the layer you want to copy from (source layer)
- 2. Load or create the layer you want to copy to (target layer)
- 3. Start editing for target layer
- 4. Make the source layer active by clicking on it in the legend
- 5. Use the Select Features by area or single click tool to select the feature(s) on the source layer
- 6. Click on the Copy Features tool

- 7. Make the destination layer active by clicking on it in the legend
- 8. Click on the Paste Features tool
- 9. Stop editing and save the changes

What happens if the source and target layers have different schemas (field names and types are not the same)? QGIS populates what matches and ignores the rest. If you don't care about the attributes being copied to the target layer, it doesn't matter how you design the fields and data types. If you want to make sure everything - the feature and its attributes - gets copied, make sure the schemas match.

### Примітка: Congruency of Pasted Features

If your source and destination layers use the same projection, then the pasted features will have geometry identical to the source layer. However, if the destination layer is a different projection, then QGIS cannot guarantee the geometry is identical. This is simply because there are small rounding-off errors involved when converting between projections.

## Порада: Copy string attribute into another

If you have created a new column in your attribute table with type 'string' and want to paste values from another attribute column that has a greater length the length of the column size will be extended to the same amount. This is because the GDAL Shapefile driver starting with GDAL/OGR 1.10 knows to auto-extend string and integer fields to dynamically accommodate for the length of the data to be inserted.

### **Deleting Selected Features**

If we want to delete an entire feature (attribute and geometry), we can do that by first selecting the geometry using the regular Select Features by area or single click tool. Selection can also be done from the attribute table. Once you have the selection set, press Delete or Backspace key or use the Delete Selected tool to delete the features. Multiple selected features can be deleted at once.

The Cut Features tool on the digitizing toolbar can also be used to delete features. This effectively deletes the feature but also places it on a "spatial clipboard". So, we cut the feature to delete. We could then use the Paste Features tool to put it back, giving us a one-level undo capability. Cut, copy, and paste work on the currently selected features, meaning we can operate on more than one at a time.

#### Saving Edited Layers

When a layer is in editing mode, any changes remain in the memory of QGIS. Therefore, they are not committed/saved immediately to the data source or disk. If you want to save edits to the current layer but want to continue editing without leaving the editing mode, you can click the Save Layer Edits button. When you turn editing mode off with Toggle editing (or quit QGIS for that matter), you are also asked if you want to save your changes or discard them.

If the changes cannot be saved (e.g., disk full, or the attributes have values that are out of range), the QGIS in-memory state is preserved. This allows you to adjust your edits and try again.

#### Порада: Data Integrity

It is always a good idea to back up your data source before you start editing. While the authors of QGIS have made every effort to preserve the integrity of your data, we offer no warranty in this regard.

#### Saving multiple layers at once

This feature allows the digitization of multiple layers. Choose Save for Selected Layers to save all changes you made in multiple layers. You also have the opportunity to Rollback for Selected Layers, so that the digitization may be withdrawn for all selected layers. If you want to stop editing the selected layers, Cancel for Selected Layer(s) is an easy way.

The same functions are available for editing all layers of the project.

## 12.6.4 Advanced digitizing

Icon	Purpose	Icon	Purpose
	Enable Advanced Digitizing Tools	ಏ	Enable Tracing
4	Undo		Redo
	Rotate Feature(s)	<b>A</b>	Simplify Feature
	Add Ring		Add Part
•	Fill Ring	×	Delete Ring
	Delete Part	<i>&gt;</i>	Reshape Features
	Offset Curve		Split Features
	Split Parts	(F)	Merge Selected Features
<b>*</b>	Merge Attributes of Selected Features	<b>(</b>	Rotate Point Symbols

Table Advanced Editing: Vector layer advanced editing toolbar

## **Undo and Redo**

The Undo and Redo tools allows you to undo or redo vector editing operations. There is also a dockable widget, which shows all operations in the undo/redo history (see Figure\_edit\_4). This widget is not displayed by default; it can be displayed by right clicking on the toolbar and activating the Undo/Redo checkbox. Undo/Redo is however active, even if the widget is not displayed.

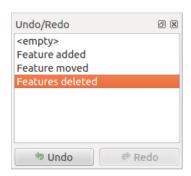


Рис. 12.70: Redo and Undo digitizing steps

When Undo is hit or Ctrl+z (or Cmd+z) pressed, the state of all features and attributes are reverted to the state before the reverted operation happened. Changes other than normal vector editing operations (for example, changes done by a plugin) may or may not be reverted, depending on how the changes were performed.

To use the undo/redo history widget, simply click to select an operation in the history list. All features will be reverted to the state they were in after the selected operation.

## Rotate Feature(s)

Use Rotate Feature(s) to rotate one or multiple features in the map canvas. Press the Rotate Feature(s) icon and then click on the feature to rotate. Either click on the map to place the rotated feature or enter an angle in the user input widget. If you want to rotate several features, they shall be selected first.

If you enable the map tool with feature(s) selected, its (their) centroid appears and will be the rotation anchor point. If you want to move the anchor point, hold the Ctrl button and click on the map to place it

If you hold Shift before clicking on the map, the rotation will be done in 45 degree steps, which can be modified afterwards in the user input widget.

To abort feature rotation, you need to click on Rotate Feature(s) icon.

### Simplify Feature

The Simplify Feature tool allows you to reduce the number of vertices of a feature, as long as the geometry remains valid. With the tool you can also simplify many features at once or multi-part features.

First, click on the feature or drag a rectangle over the features. A dialog where you can define a tolerance in map units, layer units or pixels pops up and a colored and simplified copy of the feature(s), using the given tolerance, appears over them. QGIS calculates the amount of vertices that can be deleted while maintaining the geometry. The higher the tolerance is the more vertices can be deleted. When the expected geometry fits your needs just click the [OK] button. The tolerance you used will be saved when leaving a project or when leaving an edit session. So you can go back to the same tolerance the next time when simplifying a feature.

To abort feature simplification, you need to click on



**Примітка:** unlike the feature simplification option in  $Settings \to Options \to Rendering$  menu which simplifies the geometry just for rendering, the Simplify Feature tool really modifies feature's geometry in data source.

## Add Part

You can Add Part to a selected feature generating a multipoint, multiline or multipolygon feature. The new part must be digitized outside the existing one which should be selected beforehand.

The Add Part can also be used to add a geometry to a geometryless feature. First, select the feature in the attribute table and digitize the new geometry with the Add Part tool.

## Delete Part

The Delete Part tool allows you to delete parts from multifeatures (e.g., to delete polygons from a multi-polygon feature). This tool works with all multi-part geometries: point, line and polygon. Furthermore, it can be used to totally remove the geometric component of a feature. To delete a part, simply click within the target part.

### Add Ring

You can create ring polygons using the Add Ring icon in the toolbar. This means that inside an existing area, it is possible to digitize further polygons that will occur as a 'hole', so only the area between the boundaries of the outer and inner polygons remains as a ring polygon.

#### Fill Ring

You can use the Fill Ring function to add a ring to a polygon and add a new feature to the layer at the same time. Using this tool, you simply have to digitize a polygon within an existing one. Thus you need not first use the

## **Delete Ring**

The Delete Ring tool allows you to delete rings within an existing polygon, by clicking inside the hole. This tool only works with polygon and multi-polygon features. It doesn't change anything when it is used on the outer ring of the polygon.

#### Reshape Features

You can reshape line and polygon features using the Reshape Features icon on the toolbar. It replaces the line or polygon part from the first to the last intersection with the original line. With polygons, this can sometimes lead to unintended results. It is mainly useful to replace smaller parts of a polygon, not for major overhauls, and the reshape line is not allowed to cross several polygon rings, as this would generate an invalid polygon.

For example, you can edit the boundary of a polygon with this tool. First, click in the inner area of the polygon next to the point where you want to add a new vertex. Then, cross the boundary and add the vertices outside the polygon. To finish, right-click in the inner area of the polygon. The tool will automatically add a node where the new line crosses the border. It is also possible to remove part of the area from the polygon, starting the new line outside the polygon, adding vertices inside, and ending the line outside the polygon with a right click.

**Примітка:** The reshape tool may alter the starting position of a polygon ring or a closed line. So, the point that is represented 'twice' will not be the same any more. This may not be a problem for most applications, but it is something to consider.

## Offset Curves

The Offset Curve tool creates parallel shifts of line layers. The tool can be applied to the edited layer (the geometries are modified) or also to background layers (in which case it creates copies of the lines / rings and adds them to the edited layer). It is thus ideally suited for the creation of distance line layers. The *User Input* dialog pops-up, showing the displacement distance.

To create a shift of a line layer, you must first go into editing mode and activate the Offset Curve tool. Then click on a feature to shift it. Move the mouse and click where wanted or enter the desired distance in the user input widget. Your changes may then be saved with the Save Layer Edits tool.

QGIS options dialog (Digitizing tab then **Curve offset tools** section) allows you to configure some parameters like **Join style**, **Quadrant segments**, **Miter limit**.

#### **Split Features**

You can split features using the Split Features icon on the toolbar. Just draw a line across the feature you want to split.

#### Split parts

In QGIS it is possible to split the parts of a multi part feature so that the number of parts is increased. Just draw a line across the part you want to split using the Split Parts icon.

### Merge selected features

The Merge Selected Features tool allows you to merge features. A new dialog will allow you to choose which value to choose between each selected features or select a function (Minimum, Maximum, Median, Sum, Skip Attribute) to use for each column. If features don't have a common boundaries, a multipolygon will be created.

#### Merge attributes of selected features

The Merge Attributes of Selected Features tool allows you to apply same attributes to features without merging their boundaries. First, select several features. Then press the Merge Attributes of Selected Features button. Now QGIS asks you which attributes are to be applied to all selected objects. As a result, all selected objects have the same attribute entries.

## **Rotate Point Symbols**

Rotate Point Symbols allows you to change the rotation of point symbols in the map canvas. You must first define a rotation column from the attribute table of the point layer in the Advanced menu of the Style menu of the Layer Properties. Also, you will need to go into the 'SVG marker' and choose Data defined properties .... Activate Angle and choose 'rotation' as field. Without these settings, the tool is inactive.

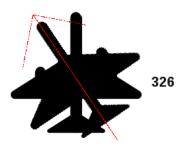


Рис. 12.71: Rotate Point Symbols

To change the rotation, select a point feature in the map canvas and rotate it, holding the left mouse button pressed. A red arrow with the rotation value will be visualized (see Figure\_edit\_5). When you release the left mouse button again, the value will be updated in the attribute table.

Примітка: If you hold the Ctrl key pressed, the rotation will be done in 15 degree steps.

## **Automatic Tracing**

Usually, when using capturing map tools (add feature, add part, add ring, reshape and split), you need to click each vertex of the feature.

Using the automatic tracing mode you can speed up the digitization process. Enable the pushing the icon or pressing t key and snap to a vertex or segment of a feature you want to trace along. Move the mouse over another vertex or segment you'd like to snap and instead of an usual straight line, the digitizing rubber band represents a path from the last point you snapped to the current position. QGIS actually uses the underlying features topology to build the shortest path between the two points. Click and QGIS places the intermediate vertices following the path. You no longer need to manually place all the vertices during digitization.

Tracing requires snapping to be activated in traceable layers to build the path. You should also snap to an existing vertex or segment while digitizing and ensure that the two nodes are topologically connectable following existing features, otherwise QGIS is unable to connect them and thus traces a single straight line.

### Примітка: Adjust map scale or snapping settings for an optimal tracing

If there are too many features in map display, tracing is disabled to avoid potentially long tracing structure preparation and large memory overhead. After zooming in or disabling some layers the tracing is enabled again.

### Порада: Quickly enable or disable automatic tracing by pressing t key

By pressing t key, tracing can be enabled/disabled anytime even while digitizing one feature, so it is possible to digitize some parts of the feature with tracing enabled and other parts with tracing disabled. Tools behave as usual when tracing is disabled.

## 12.6.5 The Advanced Digitizing panel

When capturing new geometries or geometry parts you also have the possibility to use the Advanced Digitizing panel. You can digitize lines exactly parallel or at a specific angle or lock lines to specific angles. Furthermore you can enter coordinates directly so that you can make a precise definition for your new geometry.



Рис. 12.72: The Advanced Digitizing panel

Примітка: The tools are not enabled if the map view is in geographic coordinates.

## 12.6.6 Creating new Vector layers

QGIS allows you to create new shapefile layers, new SpatiaLite layers, new GPX layers and New Temporary Scratch Layers. Creation of a new GRASS layer is supported within the GRASS plugin. Please refer to section *Creating a new GRASS vector layer* for more information on creating GRASS vector layers.

### Creating a new Shapefile layer

To create a new shape layer for editing, choose  $New \to V \otimes New$  Shapefile Layer... from the Layer menu. The New Vector Layer dialog will be displayed as shown in Figure\_edit\_6. Choose the type of layer (point, line or polygon) and the CRS (coordinate reference system).

Note that QGIS does not yet support creation of 2.5D features (i.e., features with X,Y,Z coordinates).

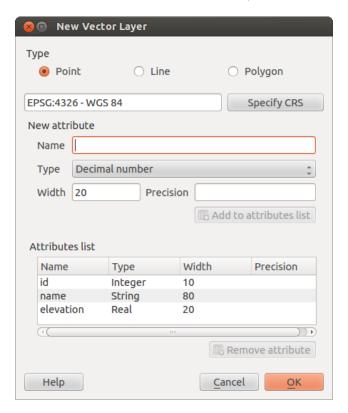


Рис. 12.73: Creating a new Shapefile layer Dialog

To complete the creation of the new shapefile layer, add the desired attributes by clicking on the [Add to attributes list] button and specifying a name and type for the attribute. A first 'id' column is added as default but can be removed, if not wanted. Only Type: real , Type: integer , Type: string and Type:date attributes are supported. Additionally and according to the attribute type, you can also define the width and precision of the new attribute column. Once you are happy with the attributes, click [OK] and provide a name for the shapefile. QGIS will automatically add a .shp extension to the name you specify. Once the layer has been created, it will be added to the map, and you can edit it in the same way as described in section Digitizing an existing layer above.

### Creating a new SpatiaLite layer

To create a new SpatiaLite layer for editing, choose  $New \rightarrow \square$  New SpatiaLite Layer... from the Layer menu. The New SpatiaLite Layer dialog will be displayed as shown in Figure\_edit\_7.

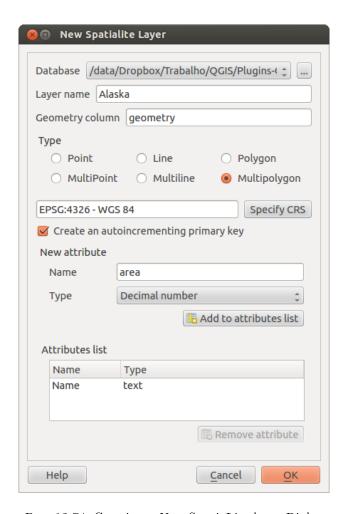


Рис. 12.74: Creating a New SpatiaLite layer Dialog

The first step is to select an existing SpatiaLite database or to create a new SpatiaLite database. This can be done with the browse button to the right of the database field. Then, add a name for the new layer, define the layer type, and specify the coordinate reference system with [Specify CRS]. If desired, you can select Create an autoincrementing primary key.

To define an attribute table for the new SpatiaLite layer, add the names of the attribute columns you want to create with the corresponding column type, and click on the [Add to attribute list] button. Once you are happy with the attributes, click [OK]. QGIS will automatically add the new layer to the legend, and you can edit it in the same way as described in section *Digitizing an existing layer* above.

Further management of SpatiaLite layers can be done with the DB Manager. See DB Manager Plugin.

#### Creating a new GPX layer

To create a new GPX file, you need to load the GPS plugin first.  $Plugins \rightarrow \ \ \ \ \ \ \ \ \$  Plugin Manager... opens the Plugin Manager Dialog. Activate the  $\ \ \ \ \ \ \ \ \ \ \ \$  GPS Tools checkbox.

When this plugin is loaded, choose  $New \to \mathbb{C}$  Create new GPX Layer... from the Layer menu. In the Save new GPX file as dialog, you can choose where to save the new GPX layer.

### Creating a new Temporary Scratch Layer

Empty, editable memory layers can be defined using  $Layer \rightarrow Create\ Layer \rightarrow New\ Temporary\ Scratch\ Layer$ . Here you can even create Multipoint, Multiline and  $Multipolygon\ Layers$  beneath Point, Line and  $Polygon\ Layers$ . Temporary Scratch Layers are not saved and will be discarded when QGIS is closed. See also  $Paste\ into\ new\ layer$ .

# 12.7 Virtual layers

A special kind of vector layer allows you to define a layer as the result of an advanced query, using the SQL language on any number of other vector layers that QGIS is able to open. These layers are called virtual layers: they do not carry data by themselves and can be seen as views to other layers.

## 12.7.1 Creating a virtual layer

Open the virtual layer creation dialog by clicking on Add Virtual Layer in the Layer menu or from the corresponding toolbar.

The dialog allows you to specify an SQL query. The query can use the name (or id) of existing vector layers as well as field names of these layers.

For example, if you have a layer called regions, you can create a new virtual layer with an SQL query like SELECT \* FROM regions WHERE id < 100. The SQL query will be executed, whatever the underlying provider of the regions layer is and even if this provider does not directly support SQL queries.

Joins and complex queries can also be created simply by directly using the names of the layers that are to be joined.

#### 12.7.2 Supported language

The underlying engine uses SQLite and Spatialite to operate.

It means you can use all of the SQL your local installation of SQLite understands.

Functions from SQLite and spatial functions from Spatialite can also be used in a virtual layer query. For instance, creating a point layer out of a attribute-only layer can be done with a query similar to: SELECT id, MakePoint(x, y, 4326) as geometry FROM coordinates

Functions of QGIS expressions can also be used in a virtual layer query.

To refer the geometry column of a layer, use the name geometry.

Contrary to a pure SQL query, all the fields of a virtual layer query must be named. Don't forget to use the as keyword to name your columns if they are the result of a computation or function call.

## 12.7.3 Performance issues

With default parameters set, the virtual layer engine will try its best to detect the type of the different columns of the query, including the type of the geometry column if one is present.

This is done by introspecting the query when possible or by fetching the first row of the query (LIMIT 1) at last resort. Fetching the first row of the result just to create the layer may be undesirable for performance reasons.

The creation dialog allows to specify different parameters:

- unique identifier column: this option allows to specify which field of the query represents unique integer values that QGIS can use as row identifiers. By default, an autoincrementing integer value is used. Specifying a unique identifier column allows to speed up selection of rows by id.
- no **geometry**: this option forces the virtual layer to ignore any geometry field. The resulting layer is an attribute-only layer.
- **geometry column**: this option allows to specify the name of the column that is to be used as the geometry of the layer.
- **geometry type**: this option allows to specify the type of the geometry of the virtual layer.
- geometry CRS: this option allows to specify the coordinate reference system of the virtual layer.

# 12.7.4 Special comments

The virtual layer engine tries to determine the type of each column of the query. If it fails, the first row of the query is fetched to determine column types.

The type of a particular column can be specified directly in the query by using some special comments.

The syntax is the following: /\*:type\*/. It has to be placed just after the name of a column. type can be either int for integers, real for floating point numbers or text.

For instance: SELECT id+1 as nid /\*:int\*/ FROM table

The type and coordinate reference system of the geometry column can also be set thanks to special comments with the following syntax /\*:gtype:srid\*/ where gtype is the geometry type (point, linestring, polygon, multipoint, multilinestring or multipolygon) and srid an integer representing the EPSG code of a coordinate reference system.

# 12.7.5 Use of indexes

When requesting a layer through a virtual layer, indexes of this source layer will be used in the following ways:

- if an = predicate is used on the primary key column of the layer, the underlying data provider will be asked for a particular id (FilterFid)
- for any other predicates (>, <=, !=, etc.) or on a column without primary key, a request built from an expression will be used to request the underlying vector data provider. It means indexes may be used on database providers if they exist.

12.7. Virtual layers

A specific syntax exists to handle spatial predicates in requests and trigger the use of a spatial index: a hidden column named \_search\_frame\_ exists for each virtual layer. This column can be compared for equality to a bounding box. Example: select \* from vtab where \_search\_frame\_=BuildMbr(-2.10,49.38,-1.3,49.99,4326)

Spatial binary predicates like  $ST_Intersects$  are greatly sped up when used in conjunction with this spatial index syntax.

# Working with Raster Data

# 13.1 Working with Raster Data

This section describes how to visualize and set raster layer properties. QGIS uses the GDAL library to read and write raster data formats, including ArcInfo Binary Grid, ArcInfo ASCII Grid, GeoTIFF, ERDAS IMAGINE, and many more. GRASS raster support is supplied by a native QGIS data provider plugin. The raster data can also be loaded in read mode from zip and gzip archives into QGIS.

As of the date of this document, more than 100 raster formats are supported by the GDAL library (see GDAL-SOFTWARE-SUITE in *Literature and Web References*). A complete list is available at http://www.gdal.org/formats list.html.

Примітка: Not all of the listed formats may work in QGIS for various reasons. For example, some require external commercial libraries, or the GDAL installation of your OS may not have been built to support the format you want to use. Only those formats that have been well tested will appear in the list of file types when loading a raster into QGIS. Other untested formats can be loaded by selecting the [GDAL] All files (\*) filter.

Working with GRASS raster data is described in section GRASS GIS Integration.

## 13.1.1 What is raster data?

Raster data in GIS are matrices of discrete cells that represent features on, above or below the earth's surface. Each cell in the raster grid is the same size, and cells are usually rectangular (in QGIS they will always be rectangular). Typical raster datasets include remote sensing data, such as aerial photography, or satellite imagery and modelled data, such as an elevation matrix.

Unlike vector data, raster data typically do not have an associated database record for each cell. They are geocoded by pixel resolution and the x/y coordinate of a corner pixel of the raster layer. This allows QGIS to position the data correctly in the map canvas.

QGIS makes use of georeference information inside the raster layer (e.g., GeoTiff) or in an appropriate world file to properly display the data.

# 13.1.2 Loading raster data in QGIS

Raster layers are loaded either by clicking on the  $^{\text{Add Raster Layer}}$  icon or by selecting the  $Layer \rightarrow Add$  Raster Layer menu option. More than one layer can be loaded at the same time by holding down the Ctrl or Shift key and clicking on multiple items in the  $Open\ a\ GDAL\ Supported\ Raster\ Data\ Source\ dialog.$ 

Once a raster layer is loaded in the map legend, you can click on the layer name with the right mouse button to select and activate layer-specific features or to open a dialog to set raster properties for the layer.

## Right mouse button menu for raster layers

- Zoom to Layer Extent
- Zoom to Best Scale (100%)
- Stretch Using Current Extend
- Show in Overview
- Remove
- Duplicate
- Set Layer CRS
- Set Project CRS from Layer
- Save as ...
- Properties
- Rename
- Copy Style
- Add New Group
- Expand all
- Collapse all
- Update Drawing Order

# 13.2 Raster Properties Dialog

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 (see figure raster 1).

There are several menus in the dialog:

- General
- Style
- Transparency
- Pyramids
- $\bullet$  Histogram
- $\bullet$  Metadata

# 13.2.1 General Menu

#### Layer Info

The *General* menu displays basic information about the selected raster, including the layer source path, the display name in the legend (which can be modified), and the number of columns, rows and no-data values of the raster.

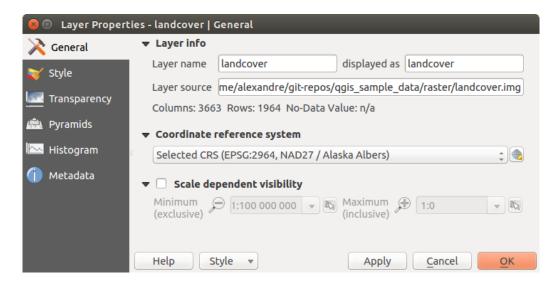


Рис. 13.1: Raster Layers Properties Dialog

#### Coordinate reference system

Here, you find the coordinate reference system (CRS) information printed as a PROJ.4 string. If this setting is not correct, it can be modified by clicking the [Specify] button.

#### Scale Dependent visibility

Additionally scale-dependent visibility can be set in this tab. You will need to check the checkbox and set an appropriate scale where your data will be displayed in the map canvas.

At the bottom, you can see a thumbnail of the layer, its legend symbol, and the palette.

# 13.2.2 Style Menu

## **Band rendering**

QGIS offers four different Render types. The renderer chosen is dependent on the data type.

- 1. Multiband color if the file comes as a multiband with several bands (e.g., used with a satellite image with several bands)
- 2. Paletted if a single band file comes with an indexed palette (e.g., used with a digital topographic map)
- 3. Singleband gray (one band of) the image will be rendered as gray; QGIS will choose this renderer if the file has neither multibands nor an indexed palette nor a continuous palette (e.g., used with a shaded relief map)
- 4. Singleband pseudocolor this renderer is possible for files with a continuous palette, or color map (e.g., used with an elevation map)

#### Multiband color

With the multiband color renderer, three selected bands from the image will be rendered, each band representing the red, green or blue component that will be used to create a color image. You can choose several *Contrast enhancement* methods: 'No enhancement', 'Stretch to MinMax', 'Stretch and clip to MinMax' and 'Clip to min max'.

This selection offers you a wide range of options to modify the appearance of your raster layer. First of all, you have to get the data range from your image. This can be done by choosing the *Extent* and

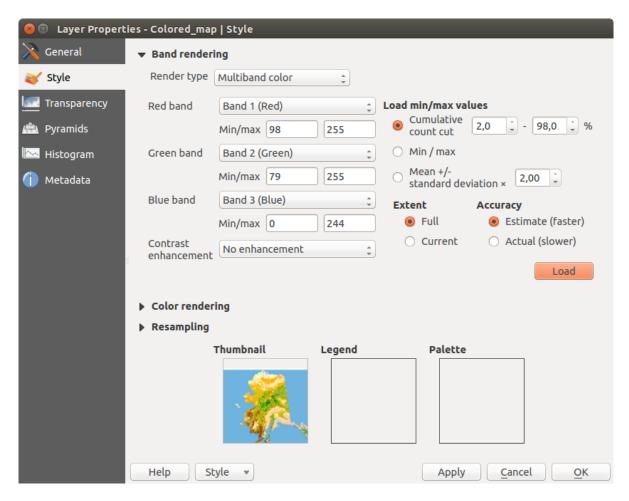


Рис. 13.2: Raster Renderer - Multiband color

pressing [Load]. QGIS can Estimate (faster) the Min and Max values of the bands or use the Actual (slower) Accuracy.

All calculations can also be made for the *Current* extent.

### Порада: Viewing a Single Band of a Multiband Raster

If you want to view a single band of a multiband image (for example, Red), you might think you would set the Green and Blue bands to "Not Set". But this is not the correct way. To display the Red band, set the image type to 'Singleband gray', then select Red as the band to use for Gray.

#### Paletted

This is the standard render option for singleband files that already include a color table, where each pixel value is assigned to a certain color. In that case, the palette is rendered automatically. If you want to change colors assigned to certain values, just double-click on the color and the *Select color* dialog appears. Also, in QGIS it's possible to assign a label to the color values. The label appears in the legend of the raster layer then.

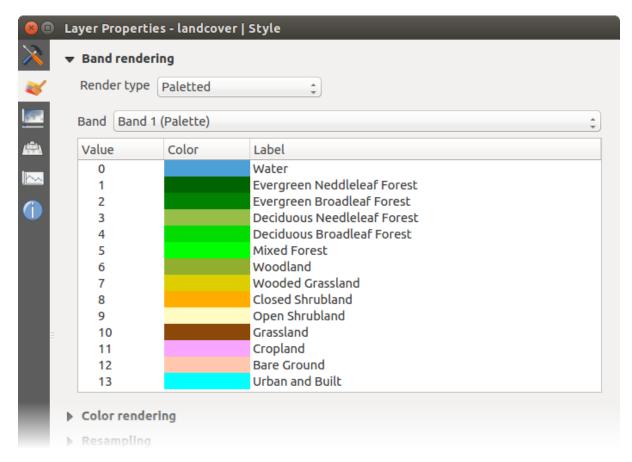


Рис. 13.3: Raster Renderer - Paletted

## Contrast enhancement

**Примітка:** When adding GRASS rasters, the option *Contrast enhancement* will always be set automatically to *stretch to min max*, regardless of if this is set to another value in the QGIS general options.

## Singleband gray

This renderer allows you to render a single band layer with a *Color gradient*: 'Black to white' or 'White to black'. You can define a *Min* and a *Max* value by choosing the *Extent* first and then pressing [Load]. QGIS can Estimate (faster) the *Min* and *Max* values of the bands or use the Actual (slower) Accuracy.

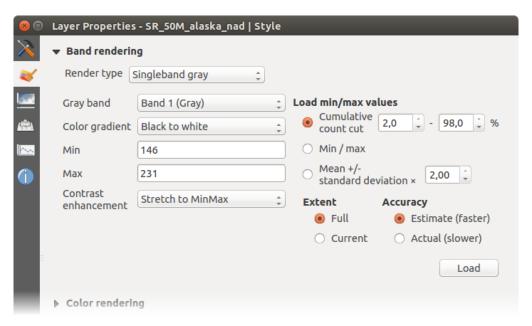


Рис. 13.4: Raster Renderer - Singleband gray

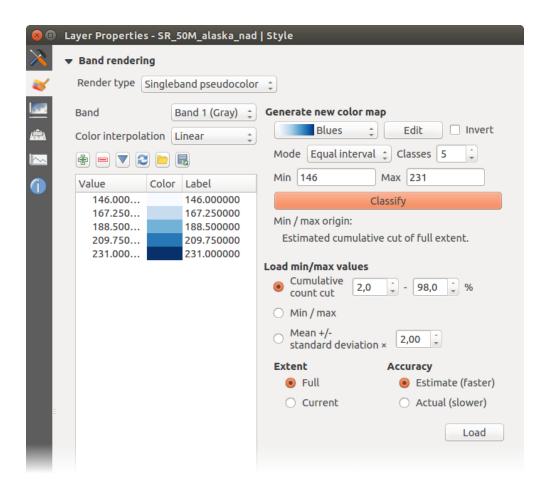
With the Load min/max values section, scaling of the color table is possible. Outliers can be eliminated using the Cumulative count cut setting. The standard data range is set from 2% to 98% of the data values and can be adapted manually. With this setting, the gray character of the image can disappear. Further settings can be made with Min/max and Mean +/- standard deviation x while the first one creates a color table with all of the data included in the original image, the second creates a color table that only considers values within the standard deviation or within multiple standard deviations. This is useful when you have one or two cells with abnormally high values in a raster grid that are having a negative impact on the rendering of the raster.

## Singleband pseudocolor

This is a render option for single-band files, including a continuous palette. You can also create individual color maps for the single bands here. 
Three types of color interpolation are available:

- 1. Discrete
- 2. Linear
- 3. Exact

In the left block, the button Add values manually adds a value to the individual color table. The button Remove selected row deletes a value from the individual color table, and the Sort colormap items button sorts the color table according to the pixel values in the value column. Double clicking on the value column lets you insert a specific value. Double clicking on the color column opens the dialog *Change color*, where you can select a color to apply on that value. Further, you can also add labels for each color, but this value won't be displayed when you use the identify feature tool. You can also click on the



 $\mbox{\sc Puc.}\ 13.5\mbox{:}\ \mbox{Raster Renderer}$  - Singleband pseudocolor

button Load color map from band, which tries to load the table from the band (if it has any). And you can use the buttons Load color map from file or Export color map to file to load an existing color table or to save the defined color table for other sessions.

In the right block, Generate new color map allows you to create newly categorized color maps. For the Classification mode 'Equal interval', you only need to select the number of classes 1.00 and press the button Classify. You can invert the colors of the color map by clicking the Invert checkbox. In the case of the Mode 'Continous', QGIS creates classes automatically depending on the Min and Max. Defining Min/Max values can be done with the help of the Load min/max values section. A lot of images have a few very low and high data. These outliers can be eliminated using the Cumulative count cut setting. The standard data range is set from 2% to 98% of the data values and can be adapted manually. With this setting, the gray character of the image can disappear. With the scaling option Min/max, QGIS creates a color table with all of the data included in the original image (e.g., QGIS creates a color table with 256 values, given the fact that you have 8 bit bands). You can also calculate your color table using the Mean +/- standard deviation x 1.00 and 1.00 the values within the standard deviation or within multiple standard deviations are considered for the color table.

# Color rendering

For every Band rendering, a Color rendering is possible.

You can also achieve special rendering effects for your raster file(s) using one of the blending modes (see *The Vector Properties Dialog*).

Further settings can be made in modifying the *Brightness*, the *Saturation* and the *Contrast*. You can also use a *Grayscale* option, where you can choose between 'By lightness', 'By luminosity' and 'By average'. For one hue in the color table, you can modify the 'Strength'.

# Resampling

The *Resampling* option makes its appearance when you zoom in and out of an image. Resampling modes can optimize the appearance of the map. They calculate a new gray value matrix through a geometric transformation.



Рис. 13.6: Raster Rendering - Resampling

When applying the 'Nearest neighbour' method, the map can have a pixelated structure when zooming in. This appearance can be improved by using the 'Bilinear' or 'Cubic' method, which cause sharp features to be blurred. The effect is a smoother image. This method can be applied, for instance, to digital topographic raster maps.

# 13.2.3 Transparency Menu

QGIS has the ability to display each raster layer at a different transparency level. Use the transparency slider to indicate to what extent the underlying layers (if any) should be visible though the current raster layer. This is very useful if you like to overlay more than one raster layer (e.g., a shaded relief map overlayed by a classified raster map). This will make the look of the map more three dimensional.

Additionally, you can enter a raster value that should be treated as NODATA in the  $Additional\ no\ data\ value\ menu.$ 

An even more flexible way to customize the transparency can be done in the *Custom transparency options* section. The transparency of every pixel can be set here.

As an example, we want to set the water of our example raster file landcover.tif to a transparency of 20%. The following steps are necessary:

- 1. Load the raster file landcover.tif.
- 2. Open the *Properties* dialog by double-clicking on the raster name in the legend, or by right-clicking and choosing *Properties* from the pop-up menu.
- 3. Select the *Transparency* menu.
- 4. From the Transparency band menu, choose 'None'.
- 5. Click the Add values manually button. A new row will appear in the pixel list.
- 6. Enter the raster value in the 'From' and 'To' column (we use 0 here), and adjust the transparency to 20%.
- 7. Press the [Apply] button and have a look at the map.

You can repeat steps 5 and 6 to adjust more values with custom transparency.

As you can see, it is quite easy to set custom transparency, but it can be quite a lot of work. Therefore, you can use the button Export to file to save your transparency list to a file. The button Import from file loads your transparency settings and applies them to the current raster layer.

# 13.2.4 Pyramids Menu

Large resolution raster layers can slow navigation in QGIS. By creating lower resolution copies of the data (pyramids), performance can be considerably improved, as QGIS selects the most suitable resolution to use depending on the level of zoom.

You must have write access in the directory where the original data is stored to build pyramids.

Several resampling methods can be used to calculate the pyramids:

- Nearest Neighbour
- Average
- Gauss
- Cubic
- Mode
- None

If you choose 'Internal (if possible)' from the *Overview format* menu, QGIS tries to build pyramids internally. You can also choose 'External' and 'External (Erdas Imagine)'.

Please note that building pyramids may alter the original data file, and once created they cannot be removed. If you wish to preserve a 'non-pyramided' version of your raster, make a backup copy prior to building pyramids.

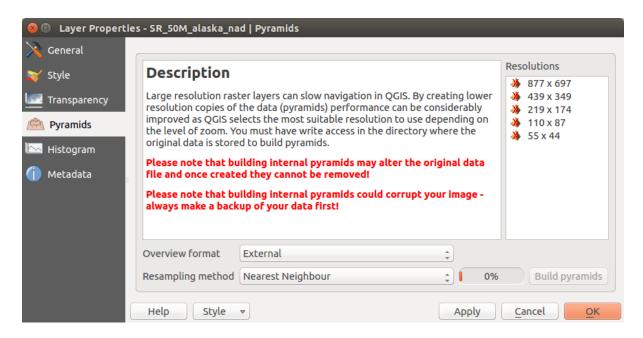


Рис. 13.7: The Pyramids Menu

# 13.2.5 Histogram Menu

The *Histogram* menu allows you to view the distribution of the bands or colors in your raster. The histogram is generated automatically when you open the *Histogram* menu. All existing bands will be displayed together. You can save the histogram as an image with the button. With the *Visibility* option in the *Prefs/Actions* menu, you can display histograms of the individual bands. You will need to select the option *Show selected band*. The *Min/max options* allow you to 'Always show min/max markers', to 'Zoom to min/max' and to 'Update style to min/max'. With the *Actions* option, you can 'Reset' and 'Recompute histogram' after you have chosen the *Min/max options*.

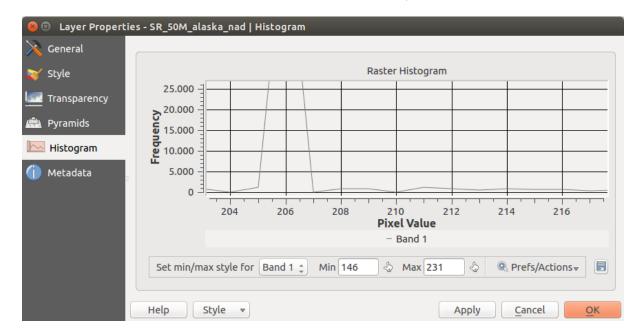


Рис. 13.8: Raster Histogram

#### 13.2.6 Metadata Menu

The *Metadata* menu displays a wealth of information about the raster layer, including statistics about each band in the current raster layer. From this menu, entries may be made for the *Description*, *Attribution*, *MetadataUrl* and *Properties*. In *Properties*, statistics are gathered on a 'need to know' basis, so it may well be that a given layer's statistics have not yet been collected.

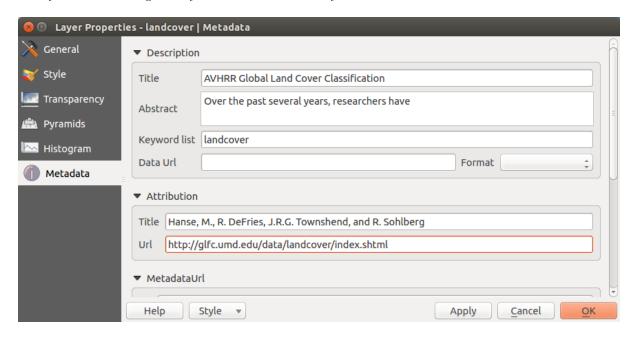


Рис. 13.9: Raster Metadata

# 13.3 Raster Analysis

# 13.3.1 Raster Calculator

The Raster Calculator in the Raster menu allows you to perform calculations on the basis of existing raster pixel values (see figure\_raster\_10). The results are written to a new raster layer with a GDAL-supported format.

The **Raster bands** list contains all loaded raster layers that can be used. To add a raster to the raster calculator expression field, double click its name in the Fields list. You can then use the operators to construct calculation expressions, or you can just type them into the box.

In the **Result layer** section, you will need to define an output layer. You can then define 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. If the input layer has a different resolution, the values will be resampled with the nearest neighbor algorithm.

The **Operators** section contains all available operators. To add an operator to the raster calculator expression box, click the appropriate button. Mathematical calculations (+, -, \*, ...) and trigonometric functions (sin, cos, tan, ...) are available. Stay tuned for more operators to come!

With the Add result to project checkbox, the result layer will automatically be added to the legend area and can be visualized.

## **Examples**

Convert elevation values from meters to feet

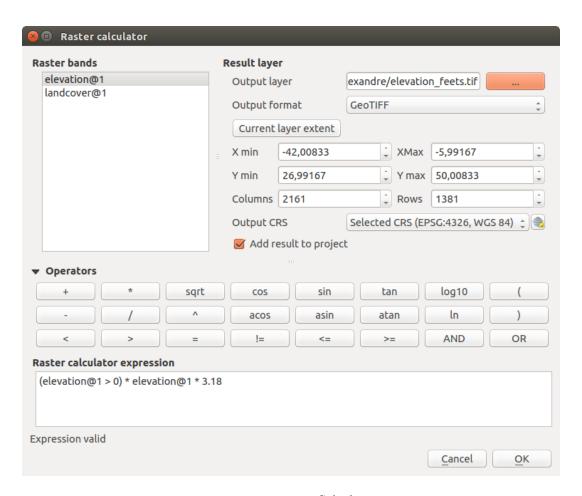


Рис. 13.10: Raster Calculator

Creating an elevation raster in feet from a raster in meters, you need to use the conversion factor for meters to feet: 3.28. The expression is:

```
"elevation@1" * 3.28
```

#### Using a mask

If you want to mask out parts of a raster - say, for instance, because you are only interested in elevations above 0 meters - you can use the following expression to create a mask and apply the result to a raster in one step.

```
("elevation@1" >= 0) * "elevation@1"
```

In other words, for every cell greater than or equal to 0, set its value to 1. Otherwise set it to 0. This creates the mask on the fly.

If you want to classify a raster - say, for instance into two elevation classes, you can use the following expression to create a raster with two values 1 and 2 in one step.

```
("elevation@1" < 50) * 1 + ("elevation@1" >= 50) * 2
```

In other words, for every cell less than 50 set its value to 1. For every cell greater than or equal 50 set its value to 2.

# 13.3.2 Raster Alignment

This tool is able to take several rasters as input and to align them perfectly, that means:

- reproject to the same CRS,
- resample to the same cell size and offset in the grid,
- clip to a region of interest,
- rescale values when required.

All rasters will be saved in another files.

First, open the tools from  $Raster o Align\ Raster...$  and click on the Add new raster button to choose one existing raster in QGIS. Select an output file to save the raster after the alignment, the resampling method and if the tools need to  $Rescale\ values\ according\ to\ the\ cell\ size$ . You can Edit file settings and Remove an existing file from the list.

Then in the main Align raster window, you can choose one or more options:

- Select the Reference Layer,
- Transform into a new CRS.
- Setup a different Cell size,
- Setup a different *Grid Offset*,
- Clip to Extent,
- Output Size,
- Add aligned raster to the map canvas.

# Working with OGC Data

# 14.1 QGIS as OGC Data Client

The Open Geospatial Consortium (OGC) is an international organization with membership of more than 300 commercial, governmental, nonprofit and research organizations worldwide. Its members develop and implement standards for geospatial content and services, GIS data processing and exchange.

Describing a basic data model for geographic features, an increasing number of specifications are developed by OGC to serve specific needs for interoperable location and geospatial technology, including GIS. Further information can be found at http://www.opengeospatial.org/.

Important OGC specifications supported by QGIS are:

- WMS Web Map Service (WMS/WMTS Client)
- WMTS Web Map Tile Service (WMS/WMTS Client)
- WFS Web Feature Service (WFS and WFS-T Client)
- WFS-T Web Feature Service Transactional (WFS and WFS-T Client)
- WCS Web Coverage Service (WCS Client)
- SFS Simple Features for SQL (PostGIS Layers)
- GML Geography Markup Language

OGC services are increasingly being used to exchange geospatial data between different GIS implementations and data stores. QGIS can deal with the above specifications as a client, being  $\mathbf{SFS}$  (through support of the PostgreSQL / PostGIS data provider, see section PostGIS Layers).

# 14.1.1 WMS/WMTS Client

#### Overview of WMS Support

QGIS currently can act as a WMS client that understands WMS 1.1, 1.1.1 and 1.3 servers. In particular, it has been tested against publicly accessible servers such as DEMIS.

A WMS server acts upon requests by the client (e.g., QGIS) for a raster map with a given extent, set of layers, symbolization style, and transparency. The WMS server then consults its local data sources, rasterizes the map, and sends it back to the client in a raster format. For QGIS, this format would typically be JPEG or PNG.

WMS is generically a REST (Representational State Transfer) service rather than a full-blown Web service. As such, you can actually take the URLs generated by QGIS and use them in a web browser to retrieve the same images that QGIS uses internally. This can be useful for troubleshooting, as there are several brands of WMS server on the market and they all have their own interpretation of the WMS standard.

WMS layers can be added quite simply, as long as you know the URL to access the WMS server, you have a serviceable connection to that server, and the server understands HTTP as the data transport mechanism.

Additionally, QGIS will cache your WMS responses (i.e. images) for 24h as long as the GetCapabilities request is not triggered. The GetCapabilities request is triggered everytime the [Connect] button in the [Add layer(s) from WMS(T)S Server] dialog is used to retrieve the WMS server capabilities. This is an automatic feature meant to optimize project loading time. If a project is saved with a WMS layer, the corresponding WMS tiles will be loaded from the cache the next time the project is opened as long as they are no older than 24H.

# Overview of WMTS Support

QGIS can also act as a WMTS client. WMTS is an OGC standard for distributing tile sets of geospatial data. This is a faster and more efficient way of distributing data than WMS because with WMTS, the tile sets are pre-generated, and the client only requests the transmission of the tiles, not their production. A WMS request typically involves both the generation and transmission of the data. A well-known example of a non-OGC standard for viewing tiled geospatial data is Google Maps.

In order to display the data at a variety of scales close to what the user might want, the WMTS tile sets are produced at several different scale levels and are made available for the GIS client to request them.

This diagram illustrates the concept of tile sets:

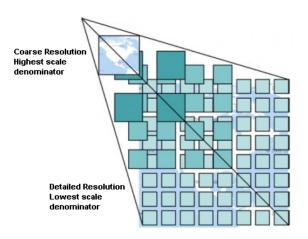


Рис. 14.1: Concept of WMTS tile sets

The two types of WMTS interfaces that QGIS supports are via Key-Value-Pairs (KVP) and RESTful. These two interfaces are different, and you need to specify them to QGIS differently.

1. In order to access a **WMTS KVP** service, a QGIS user must open the WMS/WMTS interface and add the following string to the URL of the WMTS tile service:

```
"?SERVICE=WMTS&REQUEST=GetCapabilities"
```

An example of this type of address is

For testing the topo2 layer in this WMTS works nicely. Adding this string indicates that a WMTS web service is to be used instead of a WMS service.

2. The **RESTful WMTS** service takes a different form, a straightforward URL. The format recommended by the OGC is:

{WMTSBaseURL}/1.0.0/WMTSCapabilities.xml

This format helps you to recognize that it is a RESTful address. A RESTful WMTS is accessed in QGIS by simply adding its address in the WMS setup in the URL field of the form. An example of this type of address for the case of an Austrian basemap is http://maps.wien.gv.at/basemap/1.0.0/WMTSCapabilities.xml.

Примітка: You can still find some old services called WMS-C. These services are quite similar to WMTS (i.e., same purpose but working a little bit differently). You can manage them the same as you do WMTS services. Just add ?tiled=true at the end of the url. See http://wiki.osgeo.org/wiki/Tile\_Map\_Service\_Specification for more information about this specification.

When you read WMTS, you can often think WMS-C also.

## Selecting WMS/WMTS Servers

The first time you use the WMS feature in QGIS, there are no servers defined.

Begin by clicking the  ${}^{\text{MMS layer}}$  button on the toolbar, or selecting  $Layer o Add\ WMS\ Layer....$ 

The dialog Add Layer(s) from a Server for adding layers from the WMS server appears. You can add some servers to play with by clicking the [Add default servers] button. This will add two WMS demo servers for you to use: the WMS servers of the DM Solutions Group and Lizardtech. To define a new WMS server in the Layers tab, select the [New] button. Then enter the parameters to connect to your desired WMS server, as listed in table OGC 1:

Name	A name for this connection. This name will be used in the Server Connections
	drop-down box so that you can distinguish it from other WMS servers.
URL	URL of the server providing the data. This must be a resolvable host name – the
	same format as you would use to open a telnet connection or ping a host.
Username	Username to access a secured WMS server. This parameter is optional.
Password	Password for a basic authenticated WMS server. This parameter is optional.
Ignore	■ Ignore GetMap URI reported in capabilities. Use given URI from URL field
GetMap URI	above.
Ignore	■ Ignore GetFeatureInfo URI reported in capabilities. Use given URI from URL
GetFeatureI-	field above.
nfo	
URI	

Table OGC 1: WMS Connection Parameters

If you need to set up a proxy server to be able to receive WMS services from the internet, you can add your proxy server in the options. Choose  $Settings \to Options$  and click on the  $Network \ \mathscr{C}$  Proxy tab. There, you can add your proxy settings and enable them by setting  $Use\ proxy$   $for\ web\ access$ . Make sure that you select the correct proxy type from the  $Proxy\ type$  drop-down menu.

Once the new WMS server connection has been created, it will be preserved for future QGIS sessions.

#### Порада: On WMS Server URLs

Be sure, when entering the WMS server URL, that you have the base URL only. For example, you shouldn't have fragments such as request=GetCapabilities or version=1.0.0 in your URL.

Попередження: Entering username and password in the Authentication tab will keep unprotected credentials in the connection configuration. Those credentials will be visible if, for instance, you shared the project file with someone. Therefore, it's advisable to save your credentials in a Authentication configuration instead (configurations tab). See ref:authentication\_index for more details.

# Loading WMS/WMTS Layers

Once you have successfully filled in your parameters, you can use the [Connect] button to retrieve the capabilities of the selected server. This includes the image encoding, layers, layer styles and projections. Since this is a network operation, the speed of the response depends on the quality of your network connection to the WMS server. While downloading data from the WMS server, the download progress is visualized in the lower left of the WMS dialog.

Your screen should now look a bit like figure\_OGR\_1, which shows the response provided by the European Soil Portal WMS server.

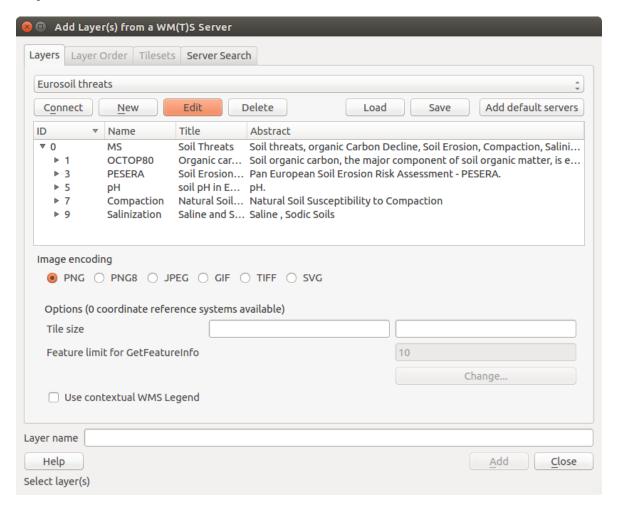


Рис. 14.2: Dialog for adding a WMS server, showing its available layers

# Image Encoding

The *Image encoding* section lists the formats that are supported by both the client and server. Choose one depending on your image accuracy requirements.

### Порада: Image Encoding

You will typically find that a WMS server offers you the choice of JPEG or PNG image encoding. JPEG is a lossy compression format, whereas PNG faithfully reproduces the raw raster data.

Use JPEG if you expect the WMS data to be photographic in nature and/or you don't mind some loss in picture quality. This trade-off typically reduces by five times the data transfer requirement compared with PNG.

Use PNG if you want precise representations of the original data and you don't mind the increased data transfer requirements.

## Options

The Options area of the dialog provides a text field where you can add a *Layer name* for the WMS layer. This name will appear in the legend after loading the layer.

Below the layer name, you can define *Tile size* if you want to set tile sizes (e.g., 256x256) to split up the WMS request into multiple requests.

The Feature limit for GetFeatureInfo defines what features from the server to query.

If you select a WMS from the list, a field with the default projection provided by the mapserver appears. If the [Change...] button is active, you can click on it and change the default projection of the WMS to another CRS provided by the WMS server.

Finally you can activate Use contextual WMS-Legend if the WMS Server supports this feature. Then only the relevant legend for your current map view extent will be shown and thus will not include legend items for things you can't see in the current map.

# Layer Order

The Layer Order tab lists the selected layers available from the current connected WMS server. You may notice that some layers are expandable; this means that the layer can be displayed in a choice of image styles.

You can select several layers at once, but only one image style per layer. When several layers are selected, they will be combined at the WMS server and transmitted to QGIS in one go.

## Порада: WMS Layer Ordering

WMS layers rendered by a server are overlaid in the order listed in the Layers section, from top to bottom of the list. If you want to change the overlay order, you can use the *Layer Order* tab.

## Transparency

In this version of QGIS, the *Global transparency* setting from the *Layer Properties* is hard coded to be always on, where available.

#### Порада: WMS Layer Transparency

The availability of WMS image transparency depends on the image encoding used: PNG and GIF support transparency, whilst JPEG leaves it unsupported.

# Coordinate Reference System

A coordinate reference system (CRS) is the OGC terminology for a QGIS projection.

Each WMS layer can be presented in multiple CRSs, depending on the capability of the WMS server.

To choose a CRS, select [Change...] and a dialog similar to Figure Projection 3 in Working with Projections will appear. The main difference with the WMS version of the dialog is that only those CRSs supported by the WMS server will be shown.

#### Server search

Within QGIS, you can search for WMS servers. Figure\_OGC\_2 shows the Server Search tab with the Add Layer(s) from a Server dialog.

As you can see, it is possible to enter a search string in the text field and hit the [Search] button. After a short while, the search result will be populated into the list below the text field. Browse the result list and inspect your search results within the table. To visualize the results, select a table entry, press the [Add selected row to WMS list] button and change back to the Layers tab. QGIS has automatically

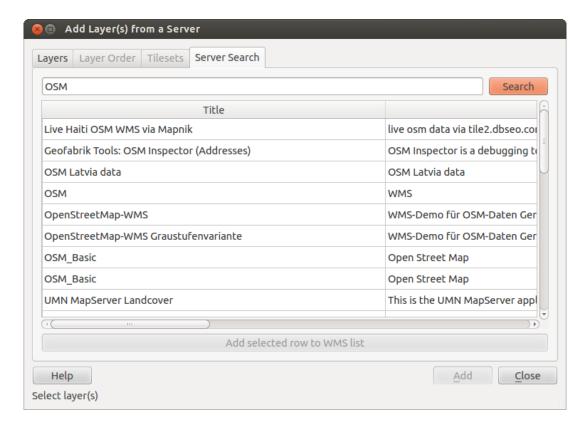


Рис. 14.3: Dialog for searching WMS servers after some keywords

updated your server list, and the selected search result is already enabled in the list of saved WMS servers in the *Layers* tab. You only need to request the list of layers by clicking the **[Connect]** button. This option is quite handy when you want to search maps by specific keywords.

Basically, this option is a front end to the API of http://geopole.org.

#### **Tilesets**

When using WMTS (Cached WMS) services like

you are able to browse through the Tilesets tab given by the server. Additional information like tile size, formats and supported CRS are listed in this table. In combination with this feature, you can use the tile scale slider by selecting  $Settings \rightarrow Panels$  (KDE) or  $View \rightarrow Panels$  (Gnome, Windows and MacOSX), then choosing  $Tile\ Scale\ Panel$ . This gives you the available scales from the tile server with a nice slider docked in.

# Using the Identify Tool

Once you have added a WMS server, and if any layer from a WMS server is queryable, you can then use the Identify tool to select a pixel on the map canvas. A query is made to the WMS server for each selection made. The results of the query are returned in plain text. The formatting of this text is dependent on the particular WMS server used. Format selection

If multiple output formats are supported by the server, a combo box with supported formats is automatically added to the identify results dialog and the selected format may be stored in the project for the layer. **GML format support** 

The Identify tool supports WMS server response (GetFeatureInfo) in GML format (it is called Feature in the QGIS GUI in this context). If "Feature" format is supported by the server and selected, results of the Identify tool are vector features, as from a regular vector layer. When a single feature is selected in the tree, it is highlighted in the map and it can be copied to the clipboard and pasted to another vector layer. See the example setup of the UMN Mapserver below to support GetFeatureInfo in GML format.

# in layer METADATA add which fields should be included and define geometry (example):

```
"gml_include_items"
                      "all"
"ows_geometries"
                      "mygeom"
"ows_mygeom_type"
                      "polygon"
# Then there are two possibilities/formats available, see a) and b):
# a) basic (output is generated by Mapserver and does not contain XSD)
# in WEB METADATA define formats (example):
"wms_getfeatureinfo_formatlist" "application/vnd.ogc.gml,text/html"
# b) using OGR (output is generated by OGR, it is send as multipart and contains XSD)
# in MAP define OUTPUTFORMAT (example):
OUTPUTFORMAT
   NAME "OGRGML"
    MIMETYPE "ogr/gml"
    DRIVER "OGR/GML"
    FORMATOPTION "FORM=multipart"
END
# in WEB METADATA define formats (example):
"wms\_getfeatureinfo\_formatlist" "OGRGML\_, text/html"
```

#### Viewing Properties

Once you have added a WMS server, you can view its properties by right-clicking on it in the legend and selecting *Properties*. **Metadata Tab** 

The tab *Metadata* displays a wealth of information about the WMS server, generally collected from the capabilities statement returned from that server. Many definitions can be gleaned by reading the WMS standards (see OPEN-GEOSPATIAL-CONSORTIUM in *Literature and Web References*), but here are a few handy definitions:

#### • Server Properties

- WMS Version The WMS version supported by the server.
- Image Formats The list of MIME-types the server can respond with when drawing the
  map. QGIS supports whatever formats the underlying Qt libraries were built with, which is
  typically at least image/png and image/jpeg.
- Identity Formats The list of MIME-types the server can respond with when you use the Identify tool. Currently, QGIS supports the text-plain type.

# • Layer Properties

- Selected Whether or not this layer was selected when its server was added to this project.
- **Visible** Whether or not this layer is selected as visible in the legend (not yet used in this version of QGIS).
- Can Identify Whether or not this layer will return any results when the Identify tool is used on it.
- Can be Transparent Whether or not this layer can be rendered with transparency. This
  version of QGIS will always use transparency if this is Yes and the image encoding supports
  transparency.

- Can Zoom In Whether or not this layer can be zoomed in by the server. This version of QGIS assumes all WMS layers have this set to Yes. Deficient layers may be rendered strangely.
- Cascade Count WMS servers can act as a proxy to other WMS servers to get the raster data for a layer. This entry shows how many times the request for this layer is forwarded to peer WMS servers for a result.
- Fixed Width, Fixed Height Whether or not this layer has fixed source pixel dimensions.
   This version of QGIS assumes all WMS layers have this set to nothing. Deficient layers may be rendered strangely.
- WGS 84 Bounding Box The bounding box of the layer, in WGS 84 coordinates. Some WMS servers do not set this correctly (e.g., UTM coordinates are used instead). If this is the case, then the initial view of this layer may be rendered with a very 'zoomed-out' appearance by QGIS. The WMS webmaster should be informed of this error, which they may know as the WMS XML elements LatLonBoundingBox, EX\_GeographicBoundingBox or the CRS:84 BoundingBox.
- Available in CRS The projections that this layer can be rendered in by the WMS server.
   These are listed in the WMS-native format.
- Available in style The image styles that this layer can be rendered in by the WMS server.

## Show WMS legend graphic in table of contents and composer

The QGIS WMS data provider is able to display a legend graphic in the table of contents' layer list and in the map composer. The WMS legend will be shown only if the WMS server has GetLegendGraphic capability and the layer has getCapability url specified, so you additionally have to select a styling for the layer.

If a legendGraphic is available, it is shown below the layer. It is little and you have to click on it to open it in real dimension (due to QgsLegendInterface architectural limitation). Clicking on the layer's legend will open a frame with the legend at full resolution.

In the print composer, the legend will be integrated at it's original (downloaded) dimension. Resolution of the legend graphic can be set in the item properties under  $Legend \rightarrow WMS \ Legend \ Graphic$  to match your printing requirements

The legend will display contextual information based on your current scale. The WMS legend will be shown only if the WMS server has GetLegendGraphic capability and the layer has getCapability url specified, so you have to select a styling.

#### **WMS Client Limitations**

Not all possible WMS client functionality had been included in this version of QGIS. Some of the more noteworthy exceptions follow.

# **Editing WMS Layer Settings**

Once you've completed the Add WMS layer procedure, there is no way to change the settings. A workaround is to delete the layer completely and start again.

## WMS Servers Requiring Authentication

Currently, publicly accessible and secured WMS services are supported. The secured WMS servers can be accessed by public authentication. You can add the (optional) credentials when you add a WMS server. See section  $Selecting\ WMS/WMTS\ Servers$  for details.

# Порада: Accessing secured OGC-layers

If you need to access secured layers with secured methods other than basic authentication, you can use InteProxy as a transparent proxy, which does support several authentication methods. More information can be found in the InteProxy manual at http://inteproxy.wald.intevation.org.

#### Порада: QGIS WMS Mapserver

Since Version 1.7.0, QGIS has its own implementation of a WMS 1.3.0 Mapserver. Read more about this in chapter QGIS as OGC Data Server.

#### 14.1.2 WCS Client

A Web Coverage Service (WCS) provides access to raster data in forms that are useful for client-side rendering, as input into scientific models, and for other clients. The WCS may be compared to the WFS and the WMS. As WMS and WFS service instances, a WCS allows clients to choose portions of a server's information holdings based on spatial constraints and other query criteria.

QGIS has a native WCS provider and supports both version 1.0 and 1.1 (which are significantly different), but currently it prefers 1.0, because 1.1 has many issues (i.e., each server implements it in a different way with various particularities).

The native WCS provider handles all network requests and uses all standard QGIS network settings (especially proxy). It is also possible to select cache mode ('always cache', 'prefer cache', 'prefer network', 'always network'), and the provider also supports selection of time position, if temporal domain is offered by the server.

Попередження: Entering username and password in the Authentication tab will keep unprotected credentials in the connection configuration. Those credentials will be visible if, for instance, you shared the project file with someone. Therefore, it's advisable to save your credentials in a Authentication configuration instead (configurations tab). See ref:authentication\_index for more details.

## 14.1.3 WFS and WFS-T Client

In QGIS, a WFS layer behaves pretty much like any other vector layer. You can identify and select features, and view the attribute table. Since QGIS 1.6, editing WFS-T is also supported.

In general, adding a WFS layer is very similar to the procedure used with WMS. The difference is that there are no default servers defined, so we have to add our own.

## Loading a WFS Layer

As an example, we use the DM Solutions WFS server and display a layer. The URL is:  $\frac{http:}{www2.dmsolutions.ca/cgi-bin/mswfs}$  gmap

- 1. Click on the Add WFS Layer tool on the Layers toolbar. The Add WFS Layer from a Server dialog appears.
- 2. Click on [New].
- 3. Enter 'DM Solutions' as name.
- 4. Enter the URL (see above).
- 5. Click **[OK]**.
- 6. Choose 'DM Solutions' from the Server Connections drop-down list.
- 7. Click [Connect].
- 8. Wait for the list of layers to be populated.
- 9. Select the *Parks* layer in the list.
- 10. Click [Apply] to add the layer to the map.

Note that any proxy settings you may have set in your preferences are also recognized.

Попередження: Entering username and password in the Authentication tab will keep unprotected credentials in the connection configuration. Those credentials will be visible if, for instance, you shared the project file with someone. Therefore, it's advisable to save your credentials in a Authentication configuration instead (configurations tab). See ref:authentication\_index for more details.



Рис. 14.4: Adding a WFS layer

You'll notice the download progress is visualized in the lower left of the QGIS main window. Once the layer is loaded, you can identify and select a province or two and view the attribute table.

Only WFS 1.0.0 is supported. At this time, there have not been many tests against WFS versions implemented in other WFS servers. If you encounter problems with any other WFS server, please do not hesitate to contact the development team. Please refer to section *Help and Support* for further information about the mailing lists.

# Порада: Finding WFS Servers

You can find additional WFS servers by using Google or your favourite search engine. There are a number of lists with public URLs, some of them maintained and some not.

# 14.2 QGIS as OGC Data Server

QGIS Server is an open source WMS 1.3, WFS 1.0.0 and WCS 1 1.1.1 implementation that, in addition, implements advanced cartographic features for thematic mapping. The QGIS Server is a FastCGI/CGI (Common Gateway Interface) application written in C++ that works together with a web server (e.g., Apache, Lighttpd). It has Python plugin support allowing for fast and efficient development and deployment of new features. The original development of QGIS Server was funded by the EU projects Orchestra, Sany and the city of Uster in Switzerland.

QGIS Server uses QGIS as back end for the GIS logic and for map rendering. Furthermore, the Qt library is used for graphics and for platform-independent C++ programming. In contrast to other WMS software, the QGIS Server uses cartographic rules as a configuration language, both for the server configuration and for the user-defined cartographic rules.

As QGIS desktop and QGIS Server use the same visualization libraries, the maps that are published on the web look the same as in desktop GIS.

In the following sections, we will provide a sample configuration to set up a QGIS Server on Debian/Ubuntu Linux. For user contributed installation instructions on other platforms or distributions, we recommend reading one of the following URLs:

- http://hub.qgis.org/projects/quantum-gis/wiki/QGIS Server Tutorial
- http://www.itopen.it/qgis-server-python-plugins-ubuntu-setup/

# 14.2.1 QGIS Server installation on Debian/Ubuntu

At this point, we will give a short and simple sample installation how-to for a minimal working configuration using Apache2 on Debian Squeeze (or with negligible variations on Ubuntu 14.04). Many other OSs provide packages for QGIS Server, too. If you have to build it all from source, please refer to the URLs above.

Firstly, add the following debian GIS repository:

```
$ cat /etc/apt/sources.list.d/debian-gis.list
deb http://qgis.org/debian trusty main
deb-src http://qgis.org/debian trusty main

$ # Add keys
$ sudo gpg --keyserver keyserver.ubuntu.com --recv-key 3FF5FFCAD71472C4
$ sudo gpg --export --armor 3FF5FFCAD71472C4 | sudo apt-key add --

$ # Update package list
$ sudo apt-get update && sudo apt-get upgrade

Now, install QGIS Server:
$ sudo apt-get install qgis-server python-qgis
```

Installation of a HelloWorld example plugin for testing the servers. You create a directory to hold server plugins. This will be specified in the virtual host configuration and passed on to the server through an environment variable:

```
$ sudo mkdir -p /opt/qgis-server/plugins
$ cd /opt/qgis-server/plugins
$ sudo wget https://github.com/elpaso/qgis-helloserver/archive/master.zip
$ # In case unzip was not installed before:
$ sudo apt-get install unzip
$ sudo unzip master.zip
$ sudo mv qgis-helloserver-master HelloServer
```

Install the Apache server in a separate virtual host listening on port 80. Enable the rewrite module to pass HTTP BASIC auth headers:

```
$ sudo a2enmod rewrite
$ cat /etc/apache2/conf-available/qgis-server-port.conf
Listen 80
$ sudo a2enconf qgis-server-port

This is the virtual host configuration, stored in /etc/apache2/sites-available/001-qgis-server.conf:

<VirtualHost *:80>
    ServerAdmin webmaster@localhost
    DocumentRoot /var/www/html

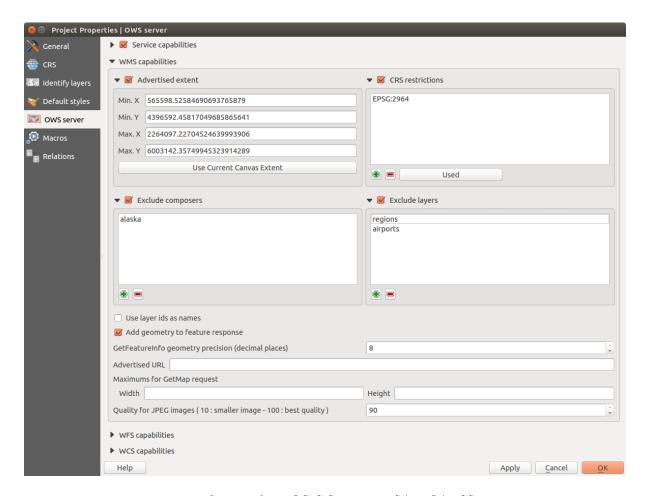
ErrorLog ${APACHE_LOG_DIR}/qgis-server-error.log
```

```
CustomLog ${APACHE_LOG_DIR}/qgis-server-access.log combined
  # Longer timeout for WPS... default = 40
  FcgidIOTimeout 120
  FcgidInitialEnv LC_ALL "en_US.UTF-8"
  FcgidInitialEnv PYTHONIOENCODING UTF-8
  FcgidInitialEnv LANG "en_US.UTF-8"
  FcgidInitialEnv QGIS_DEBUG 1
  FcgidInitialEnv QGIS_SERVER_LOG_FILE /tmp/qgis-000.log
  FcgidInitialEnv QGIS_SERVER_LOG_LEVEL O
  FcgidInitialEnv QGIS_PLUGINPATH "/opt/qgis-server/plugins"
  # Needed for QGIS HelloServer plugin HTTP BASIC auth
  <IfModule mod_fcgid.c>
      RewriteEngine on
      RewriteCond %{HTTP:Authorization} .
      RewriteRule .* - [E=HTTP_AUTHORIZATION:%{HTTP:Authorization}]
  </IfModule>
  ScriptAlias /cgi-bin/ /usr/lib/cgi-bin/
  <Directory "/usr/lib/cgi-bin">
      AllowOverride All
      Options +ExecCGI -MultiViews +FollowSymLinks
      # for apache2 > 2.4
      Require all granted
      #Allow from all
  </Directory>
 </VirtualHost>
Now enable the virtual host and restart Apache:
$ sudo a2ensite 001-qgis-server
$ sudo service apache2 restart
Test the server with the HelloWorld plugin:
$ wget -q -0 - "http://localhost/cgi-bin/qgis_mapserv.fcgi?SERVICE=HELLO"
HelloServer!
You can have a
                                                   Get Capabilities
                                                                               QGIS
                       look
                             at
                                   _{
m the}
                                         \operatorname{default}
                                                                    of
                                                                         _{
m the}
                                                                                       server
http://localhost/cgi-bin/qgis_mapserv.fcgi?SERVICE=WMS&VERSION=1.3.0&REQUEST=GetCapabilities
Порада: If you work with a feature that has many nodes then modifying and adding a new feature
will fail. In this case it is possible to insert the following code into the 001-qgis-server.conf file:
<IfModule mod_fcgid.c>
FcgidMaxRequestLen 26214400
FcgidConnectTimeout 60
</IfModule>
```

# 14.2.2 Creating a WMS/WFS/WCS server from a QGIS project

To provide a new QGIS Server WMS, WFS or WCS, we have to create a QGIS project file with some data. Here, we use the 'Alaska' shapefile from the QGIS sample dataset. Define the colors and styles of the layers in QGIS and the project CRS, if not already defined.

Then, go to the OWS Server menu of the Project o Project Project Properties dialog and provide some information about the OWS in the fields under Service Capabilities. This will appear in the GetCapabilities response of the WMS, WFS or WCS. If you don't check M Service capabilities, QGIS Server will use the information given in the wms\_metadata.xml file located in the cgi-bin folder.



 ${\it Puc.}\ 14.5{\it :}\ {\it Definitions}$  for a QGIS Server WMS/WFS/WCS project

Попередження: If you're using the QGIS project with styling based on SVG files using relative paths then you should know that the server considers the path relative to its qgis\_mapserv.fcgi file (not to the qgs file). So, if you deploy a project on the server and the SVG files are not placed accordingly, the output images may not respect the Desktop styling. To ensure this doesn't happen, you can simply copy the SVG files relative to the qgis\_mapserv.fcgi. You can also create a symbolic link in the directory where the fcgi file resides that points to the directory containing the SVG files (on Linux/Unix).

## WMS capabilities

In the WMS capabilities section, you can define the extent advertised in the WMS GetCapabilities response by entering the minimum and maximum X and Y values in the fields under Advertised extent. Clicking Use Current Canvas Extent sets these values to the extent currently displayed in the QGIS map canvas. By checking CRS restrictions, you can restrict in which coordinate reference systems (CRS) QGIS Server will offer to render maps. Use the button below to select those CRSs from the Coordinate Reference System Selector, or click Used to add the CRSs used in the QGIS project to the list

If you have print composers defined in your project, they will be listed in the GetProjectSettings response, and they can be used by the GetPrint request to create prints, using one of the print composer layouts as a template. This is a QGIS-specific extension to the WMS 1.3.0 specification. If you want to exclude any print composer from being published by the WMS, check  $Exclude\ composers$  and click the button below. Then, select a print composer from the  $Select\ print\ composer$  dialog in order to add it to the excluded composers list.

If you want to exclude any layer or layer group from being published by the WMS, check Exclude Layers and click the button below. This opens the Select restricted layers and groups dialog, which allows you to choose the layers and groups that you don't want to be published. Use the Shift or Ctrl key if you want to select multiple entries.

You can receive requested GetFeatureInfo as plain text, XML and GML. Default is XML, text or GML format depends the output format chosen for the GetFeatureInfo request.

If you wish, you can check  $\triangle$  Add geometry to feature response. This will include in the GetFeatureInfo response the geometries of the features in a text format. If you want QGIS Server to advertise specific request URLs in the WMS GetCapabilities response, enter the corresponding URL in the Advertised URL field. Furthermore, you can restrict the maximum size of the maps returned by the GetMap request by entering the maximum width and height into the respective fields under Maximums for GetMap request.

If one of your layers uses the Map Tip display (i.e. to show text using expressions) this will be listed inside the GetFeatureInfo output. If the layer uses a Value Map for one of its attributes, this information will also be shown in the GetFeatureInfo output.

QGIS supports the following requests for WMS service:

- Get Capabilities
- GetMap
- GetFeatureInfo
- GetLegendGraphic (SLD profile)
- DescribeLayer (SLD profile)
- GetStyles (custom QGIS profile)

#### WFS capabilities

In the WFS capabilities area you can select the layers you want to publish as WFS, and specify if they will allow update, insert and delete operations. If you enter a URL in the Advertised URL field of the WFS capabilities section, QGIS Server will advertise this specific URL in the WFS Get Capabilities response.

QGIS supports the following requests for WFS service:

- Get Capabilities
- DescribeFeatureType
- GetFeature
- Transaction

### WCS capabilities

In the WCS capabilities area, you can select the layers that you want to publish as WCS. If you enter a URL in the  $Advertised\ URL$  field of the WCS capabilities section, QGIS Server will advertise this specific URL in the WCS GetCapabilities response.

Now, save the session in a project file alaska.qgs. To provide the project as a WMS/WFS, we create a new folder /usr/lib/cgi-bin/project with admin privileges and add the project file alaska.qgs and a copy of the qgis\_mapserv.fcgi file - that's all.

Now we test our project WMS, WFS and WCS. Add the WMS, WFS and WCS as described in *Loading WMS/WMTS Layers*, WFS and WFS-T Client and WCS Client to QGIS and load the data. The URL is:

http://localhost/cgi-bin/project/qgis\_mapserv.fcgi

QGIS supports the following requests for WCS service:

- Get Capabilities
- DescribeCoverage
- Get Coverage

# GetCapabilities Caching

In order to improve response time, QGIS Server caches the responses to the GetCapabilities requests. When such a request comes, QGIS Server is caching the response and marking the cache valid. At the same time, it watches if the project file changes. If the project is changed then the cache is marked as invalid and QGIS Server waits for a new request in order to recreate the cache.

# Fine tuning your OWS

For vector layers, the Fields menu of the  $Layer \rightarrow Properties$  dialog allows you to define for each attribute if it will be published or not. By default, all the attributes are published by your WMS and WFS. If you don't want a specific attribute to be published, uncheck the corresponding checkbox in the WMS or WFS column.

You can overlay watermarks over the maps produced by your WMS by adding text annotations or SVG annotations to the project file. See the Annotation Tools section in *General Tools* for instructions on creating annotations. For annotations to be displayed as watermarks on the WMS output, the *Fixed map position* check box in the *Annotation text* dialog must be unchecked. This can be accessed by double clicking the annotation while one of the annotation tools is active. For SVG annotations, you will need either to set the project to save absolute paths (in the *General* menu of the *Project*  $\rightarrow$  *Project Properties* dialog) or to manually modify the path to the SVG image so that it represents a valid relative path.

# 14.2.3 Server configuration and supported parameters

QGIS Server supports some vendor parameters and requests that greatly enhance the possibilities of customising its behavior. The following paragraphs list the vendor parameters and the environment variables supported by the server.

## Extra parameters supported by all request types

- **FILE\_NAME** parameter: if set, the server response will be sent to the client as a file attachment with the specified file name.
- MAP parameter: Similar to MapServer, the MAP parameter can be used to specify the path to the QGIS project file. You can specify an absolute path or a path relative to the location of the server executable (qgis\_mapserv.fcgi). If not specified, QGIS Server searches for .qgs files in the directory where the server executable is located.

Example:

```
http://localhost/cgi-bin/qgis_mapserv.fcgi?\
REQUEST=GetMap&MAP=/home/qgis/mymap.qgs&...
```

Примітка: You can define a QGIS\_PROJECT\_FILE as an environment variable to tell the server executable where to find the QGIS project file. This variable will be the location where QGIS will look for the project file. If not defined it will use the MAP parameter in the request and finally look at the server executable directory.

## Extra parameters supported by the WMS GetMap request

In the WMS GetMap request, QGIS Server accepts a couple of extra parameters in addition to the standard parameters according to the OGC WMS 1.3.0 specification:

• **DPI** parameter: The **DPI** parameter can be used to specify the requested output resolution.

Example:

• **OPACITIES** parameter: Opacity can be set on layer or group level. Allowed values range from 0 (fully transparent) to 255 (fully opaque).

Example:

```
http://localhost/cgi-bin/qgis_mapserv.fcgi?\
REQUEST=GetMap&LAYERS=mylayer1,mylayer2&OPACITIES=125,200&...
```

• FILTER parameter: (Available in QGIS 1.8 and above). Subsets of layers can be selected with the FILTER parameter. Syntax is basically the same as for the QGIS subset string. However, there are some restrictions to avoid SQL injections into databases via QGIS server:

Text strings need to be enclosed with quotes (single quotes for strings, double quotes for attributes) A space between each word / special character is mandatory. Allowed Keywords and special characters are 'AND','OR','IN','=','<','>=', '>','>=','!=\*,'(',')'. Semicolons in string expressions are not allowed

Example:

http://myserver.com/cgi/qgis\_mapserv.fcgi?REQUEST=GetMap&LAYERS=mylayer1,mylayer2&FILTER=mylayer1:"OB

Примітка: It is possible to make attribute searches via GetFeatureInfo and omit the X/Y parameter if

a FILTER is there. QGIS server then returns info about the matching features and generates a combined bounding box in the xml output.

• SELECTION parameter: (Available in QGIS 1.8 and above) Vector features can be selected by passing comma separated lists with feature ids in GetMap and GetPrint.

Example:

 $\verb|http://myserver.com/cgi/qgis_mapserv.fcgi?REQUEST=GetMap\&LAYERS=mylayer1, mylayer2\&SELECTION=mylayer1: | the property of t$ 

## Extra parameters supported by the WMS GetFeatureInfo request

QGIS Server WMS GetFeatureInfo requests supports the following extra optional parameters to define the tolerance for point, line and polygon layers:

- FI\_POINT\_TOLERANCE parameter: Tolerance for point layers GetFeatureInfo request, in pixels.
- FI\_LINE\_TOLERANCE parameter: Tolerance for linestring layers *GetFeatureInfo* request, in pixels.
- FI\_POLYGON\_TOLERANCE parameter: Tolerance for polygon layers *GetFeatureInfo* request, in pixels.

#### GetPrint request

QGIS server has the capability to create print composer output in pdf or pixel format. Print composer windows in the published project are used as templates. In the GetPrint request, the client has the possibility to specify parameters of the contained composer maps and labels.

## Example:

The published project has two composer maps. In the GetProjectSettings response, they are listed as possible print templates:

```
<WMS_Capabilities>
...
<ComposerTemplates xsi:type="wms:_ExtendedCapabilities">
<ComposerTemplate width="297" height="210" name="Druckzusammenstellung 1">
<ComposerMap width="171" height="133" name="map0"/>
<ComposerMap width="49" height="46" name="map1"/></ComposerTemplate>
</ComposerTemplates>
...
</WMS_Capabilities>
```

The client has now the information to request a print output:

http://myserver.com/cgi/qgis\_mapserv.fcgi?...&REQUEST=GetPrint&TEMPLATE=Druckzusammenstellung 1&map0:EXTENT=xmi

Parameters in the GetPrint request are:

- <map id>:EXTENT gives the extent for a composer map as xmin,ymin,xmax,ymax.
- <map id>:ROTATION map rotation in degrees
- <map\_id>:GRID\_INTERVAL\_X, <map\_id>:GRID\_INTERVAL\_Y Grid line density for a composer map in x- and y-direction
- <map\_id>:SCALE Sets a mapscale to a composer map. This is useful to ensure scale based visibility of layers and labels even if client and server may have different algorithms to calculate the scale denominator
- <map\_id>:LAYERS, <map\_id>:STYLES possibility to give layer and styles list for composer map (useful in case of overview maps which should have only a subset of layers)

## GetLegendGraphics request

Several additional parameters are available to change the size of the legend elements:

- BOXSPACE space between legend frame and content (mm)
- LAYERSPACE versical space between layers (mm)
- LAYERTITLESPACE vertical space between layer title and items following (mm)
- SYMBOLSPACE vertical space between symbol and item following (mm)
- ICONLABELSPACE horizontal space between symbol and label text (mm)
- SYMBOLWIDTH width of the symbol preview (mm)
- SYMBOLHEIGHT height of the symbol preview (mm)

These parameters change the font properties for layer titles and item labels:

- LAYERFONTFAMILY / ITEMFONTFAMILY font family for layer title / item text
- LAYERFONTBOLD / ITEMFONTBOLD 'TRUE' to use a bold font
- LAYERFONTSIZE / ITEMFONTSIZE Font size in point
- LAYERFONTITALIC / ITEMFONTITALIC 'TRUE' to use italic font
- LAYERFONTCOLOR / ITEMFONTCOLOR Hex color code (e.g. #FF0000 for red)
- LAYERTITLE / RULELABEL (from QGIS 2.4) set them to 'FALSE' to get only the legend graphics without labels

Contest based legend. These parameters let the client request a legend showing only the symbols for the features falling into the requested area:

- BBOX the geographical area for which the legend should be built
- CRS / SRS the coordinate reference system adopted to define the BBOX coordinates
- WIDTH / HEIGHT if set these should match those defined for the GetMap request, to let QGIS Server scale symbols according to the map view image size.

Contest based legend features are based on the UMN MapServer implementation:

# GetProjectSettings request

This request type works similar to **GetCapabilities**, but it is more specific to QGIS Server and allows a client to read additional information which is not available in the GetCapabilities output:

- initial visibility of layers
- information about vector attributes and their edit types
- information about layer order and drawing order
- list of layers published in WFS

# **DXF** Export

It is possible to export layers in the DXF format using the GetMap Request. Only layers that have read access in the WFS service are exported in the DXF format. Here is a valid REQUEST and a documentation of the available parameters:

http://your.server.address/wms/liegenschaftsentwaesserung/abwasser\_werkplan?SERVICE=WMS&VERSION=1.3.0&REQUEST=G

#### Parameters:

• FORMAT=application/dxf

- FILE NAME=yoursuggested file name for download.dxf
- FORMAT OPTIONS=see options below, key:value pairs separated by Semicolon

# FORMAT OPTIONS Parameters:

- SCALE:scale to be used for symbology rules, filters and styles (not an actual scaling of the data data remains in the original scale).
- MODE:NOSYMBOLOGY|FEATURESYMBOLOGY|SYMBOLLAYERSYMBOLOGY corresponds to the three export options offered in the QGIS Desktop DXF export dialog.
- LAYERSATTRIBUTES:yourcolumn\_with\_values\_to\_be\_used\_for\_dxf\_layernames if not specified, the original QGIS layer names are used.
- USE TITLE AS LAYERNAME if enabled, the title of the layer will be used as layer name.

# Extra parameters supported by the WFS GetFeature request

In the WFS GetFeature request, QGIS Server accepts two extra parameters in addition to the standard parameters according to the OGC WFS 1.0.0 specification:

- GeometryName parameter: this parameter can be used to get the extent or the centroid as the geometry or no geometry if none if used (ie attribute only). Allowed values are extent, centroid or none.
- StartIndex parameter: STARTINDEX is standard in WFS 2.0, but it's an extension for WFS 1.0.0 which is the only version implemented in QGIS Server. STARTINDEX can be used to skip some features in the result set and in combination with MAXFEATURES will provide for the ability to use WFS GetFeature to page through results. Note that STARTINDEX=0 means start with the first feature, skipping none.

# **QGIS Server logging**

To log requests sent to the server, set the following environment variables:

- QGIS\_SERVER\_LOG\_FILE: Specify path and filename. Make sure that the server has proper permissions for writing to file. File should be created automatically, just send some requests to server. If it's not there, check permissions.
- QGIS SERVER LOG LEVEL: Specify desired log level. Available values are:
  - 0 INFO (log all requests),
  - 1 WARNING,
  - 2 CRITICAL (log just critical errors, suitable for production purposes).

#### Example:

```
SetEnv QGIS_SERVER_LOG_FILE /var/tmp/qgislog.txt SetEnv QGIS_SERVER_LOG_LEVEL 0
```

# Примітка:

- When using Fcgid module use FcgidInitialEnv instead of SetEnv!
- Server logging is also enabled if executable is compiled in release mode.

# Short name for layers, groups and project

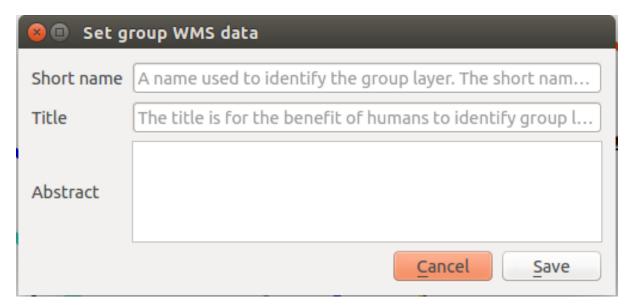
A number of elements have both a <Name > and a <Title>. The Name is a text string used for machine-to-machine communication while the **Title** is for the benefit of humans.

For example, a dataset might have the descriptive Title "Maximum Atmospheric Temperature" and be requested using the abbreviated Name "ATMAX". User can already set title for layers, groups and project.

OWS name is based on the name used in layer tree. This name is more a label for humans than a name for machine-to-machine communication.

QGIS Server supports:

- short name line edits to layers properties
- WMS data dialog to layer tree group (short name, title, abstract) By right clicking on a layer group and selecting the Set Group WMS data option you will get:



- short name line edits to project properties- add a regexp validator "^[A-Za-z][A-Za-z0-9\.\_-]\*" to short name line edit accessible through a static method
- add a regexp validator "^[A-Za-z][A-Za-z0-9\.\_-]\*" to short name line edit accessible through a static method
- add a TreeName element in the fullProjectSettings

If a short name has been set for layers, groups and project it is used by QGIS Sever as the layer name.

## Connection to service file

In order to make apache aware of the PostgreSQL service file (see the Service connection file section) you need to make your \*.conf file look like:

```
SetEnv PGSERVICEFILE /home/web/.pg_service.conf
<Directory "/home/web/apps2/bin/">
   AllowOverride None
```

# Add fonts to your linux server

Keep in mind that you may use QGIS projects that point to fonts that may not exist by default on other machines. This means that if you share the project, it may look different on other machines (if the fonts don't exist on the target machine).

In order to ensure this does not happen you just need to install the missing fonts on the target machine. Doing this on desktop systems is usually trivial (double clicking the fonts).

For linux, if you don't have a desktop environment installed (or you prefer the command line) you need to:

• On Debian based systems:

```
sudo su
mkdir -p /usr/local/share/fonts/truetype/myfonts && cd /usr/local/share/fonts/truetype/myfonts

# copy the fonts from their location
cp /fonts_location/* .

chown root *
cd .. && fc-cache -f -v

• On Fedora based systems:
sudo su
mkdir /usr/share/fonts/myfonts && cd /usr/share/fonts/myfonts

# copy the fonts from their location
cp /fonts_location/* .

chown root *
cd .. && fc-cache -f -v
```

#### **Environment variables**

You can configure some aspects of QGIS server by setting **environment variables**. For example, to set QGIS server on Apache to use /path/to/config/QGIS/QGIS2.ini settings file, add to Apache config:

```
SetEnv QGIS_OPTIONS_PATH "/path/to/config/"
```

or, if using fcgi:

FcgidInitialEnv QGIS\_OPTIONS\_PATH "/path/to/config/"

This is a list of the variables supported by QGIS server:

- QGIS\_OPTIONS\_PATH: Specifies the path to the directory with settings. It works the same way as QGIS application —optionspath option. It is looking for settings file in <QGIS\_OPTIONS\_PATH>/QGIS/QGIS2.ini.
- QUERY\_STRING: The query string, normally passed by the web server. This variable can be useful while testing QGIS server binary from the command line.
- QGIS\_PROJECT\_FILE: the .qgs project file, normally passed as a parameter in the query string, you can also set it as an environment variable (for example by using mod\_rewrite Apache module).
- QGIS\_SERVER\_LOG\_FILE: Specify path and filename. Make sure that server has proper permissions for writing to file. File should be created automatically, just send some requests to server. If it's not there, check permissions.
- QGIS SERVER LOG LEVEL: Specify desired log level. See QGIS Server logging
- MAX\_CACHE\_LAYERS: Specify the maximum number of cached layers (default: 100).
- DISPLAY: This is used to pass (fake) X server display number (needed on Unix-like systems).
- QGIS\_PLUGINPATH: Useful if you are using Python plugins for the server, this sets the folder that is searched for Python plugins.

# Working with GPS Data

# 15.1 GPS Plugin

### 15.1.1 What is GPS?

GPS, the Global Positioning System, is a satellite-based system that allows anyone with a GPS receiver to find their exact position anywhere in the world. GPS is used as an aid in navigation, for example in airplanes, in boats and by hikers. The GPS receiver uses the signals from the satellites to calculate its latitude, longitude and (sometimes) elevation. Most receivers also have the capability to store locations (known as **waypoints**), sequences of locations that make up a planned **route** and a tracklog or **track** of the receiver's movement over time. Waypoints, routes and tracks are the three basic feature types in GPS data. QGIS displays waypoints in point layers, while routes and tracks are displayed in linestring layers.

# 15.1.2 Loading GPS data from a file

There are dozens of different file formats for storing GPS data. The format that QGIS uses is called GPX (GPS eXchange format), which is a standard interchange format that can contain any number of waypoints, routes and tracks in the same file.

To load a GPX file, you first need to load the plugin.  $Plugins \rightarrow Plugin Manager...$  opens the Plugin Manager Dialog. Activate the GPS Tools checkbox. When this plugin is loaded, a button with a small handheld GPS device will show up in the toolbar and in  $Layer \rightarrow Create Layer \rightarrow :$ 

- F GPS Tools
- Greate new GPX Layer

For working with GPS data, we provide an example GPX file available in the QGIS sample dataset: qgis\_sample\_data/gps/national\_monuments.gpx. See section Sample Data for more information about the sample data.

- 1. Select  $Vector \to GPS \to GPS$  Tools or click the GPS Tools icon in the toolbar and open the Load GPX file tab (see figure\_GPS\_1).
- 2. Browse to the folder qgis\_sample\_data/gps/, select the GPX file national\_monuments.gpx and click [Open].

Use the [Browse...] button to select the GPX file, then use the checkboxes to select the feature types you want to load from that GPX file. Each feature type will be loaded in a separate layer when you click [OK]. The file national\_monuments.gpx only includes waypoints.

Примітка: GPS units allow you to store data in different coordinate systems. When downloading a GPX file (from your GPS unit or a web site) and then loading it in QGIS, be sure that the data

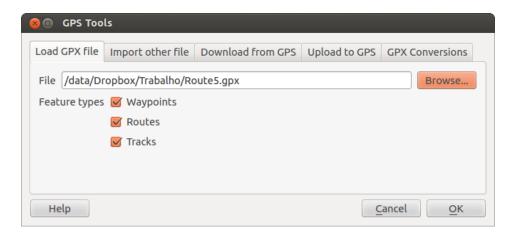


Рис. 15.1: The GPS Tools dialog window

stored in the GPX file uses WGS 84 (latitude/longitude). QGIS expects this, and it is the official GPX specification. See http://www.topografix.com/GPX/1/1/.

# 15.1.3 GPSBabel

Since QGIS uses GPX files, you need a way to convert other GPS file formats to GPX. This can be done for many formats using the free program GPSBabel, which is available at http://www.gpsbabel.org. This program can also transfer GPS data between your computer and a GPS device. QGIS uses GPSBabel to do these things, so it is recommended that you install it. However, if you just want to load GPS data from GPX files you will not need it. Version 1.2.3 of GPSBabel is known to work with QGIS, but you should be able to use later versions without any problems.

### 15.1.4 Importing GPS data

To import GPS data from a file that is not a GPX file, you use the tool *Import other file* in the GPS Tools dialog. Here, you select the file that you want to import (and the file type), which feature type you want to import from it, where you want to store the converted GPX file and what the name of the new layer should be. Note that not all GPS data formats will support all three feature types, so for many formats you will only be able to choose between one or two types.

### 15.1.5 Downloading GPS data from a device

QGIS can use GPSBabel to download data from a GPS device directly as new vector layers. For this we use the *Download from GPS* tab of the GPS Tools dialog (see Figure\_GPS\_2). Here, we select the type of GPS device, the port that it is connected to (or USB if your GPS supports this), the feature type that you want to download, the GPX file where the data should be stored, and the name of the new layer.

The device type you select in the GPS device menu determines how GPSBabel tries to communicate with your GPS device. If none of the available types work with your GPS device, you can create a new type (see section *Defining new device types*).

The port may be a file name or some other name that your operating system uses as a reference to the physical port in your computer that the GPS device is connected to. It may also be simply USB, for USB-enabled GPS units.

- 🚨 On Linux, this is something like /dev/ttyS0 or /dev/ttyS1.
- No Windows, it is COM1 or COM2.

When you click [OK], the data will be downloaded from the device and appear as a layer in QGIS.



Рис. 15.2: The download tool

# 15.1.6 Uploading GPS data to a device

You can also upload data directly from a vector layer in QGIS to a GPS device using the *Upload to GPS* tab of the GPS Tools dialog. To do this, you simply select the layer that you want to upload (which must be a GPX layer), your GPS device type, and the port (or USB) that it is connected to. Just as with the download tool, you can specify new device types if your device isn't in the list.

This tool is very useful in combination with the vector-editing capabilities of QGIS. It allows you to load a map, create waypoints and routes, and then upload them and use them on your GPS device.

# 15.1.7 Defining new device types

There are lots of different types of GPS devices. The QGIS developers can't test all of them, so if you have one that does not work with any of the device types listed in the *Download from GPS* and *Upload to GPS* tools, you can define your own device type for it. You do this by using the GPS device editor, which you start by clicking the [Edit devices] button in the download or the upload tab.

To define a new device, you simply click the [New device] button, enter a name, enter download and upload commands for your device, and click the [Update device] button. The name will be listed in the device menus in the upload and download windows – it can be any string. The download command is the command that is used to download data from the device to a GPX file. This will probably be a GPSBabel command, but you can use any other command line program that can create a GPX file. QGIS will replace the keywords "type, "in, and "out when it runs the command.

**%type** will be replaced by -w if you are downloading waypoints, -r if you are downloading routes and -t if you are downloading tracks. These are command-line options that tell GPSBabel which feature type to download.

%in will be replaced by the port name that you choose in the download window and %out will be replaced by the name you choose for the GPX file that the downloaded data should be stored in. So, if you create a device type with the download command gpsbabel %type -i garmin -o gpx %in %out (this is actually the download command for the predefined device type 'Garmin serial') and then use it to download waypoints from port /dev/ttySO to the file output.gpx, QGIS will replace the keywords and run the command gpsbabel -w -i garmin -o gpx /dev/ttySO output.gpx.

The upload command is the command that is used to upload data to the device. The same keywords are used, but %in is now replaced by the name of the GPX file for the layer that is being uploaded, and %out is replaced by the port name.

You can learn more about GPSBabel and its available command line options at http://www.gpsbabel.org.

Once you have created a new device type, it will appear in the device lists for the download and upload tools.

15.1. GPS Plugin 215

# 15.1.8 Download of points/tracks from GPS units

As described in previous sections QGIS uses GPSBabel to download points/tracks directly in the project. QGIS comes out of the box with a pre-defined profile to download from Garmin devices. Unfortunately there is a bug #6318 that does not allow create other profiles, so downloading directly in QGIS using the GPS Tools is at the moment limited to Garmin USB units.

#### Garmin GPSMAP 60cs

#### MS Windows

Install the Garmin USB drivers from http://www8.garmin.com/support/download details.jsp?id=591

Connect the unit. Open GPS Tools and use type=garmin serial and port=usb: Fill the fields *Layer name* and *Output file*. Sometimes it seems to have problems saving in a certain folder, using something like c:\temp usually works.

#### Ubuntu/Mint GNU/Linux

It is first needed an issue about the permissions of the device, as described at <a href="https://wiki.openstreetmap.org/wiki/USB\_Garmin\_on\_GNU/Linux">https://wiki.openstreetmap.org/wiki/USB\_Garmin\_on\_GNU/Linux</a>. You can try to create a file /etc/udev/rules.d/51-garmin.rules containing this rule

ATTRS{idVendor}=="091e", ATTRS{idProduct}=="0003", MODE="666"

After that is necessary to be sure that the garmin\_gps kernel module is not loaded

rmmod garmin\_gps

and then you can use the GPS Tools. Unfortunately there seems to be a bug #7182 and usually QGIS freezes several times before the operation work fine.

#### BTGP-38KM datalogger (only Bluetooth)

#### MS Windows

The already referred bug does not allow to download the data from within QGIS, so it is needed to use GPSBabel from the command line or using its interface. The working command is

gpsbabel -t -i skytraq,baud=9600,initbaud=9600 -f COM9 -o gpx -F C:/GPX/aaa.gpx

### Ubuntu/Mint GNU/Linux

Use same command (or settings if you use GPSBabel GUI) as in Windows. On Linux it maybe somehow common to get a message like

skytraq: Too many read errors on serial port

it is just a matter to turn off and on the datalogger and try again.

# BlueMax GPS-4044 datalogger (both BT and USB)

#### MS Windows

Downloading with GPSBabel, both with USB and BT returns always an error like

```
gpsbabel -t -i mtk -f COM12 -o gpx -F C:/temp/test.gpx
mtk_logger: Can't create temporary file data.bin
Error running gpsbabel: Process exited unsuccessfully with code 1
```

### Ubuntu/Mint GNU/Linux

#### With USB

After having connected the cable use the dmesg command to understand what port is being used, for example /dev/ttyACM3. Then as usual use GPSBabel from the CLI or GUI

```
gpsbabel -t -i mtk -f /dev/ttyACM3 -o gpx -F /home/user/bluemax.gpx
```

#### With Bluetooth

Use Blueman Device Manager to pair the device and make it available through a system port, then run GPSBabel

```
gpsbabel -t -i mtk -f /dev/rfcomm0 -o gpx -F /home/user/bluemax_bt.gpx
```

# 15.2 Live GPS tracking

There are four possible screens in this GPS tracking window:

- / GPS position coordinates and an interface for manually entering vertices and features
- III GPS signal strength of satellite connections
- GPS polar screen showing number and polar position of satellites
- \$\simeq \text{GPS options screen (see figure gps options)}\$

With a plugged-in GPS receiver (has to be supported by your operating system), a simple click on **[Connect]** connects the GPS to QGIS. A second click (now on **[Disconnect]**) disconnects the GPS receiver from your computer. For GNU/Linux, gpsd support is integrated to support connection to most GPS receivers. Therefore, you first have to configure gpsd properly to connect QGIS to it.

Попередження: If you want to record your position to the canvas, you have to create a new vector layer first and switch it to editable status to be able to record your track.

## 15.2.1 Position and additional attributes

If the GPS is receiving signals from satellites, you will see your position in latitude, longitude and altitude together with additional attributes.

## 15.2.2 GPS signal strength

Here, you can see the signal strength of the satellites you are receiving signals from.

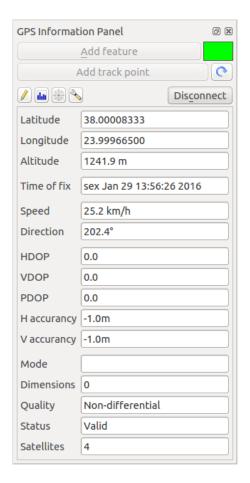
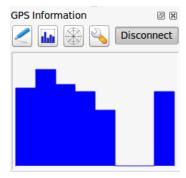


Рис. 15.3: GPS tracking position and additional attributes



 $\mbox{Puc.}$ 15.4: GPS tracking signal strength

# 15.2.3 GPS polar window

If you want to know where in the sky all the connected satellites are, you have to switch to the polar screen. You can also see the ID numbers of the satellites you are receiving signals from.

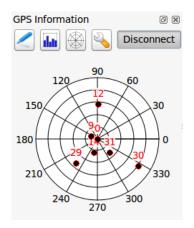


Рис. 15.5: GPS tracking polar window

# 15.2.4 GPS options

🔧 In case of connection problems, you can switch between:

- • Autodetect
- Internal
- Serial device
- gpsd (selecting the Host, Port and Device your GPS is connected to)

A click on [Connect] again initiates the connection to the GPS receiver.

You can activate Automatically save added features when you are in editing mode. Or you can activate Automatically add points to the map canvas with a certain width and color.

Activating Cursor, you can use a slider to shrink and grow the position cursor on the canvas

Activating Map centering allows you to decide in which way the canvas will be updated. This includes 'always', 'when leaving', if your recorded coordinates start to move out of the canvas, or 'never', to keep map extent.

Finally, you can activate **\( \sigma \)** Log file and define a path and a file where log messages about the GPS tracking are logged.

If you want to set a feature manually, you have to go back to Position and click on [Add Point] or [Add track point].

# 15.2.5 Connect to a Bluetooth GPS for live tracking

With QGIS you can connect a Bluetooth GPS for field data collection. To perform this task you need a GPS Bluetooth device and a Bluetooth receiver on your computer.

At first you must let your GPS device be recognized and paired to the computer. Turn on the GPS, go to the Bluetooth icon on your notification area and search for a New Device.

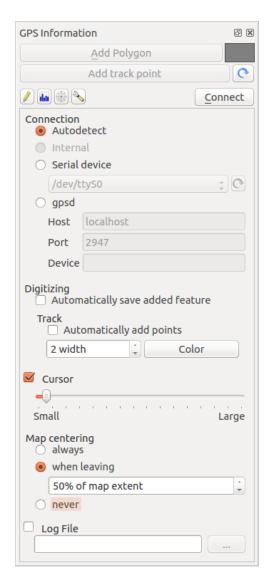


Рис. 15.6: GPS tracking options window

On the right side of the Device selection mask make sure that all devices are selected so your GPS unit will probably appear among those available. In the next step a serial connection service should be available, select it and click on [Configure] button.

Remember the number of the COM port assigned to the GPS connection as resulting by the Bluetooth properties.

After the GPS has been recognized, make the pairing for the connection. Usually the authorization code is 0000.

Now open *GPS information* panel and switch to GPS options screen. Select the COM port assigned to the GPS connection and click the [Connect]. After a while a cursor indicating your position should appear.

If QGIS can't receive GPS data, then you should restart your GPS device, wait 5-10 seconds then try to connect again. Usually this solution work. If you receive again a connection error make sure you don't have another Bluetooth receiver near you, paired with the same GPS unit.

## 15.2.6 Using GPSMAP 60cs

#### **MS Windows**

Easiest way to make it work is to use a middleware (freeware, not open) called GPSGate.

Launch the program, make it scan for GPS devices (works for both USB and BT ones) and then in QGIS just click [Connect] in the Live tracking panel using the Autodetect mode.

### Ubuntu/Mint GNU/Linux

As for Windows the easiest way is to use a server in the middle, in this case GPSD, so

sudo apt-get install gpsd

Then load the garmin\_gps kernel module

sudo modprobe garmin\_gps

And then connect the unit. Then check with dmesg the actual device being used but he unit, for example /dev/ttyUSBO. Now you can launch gpsd

gpsd /dev/ttyUSB0

And finally connect with the QGIS live tracking tool.

# 15.2.7 Using BTGP-38KM datalogger (only Bluetooth)

Using GPSD (under Linux) or GPSGate (under Windows) is effortless.

# 15.2.8 Using BlueMax GPS-4044 datalogger (both BT and USB)

### **MS Windows**

The live tracking works for both USB and BT modes, by using GPSGate or even without it, just use the Autodetect mode, or point the tool the right port.

# Ubuntu/Mint GNU/Linux

### For USB

The live tracking works both with GPSD

gpsd /dev/ttyACM3

or without it, by connecting the QGIS live tracking tool directly to the device (for example /dev/ttyACM3).

## For Bluetooth

The live tracking works both with GPSD

gpsd /dev/rfcomm0

or without it, by connecting the QGIS live tracking tool directly to the device (for example /dev/rfcomm0).

# **Authentication System**

# 16.1 Authentication System Overview

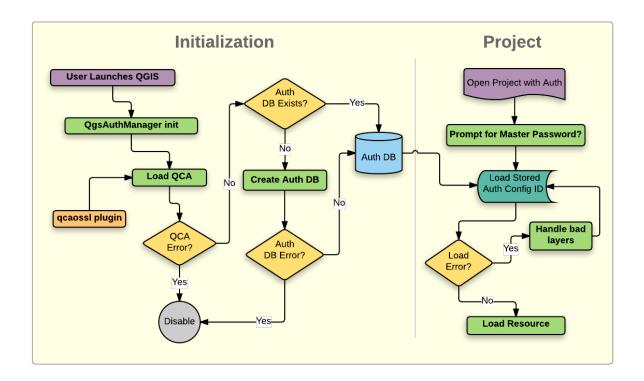


Рис. 16.1: Anatomy of authentication system

#### 16.1.1 Authentication database

The new authentication system stores authentication configurations in an SQLite database file located, by default, at:

 ${\ensuremath{\mbox{\sc dis} 2\qgis-auth.db}}$ 

This authentication database can be moved between QGIS installations without affecting other current QGIS user preferences, as it is completely separate from normal QGIS settings. A configuration ID (a random 7-character alphanumeric string) is generated when initially storing a configuration to the database. This represents the configuration, thereby allowing the ID to be stored in plain text application components, (such as project, plugin, or settings files) without disclosure of its associated credentials.

**Примітка:** The parent directory of the *qgis-auth.db* can be set using the following environment variable, QGIS\_AUTH\_DB\_DIR\_PATH, or set on the command line during launch with the --authdbdirectory option.

## 16.1.2 Master password

To store or access sensitive information within the database, a user must define a master password. A new master password is requested and verified when initially storing any encrypted data to the database. Only when sensitive information is accessed is the user prompted for the master password, which is then cached for the remainder of the session (until application is quit), unless the user manually chooses an action to clear its cached value. Some instances of using the authentication system do not require input of the master password, such as when selecting an existing authentication configuration, or applying a configuration to a server configuration (such as when adding a WMS layer).

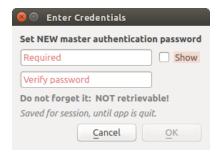


Рис. 16.2: Input new master password

Примітка: A path to a file containing the master password can be set using the following environment variable, QGIS\_AUTH\_PASSWORD\_FILE.

### Managing the master password

Once set, the master password can be reset; the current master password will be needed prior to resetting. During this process, there is an option to generate a complete backup of the current database.



Рис. 16.3: Resetting master password

If the user forgets the master password, there is no way to retrieve or override it. There is also no means of retrieving encrypted information without knowing the master password.

If a user inputs their existing password incorrectly three times, the dialog will offer to erase the database.



Рис. 16.4: Password prompt after three invalid attempts

# 16.1.3 Authentication Configurations

You can manage authentication configurations from Configurations in the Authentication tab of the QGIS Options dialog (Settings  $\rightarrow$  Options).

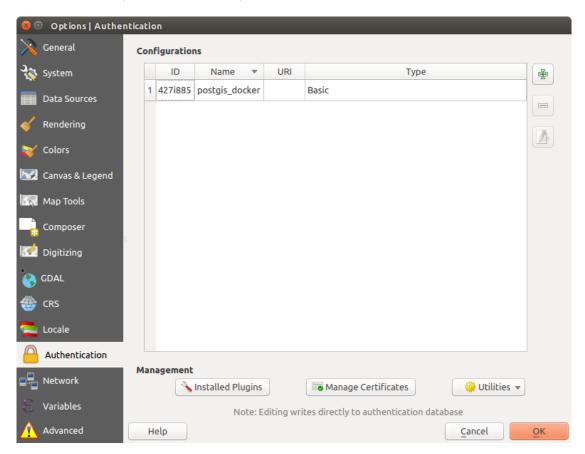


Рис. 16.5: Configurations editor

Use the button to add a new configuration, the button to remove configurations, and the button to modify existing ones.

The same type of operations for authentication configuration management (Add, Edit and Remove) can be done when configuring a given service connection, such as configuring an OWS service connection. For that, there are action buttons within the configuration selector for fully managing configurations found within the authentication database. In this case, there is no need to go to the *configurations* in *Authentication* tab of QGIS options unless you need to do more comprehensive configuration management.

When creating or editing an authentication configuration, the info required is a name, an authentication method and any other info that the authentication method requires (see more about the available authentication types in *Authentication Methods*).

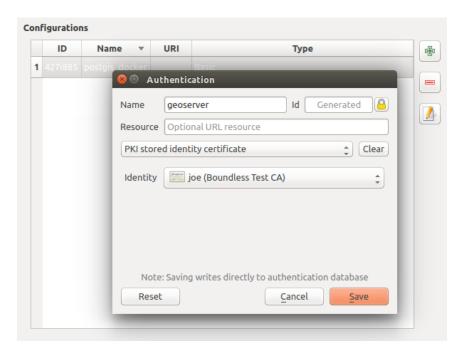


Рис. 16.6: Adding config from within Configuration editor

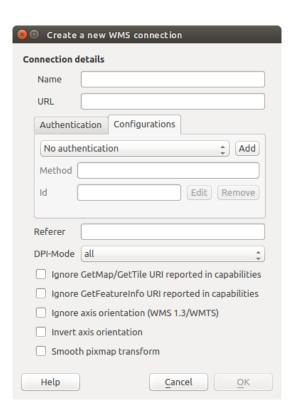


Рис. 16.7: WMS connection dialog showing [Add], [Edit], and [Remove] authentication configuration buttons

### 16.1.4 Authentication Methods

Available authentications are provided by C++ plugins much in the same way data provider plugins are supported by QGIS. The method of authentication that can be selected is relative to the access needed for the resource/provider, e.g. HTTP(S) or database, and whether there is support in both QGIS code and a plugin. As such, some authentication method plugins may not be applicable everywhere an authentication configuration selector is shown. A list of available authentication method plugins and their compatible resource/providers can be accessed going to Settings -> Option and, in the Authentication tab, click the **Installed plugins** button.

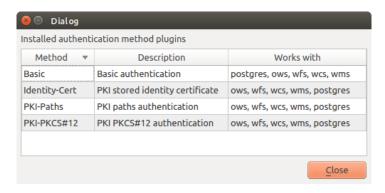


Рис. 16.8: Available method plugins list

Plugins can be created for new authentication methods that do not require QGIS to be recompiled. Since the support for plugins is currently (since QGIS 2.12) C++-only, QGIS will need to be restarted for the new dropped-in plugin to become available to the user. Ensure your plugin is compiled against the same target version of QGIS if you intend to add it to an existing target install.

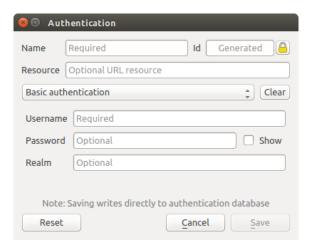


Рис. 16.9: Basic HTTP authentication configs

Примітка: The Resource URL is currently an *unimplemented* feature that will eventually allow a particular configuration to be auto-chosen when connecting to resources at a given URL.

# 16.1.5 Master Password and Auth Config Utilities

Under the Options menu ( $Settings \rightarrow Options$ ) in the Authentication tab, there are several utility actions to manage the authentication database and configurations:

• Input master password — Opens the master password input dialog, independent of performing any auth db command. Clear cached master password—Unsets the master password if it has been



Рис. 16.10: PKI paths authentication configs

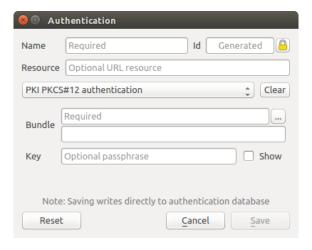
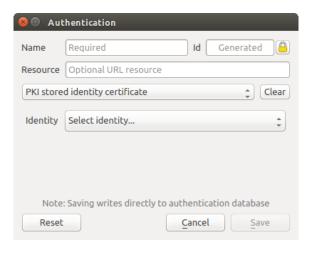


Рис. 16.11: PKI PKCS#12 file paths authentication configs



 $\mbox{Puc.}$  16.12: Stored Identity authentication configs



Рис. 16.13: Utilities menu

set via input dialog. Reset master password—Opens a dialog to change the master password (the current password must be known) and optionally back up the current database.

- Clear cached authentication configurations Clears the internal lookup cache for configurations used to speed up network connections. This does not clear QGIS's core network access manager's cache, which requires a relaunch of QGIS.
- Reset master password Replaces the current master password for a new one. The current master password will be needed prior to resetting and a backup of database can be done.
- Remove all authentication configurations Clears the database of all configuration records, without removing other stored records.
- Erase authentication database Schedules a backup of the current database and complete rebuild of the database table structure. These actions are scheduled for a later time, so as to ensure other operations like project loading do not interrupt the operation or cause errors due to a temporarily missing database.



Рис. 16.14: DB erase verification menu

## 16.1.6 Using authentication configurations

Typically, an authentication configuration is selected in a configuration dialog for a network services (such as WMS). However, the selector widget can be embedded anywhere authentication is needed or in non-core functionality, like in third-party PyQGIS or C++ plugins.

When using the selector, *No authentication* is displayed in the pop-up menu control when nothing is selected, when there are no configurations to choose from, or when a previously assigned configuration can no longer be found in the database. The *Type* and *Id* fields are read-only and provide a description of the authentication method and the config's ID respectively.

### 16.1.7 Python bindings

All classes and public functions have sip bindings, except QgsAuthCrypto, since management of the master password hashing and auth database encryption should be handled by the main app, and not via Python. See Security Considerations concerning Python access.



Рис. 16.15: Auth config selector with no autentication



Рис. 16.16: Auth config selector with config selected

# 16.2 User Authentication Workflows

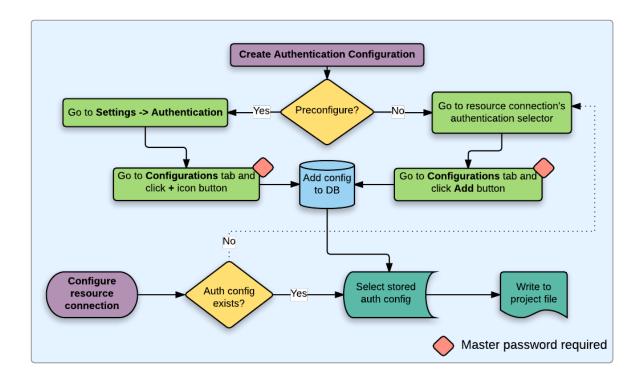


Рис. 16.17: Generic user workflow

# 16.2.1 HTTP(S) authentication

One of the most common resource connections is via HTTP(S), e.g. web mapping servers, and authentication method plugins often work for these types of connections. Method plugins have access to the HTTP request object and can manipulate both the request as well as its headers. This allows for many forms of internet-based authentication. When connecting via HTTP(S) using the standard username/password authentication method will attempt HTTP BASIC authentication upon connection.

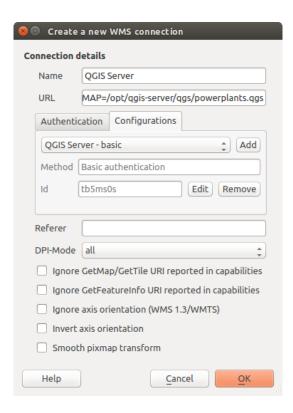


Рис. 16.18: Configuring a WMS connection for HTTP BASIC

#### 16.2.2 Database authentication

Connections to database resources are generally stored as key=value pairs, which will expose usernames and (optionally) passwords, if *not* using an authentication configuration. When configuring with the new auth system, the key=value will be an abstracted representation of the credentials, e.g. authfg=81t21b9

### 16.2.3 PKI authentication

When configuring PKI components within the authentication system, you have the option of importing components into the database or referencing component files stored on your filesystem. The latter may be useful if such components change frequently, or where the components will be replaced by a system administrator. In either instance you will need to store any passphrase needed to access private keys within the database.

All PKI components can be managed in separate editors within the **Certificate Manager**, which can be accessed in the *Authentication* tab in QGIS *Options* dialog ( $Settings \rightarrow Options$ ) by clicking the [Manage certificates] button.

In the Certificate manager, there are editors for Identities, Servers and Authorities. Each of these are contained in their own tabs, and are described below in the order they are encountered in the workflow chart above. The tab order is relative to frequently accessed editors once you are accustomed to the workflow.

Примітка: Because all authentication system edits write immediately to the authentication database, there is no need to click the *Options* dialog [OK] button for any changes to be saved. This is unlike other settings in the Options dialog.



Рис. 16.19: Configuring a Postgres SSL-with-PKI connection

#### **Authorities**

You can manage available Certificate Authorities (CAs) from the **Authorities** tab in the **Certificate** manager from the **Authentication** tab of the QGIS **Options** dialog.

As referenced in the workflow chart above, the first step is to import or reference a file of CAs. This step is optional, and may be unnecessary if your PKI trust chain originates from root CAs already installed in your operating system (OS), such as a certificate from a commercial certificate vendor. If your authenticating root CA is not in the OS's trusted root CAs, it will need to be imported or have its file system path referenced. (Contact your system administrator if unsure.)

By default, the root CAs from your OS are available; however, their trust settings are not inherited. You should review the certificate trust policy settings, especially if your OS root CAs have had their policies adjusted. Any certificate that is expired will be set to untrusted and will not be used in secure server connections, unless you specifically override its trust policy. To see the QGIS-discoverable trust chain for any certificate, select it and click the Show information for certificate.

You can edit the *trust policy* for any selected certificate within the chain. Any change in trust policy to a selected certificate will not be saved to the database unless the Save certificate trust policy change to database button is clicked *per* selected certification. Closing the dialog will **not** apply the policy changes.

You can review the filtered CAs, both intermediate and root certificates, that will be trusted for secure connections or change the default trust policy by clicking the Options button.

Попередження: Changing the default trust policy may result in problems with secure connections.

You can import CAs or save a file system path from a file that contains multiple CAs, or import individual

232

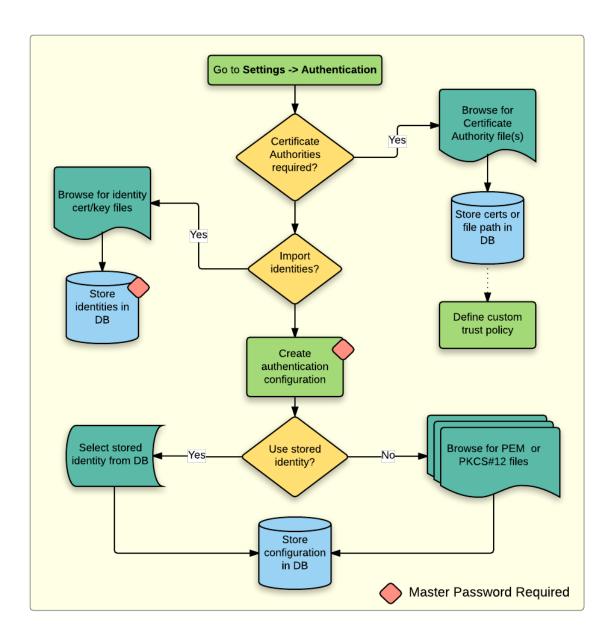


Рис. 16.20: PKI configuration workflow

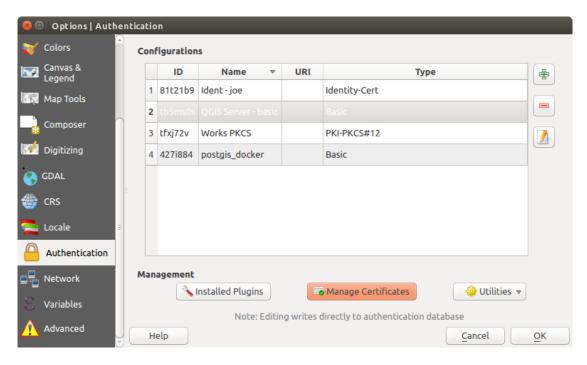


Рис. 16.21: Opening the Certificate Manager

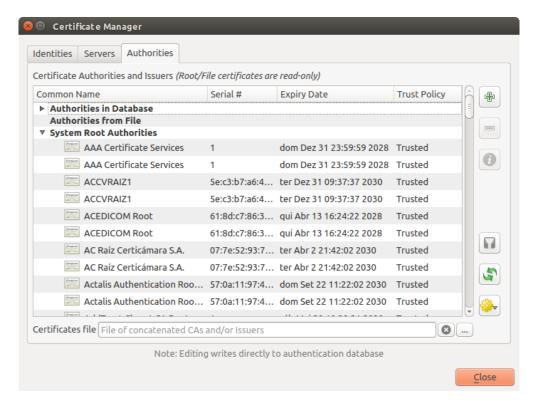


Рис. 16.22: Authorities editor

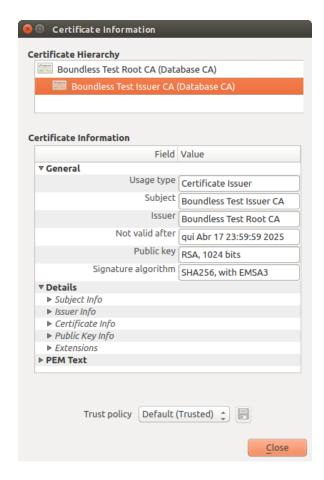


Рис. 16.23: Certificate info dialog



Рис. 16.24: Saving the trust policy changes



Рис. 16.25: Authorities options menu

CAs. The standard PEM format for files that contain multiple CA chain certifications has the root cert at the bottom of the file and all subsequently signed child certificates above, towards the beginning of the file.

The CA certificate import dialog will find all CA certificates within the file, regardless of order, and also offers the option to import certificates that are considered invalid (in case you want to override their trust policy). You can override the trust policy upon import, or do so later within the **Authorities** editor.

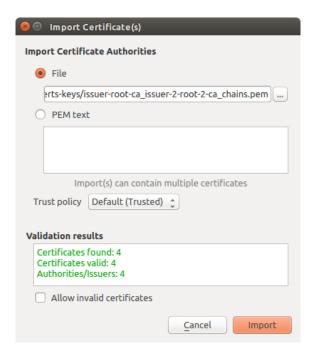


Рис. 16.26: Import certificates dialog

**Примітка:** If you are pasting certificate information into the PEM text field, note that encrypted certificates are not supported.

#### Identities

You can manage available client identity bundles from the *Identities* tab in the *Certificate manager* from the **Authentication** tab of the QGIS **Options** dialog. An identity is what authenticates you against a PKI-enabled service and usually consists of a client certificate and private key, either as separate files or combined into a single "bundled" file. The bundle or private key is often passphrase-protected.

Once you have any Certificate Authorities (CAs) imported you can optionally import any identity bundles into the authentication database. If you do not wish to store the identities, you can reference their component file system paths within an individual authentication configuration.

When importing an identity bundle, it can be passphrase-protected or unprotected, and can contain CA certificates forming a trust chain. Trust chain certifications will not be imported here; they can be added separately under the *Authorities* tab.

Upon import the bundle's certificate and private key will be stored in the database, with the key's storage encrypted using the QGIS master password. Subsequent usage of the stored bundle from the database will only require input of the master password.

Personal identity bundles consisting of PEM/DER (.pem/.der) and PKCS#12 (.p12/.pfx) components are supported. If a key or bundle is passphrase-protected, the password will be required to validate the component prior to import. Likewise, if the client certificate in the bundle is invalid (for example, its effective date has not yet started or has elapsed) the bundle can not be imported.

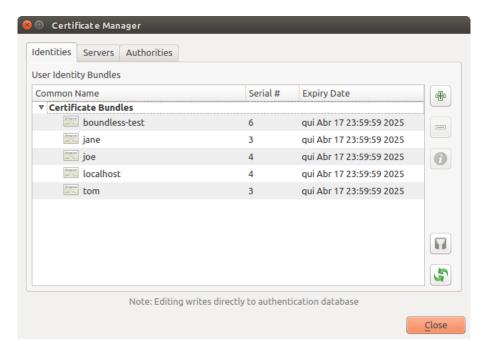


Рис. 16.27: Identities editor



Рис. 16.28: PEM/DER identity import

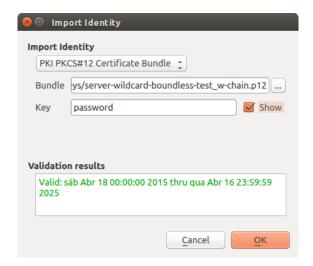


Рис. 16.29: PKCS#12 identity import

# 16.2.4 Handling bad layers

Occasionally, the authentication configuration ID that is saved with a project file is no longer valid, possibly because the current authentication database is different than when the project was last saved, or due to a credentials mismatch. In such cases the *Handle bad layers* dialog will be presented upon QGIS launch.

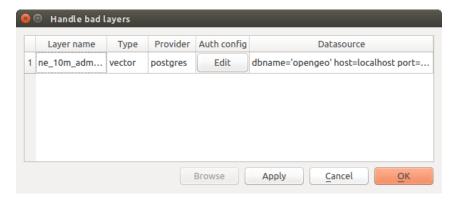


Рис. 16.30: Handle bad layers with authentication

If a data source is found to have an authentication configuration ID associated with it, you will be able to edit it. Doing so will automatically edit the data source string, much in the same way as opening the project file in a text editor and editing the string.

# 16.2.5 Changing authentication config ID

Occasionally, you will need to change the authenticationn configuration ID that is associated with accessing a resource. There are instances where this is useful:

- Resource auth config ID is no longer valid This can occur when you have switched auth databases add need to align a new configuration to the ID already associated with a resource.
- Shared project files If you intended to share projects between users, e.g. via a shared file server, you can predefine a 7-character (containing a-z and/or 0-9) that is associated with the resource. Then, individual users change the ID of an authentication configuration that is specific to their credentials of the resource. When the project is opened, the ID is found in the authentication database, but the credentials are different per user.

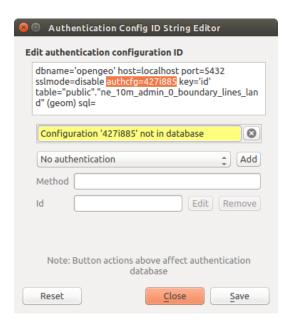


Рис. 16.31: Edit bad layer's authentication config ID

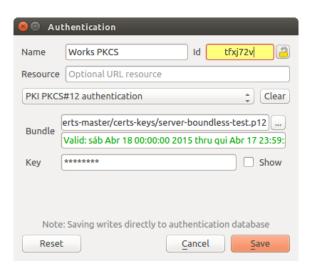


Рис. 16.32: Changing a layer's authentication config ID (unlocked yellow text field)

Попередження: Changing the auth config ID is considered an advanced operation and should only be done with full knowledge as to why it is necessary. This is why there is a lock button that needs clicked, to unlock the ID's text field prior to editing the ID.

### 16.2.6 QGIS Server support

When using a project file, with layers that have authentication configurations, as a basis for a map in QGIS Server, there are a couple of additional setup steps necessary for QGIS to load the resources:

- Authentication database needs to be available
- Authentication database's master password needs to be available

When instantiating the authentication system, Server will create or use qgis-auth.db in ~/.qgis2/ or the directory defined by the QGIS\_AUTH\_DB\_DIR\_PATH environment variable. It may be that the Server's user has no HOME directory, in which case, use the environment variable to define a directory that the Server's user has read/write permissions and is not located within the web-accessible directories.

To pass the master password to Server, write it to the first line of file at a path on the file system readable by the Server processes user and defined using the QGIS\_AUTH\_PASSWORD\_FILE environment variable. Ensure to limit the file as only readable by the Server's process user and to not store the file within web-accessible directories.

 $\Pi$ римітка: QGIS\_AUTH\_PASSWORD\_FILE variable will be removed from the Server environment immediately after accessing

# 16.2.7 SSL server exceptions

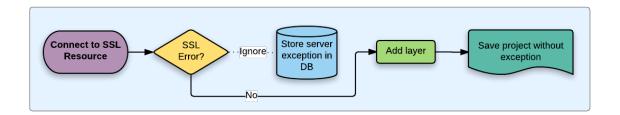


Рис. 16.33: SSL server exception

You can manage SSL server configurations and exceptions from the **Servers** tab in the **Authentication** section of the QGIS **Options** dialog.

Sometimes, when connecting to an SSL server, there are errors with the SSL "handshake" or the server's certificate. You can ignore those errors or create an SSL server configuration as an exception. This is similar to how web browsers allow you to override SSL errors, but with more granular control.

Попередження: You should not create an SSL server configuration unless you have complete knowledge of the entire SSL setup between the server and client. Instead, report the issue to the server administrator.

Примітка: Some PKI setups use a completely different CA trust chain to validate client identities than the chain used to validate the SSL server certificate. In such circumstances, any configuration created for the connecting server will not necessarily fix an issue with the validation of your client identity, and only your client identity's issuer or server administrator can fix the issue.

You can pre-configure an SSL server configuration by clicking the button. Alternatively, you can add a configuration when an SSL error occurs during a connection and you are presented with an SSL Error dialog (where the error can be ignored temporarily or saved to the database and ignored):

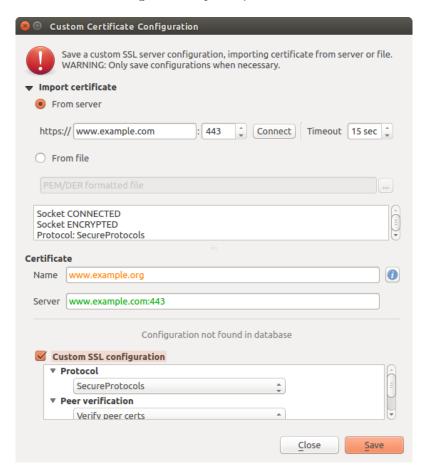


Рис. 16.34: Manually adding configuration

Once an SSL configuration is saved to the database, it can be edited or deleted.

If you want to pre-configure an SSL configuration and the import dialog is not working for your server's connection, you can manually trigger a connection via the **Python Console** by running the following code (replace https://bugreports.qt-project.org with the URL of your server):

```
from PyQt4.QtNetwork import *
req = QNetworkRequest(QUrl('https://bugreports.qt-project.org'))
reply = QgsNetworkAccessManager.instance().get(req)
```

This will open an SSL error dialog if any errors occur, where you can choose to save the configuration to the database.

# 16.3 Security Considerations

Once the master password is entered, the API is open to access authentication configs in the authentication database, similar to how Firefox works. However, in the initial implementation, no wall against PyQGIS access has been defined. This may lead to issues where a user downloads/installs a malicious PyQGIS plugin or standalone app that gains access to authentication credentials.

The quick solution for initial release of feature is to just not include most PyQGIS bindings for the authentication system.

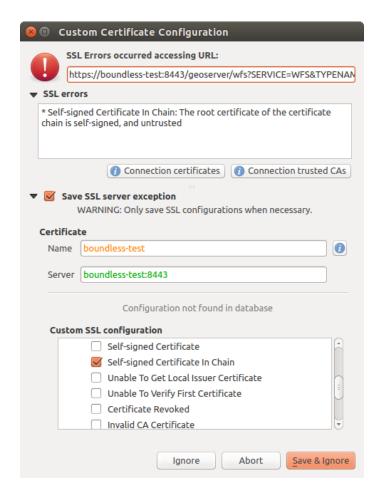


Рис. 16.35: Adding configuration during SSL error

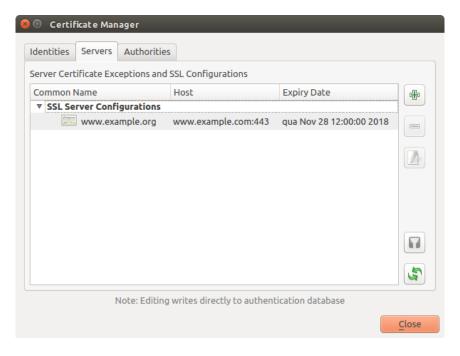


Рис. 16.36: Existing SSL configuration



Рис. 16.37: Editing an existing SSL configuration

Another simple, though not robust, fix is to add a combobox in  $Settings \to Options \to Authentication$  (defaults to "never"):

```
"Allow Python access to authentication system"

Choices: [ confirm once per session | always confirm | always allow | never]
```

Such an option's setting would need to be saved in a location non-accessible to Python, e.g. the authentication database, and encrypted with the master password.

- Another option may be to track which plugins the user has specifically
- allowed to access the authentication system, though it may be tricky to deduce which plugin is actually making the call.
- Sandboxing plugins, possibly in their own virtual environments, would reduce 'cross-plugin' hacking of authentication configs from another plugin that is authorized. This might mean limiting cross-plugin communication as well, but maybe only between third-party plugins.
- Another good solution is to issue code-signing certificates to vetted plugin authors. Then validate the plugin's certificate upon loading. If need be the user can also directly set an untrusted policy for the certificate associated with the plugin using existing certificate management dialogs.
- Alternatively, access to sensitive authentication system data from Python
- could never be allowed, and only the use of QGIS core widgets, or duplicating authentication system integrations, would allow the plugin to work with resources that have an authentication configuration, while keeping master password and authentication config loading in the realm of the main app.

The same security concerns apply to C++ plugins, though it will be harder to restrict access, since there is no function binding to simply be removed as with Python.

# 16.3.1 Restrictions

The confusing licensing and exporting issues associated with OpenSSL apply. In order for Qt to work with SSL certificates, it needs access to the OpenSSL libraries. Depending upon how Qt was compiled, the default is to dynamically link to the OpenSSL libs at run-time (to avoid the export limitations).

QCA follows a similar tactic, whereby linking to QCA incurs no restrictions, because the qca-ossl (OpenSSL) plugin is loaded at run-time. The qca-ossl plugin is directly linked to the OpenSSL libs. Packagers would be the ones needing to ensure any OpenSSL-linking restrictions are met, if they ship the plugin. Maybe. I don't really know. I'm not a lawyer.

The authentication system safely disables itself when qca-ossl is not found at run-time.

# **GRASS GIS Integration**

GRASS integration provides access to GRASS GIS databases and functionalities (see GRASS-PROJECT in *Literature and Web References*). The integration consists of two parts: provider and plugin. The provider allows to browse, manage and visualize GRASS raster and vector layers. The plugin can be used to create new GRASS locations and mapsets, change GRASS region, create and edit vector layers and analyze GRASS 2-D and 3-D data with more than 400 GRASS modules. In this section, we'll introduce the provider and plugin functionalities and give some examples of managing and working with GRASS data.

The provider supports GRASS version 6 and 7, the plugin supports GRASS 6 and 7 (starting from QGIS 2.12). QGIS distribution may contain provider/plugin for either GRASS 6 or GRASS 7 or for both versions at the same time (binaries have different file names). Only one version of the provider/plugin may be loaded on runtime however.

### 17.1 Demo dataset

As an example, we will use the QGIS Alaska dataset (see section *Sample Data*). It includes a small sample GRASS LOCATION with three vector layers and one raster elevation map. Create a new folder called grassdata, download the QGIS 'Alaska' dataset qgis\_sample\_data.zip from http://download.osgeo.org/qgis/data/ and unzip the file into grassdata.

More sample GRASS LOCATIONs are available at the GRASS website at http://grass.osgeo.org/download/sample-data/.

# 17.2 Loading GRASS raster and vector layers

If the provider is loaded in QGIS, the location item with GRASS  $\forall$  icon is added in the browser tree under each folder item which contains GRASS location. Go to the folder grassdata and expand location alaska and mapset demo.

You can load GRASS raster and vector layers like any other layer from the browser either by double click on layer item or by dragging and dropping to map canvas or legend.

### Порада: GRASS Data Loading

If you don't see GRASS location item, verify in  $Help \to About \to Providers$  if GRASS vector provider is loaded.

# 17.3 Importing data into a GRASS LOCATION via drag and drop

This section gives an example of how to import raster and vector data into a GRASS mapset.

- 1. In QGIS browser navigate to the mapset you want to import data into.
- 2. In QGIS browser find a layer you want to import to GRASS, note that you can open another instance of the browser (Browser Panel (2)) if source data are too far from the mapset in the tree.
- 3. Drag a layer and drop it on the target mapset. The imported may take some time for larger layers, you will see animated icon in front of new layer item until the import finishes.

Where raster data are in different CRS, they can be reprojected using an *Approximate* (fast) or *Exact* (precise) transformation. If a link to the source raster is created (using r.external), the source data are in the same CRS and the format is known to GDAL, the source data CRS will be used. You can set these options in the *Browser* tab in *GRASS Options*.

If a source raster has more bands, a new GRASS map is created for each layer with .<br/>
band number>
suffix and group of all maps with icon is created. External rasters have a different icon.

# 17.4 Managing GRASS data in QGIS browser

- Copying maps: GRASS maps may be copied between mapsets within the same location using drag and drop.
- Deleting maps: Right click on a GRASS map and select *Delete* from context menu.
- Renaming maps: Right click on a GRASS map and select Rename from context menu.

# 17.5 GRASS Options

GRASS options may be set in GRASS Options dialog, which can be opened by right clicking on the location or mapset item in the browser and then choosing GRASS Options.

# 17.6 Starting the GRASS plugin

To use GRASS functionalities in QGIS, you must select and load the GRASS plugin using the Plugin Manager. To do this, go to the menu  $Plugins \rightarrow \textcircled{} Manage$  and  $Install\ Plugins...$ , select GRASS and click [OK].

The following main features are provided with the toolbar menu when you start the GRASS plugin:

- Open Mapset
- New Mapset
- Close Mapset
- M Open GRASS Tools
- Display Current GRASS Region
- RASS Options

## 17.7 Opening GRASS mapset

A GRASS mapset must be opened to get access to GRASS Tools in the plugin (the tools are disabled if no mapset is open). You can open a mapset from the browser: right click on mapset item and then choose *Open mapset* from context menu.

## 17.8 GRASS LOCATION and MAPSET

GRASS data are stored in a directory referred to as GISDBASE. This directory, often called grassdata, must be created before you start working with the GRASS plugin in QGIS. Within this directory, the GRASS GIS data are organized by projects stored in subdirectories called LOCATIONs. Each LOCATION is defined by its coordinate system, map projection and geographical boundaries. Each LOCATION can have several MAPSETs (subdirectories of the LOCATION) that are used to subdivide the project into different topics or subregions, or as workspaces for individual team members (see Neteler & Mitasova 2008 in Literature and Web References). In order to analyse vector and raster layers with GRASS modules, you generally have to import them into a GRASS LOCATION. (This is not strictly true — with the GRASS modules r.external and v.external you can create read-only links to external GDAL/OGR-supported datasets without importing them. This is not the usual way for beginners to work with GRASS, therefore this functionality will not be described here.)

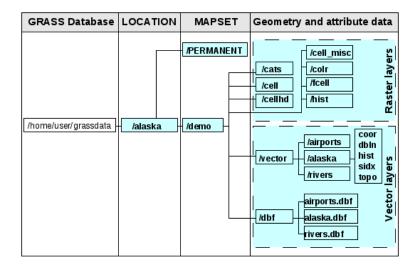


Рис. 17.1: GRASS data in the alaska LOCATION

# 17.9 Importing data into a GRASS LOCATION

See section Importing data into a GRASS LOCATION via drag and drop to find how data can be easily imported by dragging and dropping in the browser.

This section gives an example of how to import raster and vector data into the 'alaska' GRASS LOCATION provided by the QGIS 'Alaska' dataset in traditional way, using standard GRASS modules. Therefore, we use the landcover raster map landcover.img and the vector GML file lakes.gml from the QGIS 'Alaska' dataset (see Sample Data).

- 1. Start QGIS and make sure the GRASS plugin is loaded.
- 2. In the GRASS toolbar, click the Open MAPSET icon to bring up the MAPSET wizard.
- 3. Select as GRASS database the folder grassdata in the QGIS Alaska dataset, as LOCATION 'alaska', as MAPSET 'demo' and click [OK].

- 4. Now click the Open GRASS tools icon. The GRASS Toolbox (see section The GRASS Toolbox) dialog appears.
- 5. To import the raster map landcover.img, click the module r.in.gdal in the *Modules Tree* tab. This GRASS module allows you to import GDAL-supported raster files into a GRASS LOCATION. The module dialog for r.in.gdal appears.
- 6. Browse to the folder raster in the QGIS 'Alaska' dataset and select the file landcover.img.
- 7. As raster output name, define landcover\_grass and click [Run]. In the *Output* tab, you see the currently running GRASS command r.in.gdal -o input=/path/to/landcover.img output=landcover\_grass.
- 8. When it says **Successfully finished**, click [**View output**]. The landcover\_grass raster layer is now imported into GRASS and will be visualized in the QGIS canvas.
- 9. To import the vector GML file lakes.gml, click the module v.in.ogr in the *Modules Tree* tab. This GRASS module allows you to import OGR-supported vector files into a GRASS LOCATION. The module dialog for v.in.ogr appears.
- 10. Browse to the folder gml in the QGIS 'Alaska' dataset and select the file lakes.gml as OGR file.
- 11. As vector output name, define lakes\_grass and click [Run]. You don't have to care about the other options in this example. In the *Output* tab you see the currently running GRASS command v.in.ogr -o dsn=/path/to/lakes.gml output=lakes\\_grass.
- 12. When it says **Successfully finished**, click [View output]. The lakes\_grass vector layer is now imported into GRASS and will be visualized in the QGIS canvas.

## 17.9.1 Creating a new GRASS LOCATION

As an example, here is the sample GRASS LOCATION alaska, which is projected in the Albers Equal Area projection using feet as units. This sample GRASS LOCATION alaska will be used for all examples and exercises in the following GRASS-related sections. It is useful to download and install the dataset on your computer (see Sample Data).

- 1. Start QGIS and make sure the GRASS plugin is loaded.
- 2. Visualize the alaska.shp shapefile (see section Loading a layer from a file) from the QGIS Alaska dataset (see Sample Data).
- 3. In the GRASS toolbar, click on the New mapset icon to bring up the MAPSET wizard.
- 4. Select an existing GRASS database (GISDBASE) folder grassdata, or create one for the new LOCATION using a file manager on your computer. Then click [Next].
- 5. We can use this wizard to create a new MAPSET within an existing LOCATION (see section Adding a new MAPSET) or to create a new LOCATION altogether. Select Create new location (see figure\_grass\_location\_2).
- 6. Enter a name for the LOCATION we used 'alaska' and click [Next].
- 7. Define the projection by clicking on the radio button Projection to enable the projection list.
- 8. We are using Albers Equal Area Alaska (feet) projection. Since we happen to know that it is represented by the EPSG ID 2964, we enter it in the search box. (Note: If you want to repeat this process for another LOCATION and projection and haven't memorized the EPSG ID, click on the CRS Status icon in the lower right-hand corner of the status bar (see section Working with Projections)).
- 9. In Filter, insert 2964 to select the projection.
- 10. Click [Next].

- 11. To define the default region, we have to enter the LOCATION bounds in the north, south, east, and west directions. Here, we simply click on the button [Set current QGIS extent], to apply the extent of the loaded layer alaska.shp as the GRASS default region extent.
- 12. Click [Next].
- 13. We also need to define a MAPSET within our new LOCATION (this is necessary when creating a new LOCATION). You can name it whatever you like we used 'demo'. GRASS automatically creates a special MAPSET called PERMANENT, designed to store the core data for the project, its default spatial extent and coordinate system definitions (see Neteler & Mitasova 2008 in *Literature and Web References*).
- 14. Check out the summary to make sure it's correct and click [Finish].
- 15. The new LOCATION, 'alaska', and two MAPSETS, 'demo' and 'PERMANENT', are created. The currently opened working set is 'demo', as you defined.
- 16. Notice that some of the tools in the GRASS toolbar that were disabled are now enabled.

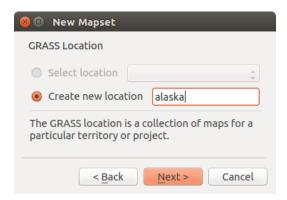


Рис. 17.2: Creating a new GRASS LOCATION or a new MAPSET in QGIS

If that seemed like a lot of steps, it's really not all that bad and a very quick way to create a LOCATION. The LOCATION 'alaska' is now ready for data import (see section *Importing data into a GRASS LOCATION*). You can also use the already-existing vector and raster data in the sample GRASS LOCATION 'alaska', included in the QGIS 'Alaska' dataset *Sample Data*, and move on to section *The GRASS vector data model*.

#### 17.9.2 Adding a new MAPSET

A user has write access only to a GRASS MAPSET which he or she created. This means that besides access to your own MAPSET, you can read maps in other users' MAPSETs (and they can read yours), but you can modify or remove only the maps in your own MAPSET.

All MAPSETs include a WIND file that stores the current boundary coordinate values and the currently selected raster resolution (see Neteler & Mitasova 2008 in *Literature and Web References*, and section *The GRASS region tool*).

- 1. Start QGIS and make sure the GRASS plugin is loaded.
- 2. In the GRASS toolbar, click on the Wew mapset icon to bring up the MAPSET wizard.
- 3. Select the GRASS database (GISDBASE) folder grassdata with the LOCATION 'alaska', where we want to add a further MAPSET called 'test'.
- 4. Click [Next].
- 5. We can use this wizard to create a new MAPSET within an existing LOCATION or to create a new LOCATION altogether. Click on the radio button Select location (see figure\_grass\_location\_2) and click [Next].

- 6. Enter the name text for the new MAPSET. Below in the wizard, you see a list of existing MAPSETs and corresponding owners.
- 7. Click [Next], check out the summary to make sure it's all correct and click [Finish].

#### 17.10 The GRASS vector data model

It is important to understand the GRASS vector data model prior to digitizing. In general, GRASS uses a topological vector model. This means that areas are not represented as closed polygons, but by one or more boundaries. A boundary between two adjacent areas is digitized only once, and it is shared by both areas. Boundaries must be connected and closed without gaps. An area is identified (and labelled) by the **centroid** of the area.

Besides boundaries and centroids, a vector map can also contain points and lines. All these geometry elements can be mixed in one vector and will be represented in different so-called 'layers' inside one GRASS vector map. So in GRASS, a layer is not a vector or raster map but a level inside a vector layer. This is important to distinguish carefully. (Although it is possible to mix geometry elements, it is unusual and, even in GRASS, only used in special cases such as vector network analysis. Normally, you should prefer to store different geometry elements in different layers.)

It is possible to store several 'layers' in one vector dataset. For example, fields, forests and lakes can be stored in one vector. An adjacent forest and lake can share the same boundary, but they have separate attribute tables. It is also possible to attach attributes to boundaries. An example might be the case where the boundary between a lake and a forest is a road, so it can have a different attribute table.

The 'layer' of the feature is defined by the 'layer' inside GRASS. 'Layer' is the number which defines if there is more than one layer inside the dataset (e.g., if the geometry is forest or lake). For now, it can be only a number. In the future, GRASS will also support names as fields in the user interface.

Attributes can be stored inside the GRASS LOCATION as dBase, SQLite3 or in external database tables, for example, PostgreSQL, MySQL, Oracle, etc.

Attributes in database tables are linked to geometry elements using a 'category' value.

'Category' (key, ID) is an integer attached to geometry primitives, and it is used as the link to one key column in the database table.

#### Порада: Learning the GRASS Vector Model

The best way to learn the GRASS vector model and its capabilities is to download one of the many GRASS tutorials where the vector model is described more deeply. See  $\frac{\text{http:}}{\text{grass.osgeo.org/documentation/manuals}}$  for more information, books and tutorials in several languages.

# 17.11 Creating a new GRASS vector layer

To create a new GRASS vector layer, select one of following items from mapset context menu in the browser:

- New Point Layer
- New Line Layer
- New Polygon Layer

and enter a name in the dialog. A new vector map will be created and layer will be added to canvas and editing started. Selecting type of the layer does not restrict geometry types which can be digitized in the vector map. In GRASS, it is possible to organize all sorts of geometry types (point, line and polygon) in one vector map. The type is only used to add the layer to the canvas, because QGIS requires a layer to have a specific type.

It is also possible to add layers to existing vector maps selecting one of the items described above from context menu of existing vector map.

In GRASS, it is possible to organize all sorts of geometry types (point, line and area) in one layer, because GRASS uses a topological vector model, so you don't need to select the geometry type when creating a new GRASS vector. This is different from shapefile creation with QGIS, because shapefiles use the Simple Feature vector model (see section *Creating new Vector layers*).

# 17.12 Digitizing and editing a GRASS vector layer

GRASS vector layers can be digitized using the standard QGIS digitizing tools. There are however some particularities, which you should know about, due to

- GRASS topological model versus QGIS simple feature
- complexity of GRASS model
  - multiple layers in single maps
  - multiple geometry types in single map
  - geometry sharing by multiple features from multiple layers

The particularities are discussed in the following sections.

#### Save, discard changes, undo, redo

Попередження: All the changes done during editing are immediately written to vector map and related attribute tables.

Changes are written after each operation, it is however, possible to do undo/redo or discard all changes when closing editing. If undo or discard changes is used, original state is rewritten in vector map and attribute tables.

There are two main reasons for this behaviour:

- It is the nature of GRASS vectors coming from conviction that user wants to do what he is doing and it is better to have data saved when the work is suddenly interrupted (for example, blackout)
- Necessity for effective editing of topological data is visualized information about topological correctness, such information can only be acquired from GRASS vector map if changes are written to the map.

#### Toolbar

The 'Digitizing Toolbar' has some specific tools when a GRASS layer is edited:

Icon	Tool	Purpose
• 🔯	New Point	Digitize new point
V N	New Line	Digitize new line
	New Boundary	Digitize new boundary
	New Centroid	Digitize new centroid (label existing area)
*	New Closed Boundary	Digitize new closed boundary

Table GRASS Digitizing 1: GRASS Digitizing Tools

## Порада: Digitizing polygons in GRASS

If you want to create a polygon in GRASS, you first digitize the boundary of the polygon. Then you add a centroid (label point) into the closed boundary. The reason for this is that a topological vector model links the attribute information of a polygon always to the centroid and not to the boundary.

#### Category

Category, often called cat, is sort of ID. The name comes from times when GRASS vectors had only singly attribute "category". Category is used as a link between geometry and attributes. A single geometry may have multiple categories and thus represent multiple features in different layers. Currently it is possible to assign only one category per layer using QGIS editing tools. New features have automatically assigned new unique category, except boundaries. Boundaries usually only form areas and do not represent linear features, it is however possible to define attributes for a boundary later, for example in different layer.

New categories are always created only in currently being edited layer.

It is not possible to assign more categories to geometry using QGIS editing, such data are properly represented as multiple features, and individual features, even from different layers, may be deleted.

#### Attributes

Attributes of currently edited layer can only be modified. If the vector map contains more layers, features of other layers will have all attributes set to '<not editable (layer #)>' to warn you that such attribute is not editable. The reason is, that other layers may have and usually have different set of fields while QGIS only supports one fixed set of fields per layer.

If a geometry primitive does not have a category assigned, a new unique category is automatically assigned and new record in attribute table is created when an attribute of that geometry is changed.

Порада: If you want to do bulk update of attributes in table, for example using 'Field Calculator' (Field Calculator), and there are features without category which you don't want to update (typically boundaries), you can filter them out by setting 'Advanced Filter' to cat is not null.

#### Editing style

The topological symbology is essential for effective editing of topological data. When editing starts, a specialized 'GRASS Edit' renderer is set on the layer automatically and original renderer is restored when editing is closed. The style may be customized in layer properties 'Style' tab. The style can also be stored in project file or in separate file as any other style. If you customize the style, do not change its name, because it is used to reset the style when editing is started again.

Порада: Do not save project file when the layer is edited, the layer would be stored with 'Edit Style' which has no meaning if layer is not edited.

The style is based on topological information which is temporarily added to attribute table as field 'topo\_symbol'. The field is automatically removed when editing is closed.

Порада: Do not remove 'topo\_symbol' field from attribute table, that would make features invisible because the renderer is based on that column.

#### Snapping

To form an area, vertices of connected boundaries must have **exactly** the same coordinates. This can be achieved using snapping tool only if canvas and vector map have the same CRS. Otherwise, due conversion from map coordinates to canvas and back, the coordinate may become slightly different due to representation error and CRS transformations.

Порада: Use layer's CRS also for canvas when editing.

#### Limitations

Simultaneous editing of multiple layers within the same vector at the same time is not supported. This is mainly due to the impossibility of handling multiple undo stacks for a single data source.

△ X On Linux and Mac OSX only one GRASS layer can be edited at time. This is due to a bug in GRASS which does not allow to close database drivers in random order. This is being solved with GRASS developers.

#### Порада: GRASS Edit Permissions

You must be the owner of the GRASS MAPSET you want to edit. It is impossible to edit data layers in a MAPSET that is not yours, even if you have write permission.

## 17.13 The GRASS region tool

The region definition (setting a spatial working window) in GRASS is important for working with raster layers. Vector analysis is by default not limited to any defined region definitions. But all newly created rasters will have the spatial extension and resolution of the currently defined GRASS region, regardless of their original extension and resolution. The current GRASS region is stored in the \$LOCATION/\$MAPSET/WIND file, and it defines north, south, east and west bounds, number of columns and rows, horizontal and vertical spatial resolution.

It is possible to switch on and off the visualization of the GRASS region in the QGIS canvas using the Display current GRASS region button.

The region can be modified in 'Region' tab in 'GRASS Tolls' dock widget. Type in the new region bounds and resolution, and click [Apply]. If you click on [Select the extent by dragging on canvas] you can select a new region interactively with your mouse on the QGIS canvas dragging a rectangle.

The GRASS module g.region provides a lot more parameters to define an appropriate region extent and resolution for your raster analysis. You can use these parameters with the GRASS Toolbox, described in section *The GRASS Toolbox*.

### 17.14 The GRASS Toolbox

The Open GRASS Tools box provides GRASS module functionalities to work with data inside a selected GRASS LOCATION and MAPSET. To use the GRASS Toolbox you need to open a LOCATION and MAPSET that you have write permission for (usually granted, if you created the MAPSET). This is necessary, because new raster or vector layers created during analysis need to be written to the currently selected LOCATION and MAPSET.

#### 17.14.1 Working with GRASS modules

The GRASS shell inside the GRASS Toolbox provides access to almost all (more than 300) GRASS modules in a command line interface. To offer a more user-friendly working environment, about 200 of the available GRASS modules and functionalities are also provided by graphical dialogs within the GRASS plugin Toolbox.

A complete list of GRASS modules available in the graphical Toolbox in QGIS version 2.14 is available in the GRASS wiki at  $http://grass.osgeo.org/wiki/GRASS-QGIS\_relevant\_module\_list$ .

It is also possible to customize the GRASS Toolbox content. This procedure is described in section  $Customizing \ the \ GRASS \ Toolbox.$ 

As shown in figure\_grass\_toolbox\_1, you can look for the appropriate GRASS module using the thematically grouped *Modules Tree* or the searchable *Modules List* tab.

By clicking on a graphical module icon, a new tab will be added to the Toolbox dialog, providing three new sub-tabs: *Options*, *Output* and *Manual*.

#### Options

The *Options* tab provides a simplified module dialog where you can usually select a raster or vector layer visualized in the QGIS canvas and enter further module-specific parameters to run the module.

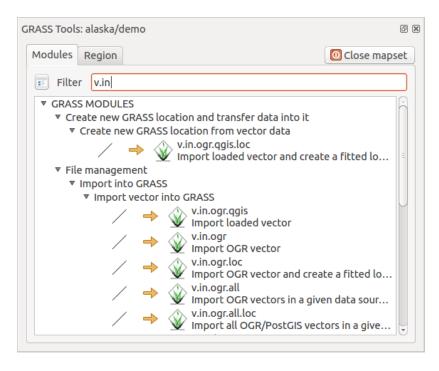


Рис. 17.3: GRASS Toolbox and Module Tree

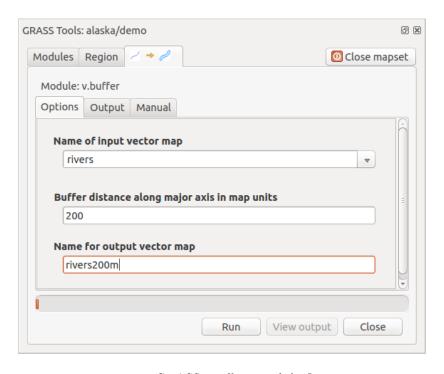


Рис. 17.4: GRASS Toolbox Module Options

The provided module parameters are often not complete to keep the dialog simple. If you want to use further module parameters and flags, you need to start the GRASS shell and run the module in the command line.

A new feature since QGIS 1.8 is the support for a *Show Advanced Options* button below the simplified module dialog in the *Options* tab. At the moment, it is only added to the module v.in.ascii as an example of use, but it will probably be part of more or all modules in the GRASS Toolbox in future versions of QGIS. This allows you to use the complete GRASS module options without the need to switch to the GRASS shell.

#### Output

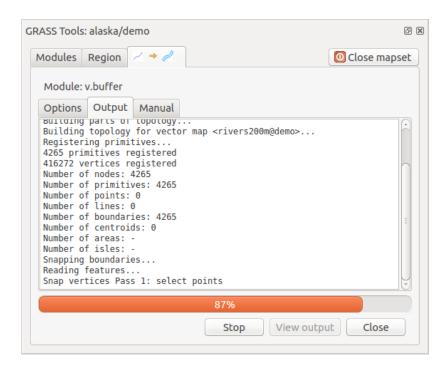


Рис. 17.5: GRASS Toolbox Module Output

The *Output* tab provides information about the output status of the module. When you click the [Run] button, the module switches to the *Output* tab and you see information about the analysis process. If all works well, you will finally see a Successfully finished message.

#### Manual

The *Manual* tab shows the HTML help page of the GRASS module. You can use it to check further module parameters and flags or to get a deeper knowledge about the purpose of the module. At the end of each module manual page, you see further links to the Main Help index, the Thematic index and the Full index. These links provide the same information as the module g.manual.

#### Порада: Display results immediately

If you want to display your calculation results immediately in your map canvas, you can use the 'View Output' button at the bottom of the module tab.

## 17.14.2 GRASS module examples

The following examples will demonstrate the power of some of the GRASS modules.

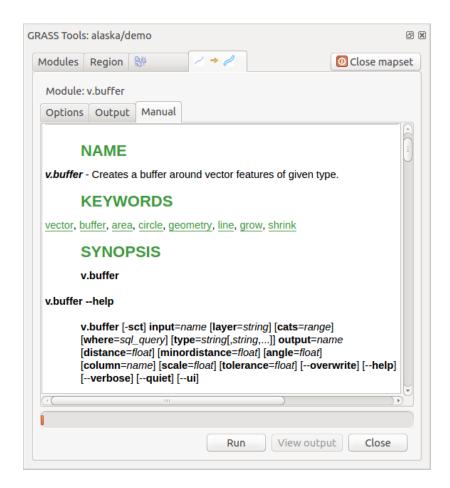


Рис. 17.6: GRASS Toolbox Module Manual

#### Creating contour lines

The first example creates a vector contour map from an elevation raster (DEM). Here, it is assumed that you have the Alaska LOCATION set up as explained in section *Importing data into a GRASS LOCATION*.

- First, open the location by clicking the Open mapset button and choosing the Alaska location.
- Now open the Toolbox with the M Open GRASS tools button.
- In the list of tool categories, double-click  $Raster \rightarrow Surface\ Management \rightarrow Generate\ vector\ contour\ lines$
- Now a single click on the tool **r.contour** will open the tool dialog as explained above (see *Working with GRASS modules*).
- In the Name of input raster map enter gtopo30.
- Type into the *Increment between Contour levels* 1,00 \$\circ\$ the value 100. (This will create contour lines at intervals of 100 meters.)
- Type into the *Name for output vector map* the name ctour\_100.
- Click [Run] to start the process. Wait for several moments until the message Successfully finished appears in the output window. Then click [View Output] and [Close].

Since this is a large region, it will take a while to display. After it finishes rendering, you can open the layer properties window to change the line color so that the contours appear clearly over the elevation raster, as in *The Vector Properties Dialog*.

Next, zoom in to a small, mountainous area in the center of Alaska. Zooming in close, you will notice that the contours have sharp corners. GRASS offers the **v.generalize** tool to slightly alter vector maps while keeping their overall shape. The tool uses several different algorithms with different purposes. Some of the algorithms (i.e., Douglas Peuker and Vertex Reduction) simplify the line by removing some of the vertices. The resulting vector will load faster. This process is useful when you have a highly detailed vector, but you are creating a very small-scale map, so the detail is unnecessary.

#### Порада: The simplify tool

Note that the QGIS fTools plugin has a Simplify geometries  $\rightarrow$  tool that works just like the GRASS v.generalize Douglas-Peuker algorithm.

However, the purpose of this example is different. The contour lines created by **r.contour** have sharp angles that should be smoothed. Among the **v.generalize** algorithms, there is Chaiken's, which does just that (also Hermite splines). Be aware that these algorithms can **add** additional vertices to the vector, causing it to load even more slowly.

- Open the GRASS Toolbox and double-click the categories  $Vector \to Develop \ map \to Generalization$ , then click on the **v.generalize** module to open its options window.
- Check that the 'ctour 100' vector appears as the Name of input vector.
- From the list of algorithms, choose Chaiken's. Leave all other options at their default, and scroll down to the last row to enter in the field *Name for output vector map* 'ctour\_100\_smooth', and click [Run].
- The process takes several moments. Once Successfully finished appears in the output windows, click [View output] and then [Close].
- You may change the color of the vector to display it clearly on the raster background and to contrast with the original contour lines. You will notice that the new contour lines have smoother corners than the original while staying faithful to the original overall shape.

Порада: Other uses for r.contour



Рис. 17.7: GRASS module v.generalize to smooth a vector map

The procedure described above can be used in other equivalent situations. If you have a raster map of precipitation data, for example, then the same method will be used to create a vector map of isohyetal (constant rainfall) lines.

#### Creating a Hillshade 3-D effect

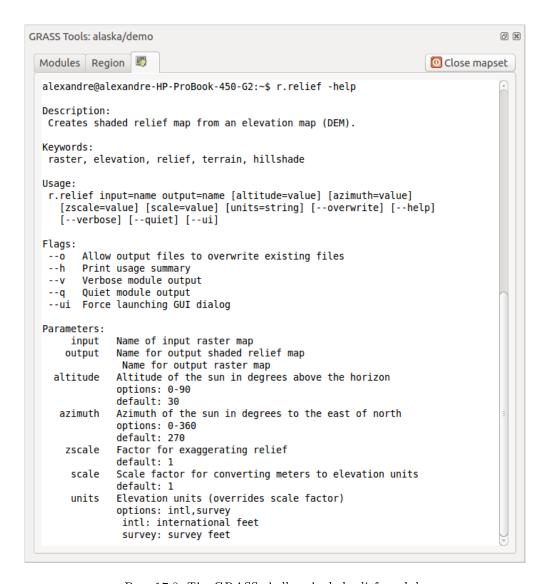
Several methods are used to display elevation layers and give a 3-D effect to maps. The use of contour lines, as shown above, is one popular method often chosen to produce topographic maps. Another way to display a 3-D effect is by hillshading. The hillshade effect is created from a DEM (elevation) raster by first calculating the slope and aspect of each cell, then simulating the sun's position in the sky and giving a reflectance value to each cell. Thus, you get sun-facing slopes lighted; the slopes facing away from the sun (in shadow) are darkened.

- Begin this example by loading the gtopo30 elevation raster. Start the GRASS Toolbox, and under the Raster category, double-click to open Spatial analysis → Terrain analysis.
- Then click **r.shaded.relief** to open the module.
- Change the azimuth angle 1,00  $\updownarrow$  270 to 315.
- Enter gtopo30\_shade for the new hillshade raster, and click [Run].
- When the process completes, add the hillshade raster to the map. You should see it displayed in grayscale.
- To view both the hillshading and the colors of the gtopo30 together, move the hillshade map below the gtopo30 map in the table of contents, then open the *Properties* window of gtopo30, switch to the *Transparency* tab and set its transparency level to about 25%.

You should now have the gtopo30 elevation with its colormap and transparency setting displayed above the grayscale hillshade map. In order to see the visual effects of the hillshading, turn off the gtopo30\_shade map, then turn it back on.

#### Using the GRASS shell

The GRASS plugin in QGIS is designed for users who are new to GRASS and not familiar with all the modules and options. As such, some modules in the Toolbox do not show all the options available, and some modules do not appear at all. The GRASS shell (or console) gives the user access to those additional GRASS modules that do not appear in the Toolbox tree, and also to some additional options to the modules that are in the Toolbox with the simplest default parameters. This example demonstrates the use of an additional option in the **r.shaded.relief** module that was shown above.



 $\mbox{Puc.}$ 17.8: The GRASS shell, r.shaded.relief module

The module **r.shaded.relief** can take a parameter **zmult**, which multiplies the elevation values relative to the X-Y coordinate units so that the hillshade effect is even more pronounced.

- Load the gtopo30 elevation raster as above, then start the GRASS Toolbox and click on the GRASS shell. In the shell window, type the command r.shaded.relief map=gtopo30 shade=gtopo30\_shade2 azimuth=315 zmult=3 and press [Enter].
- After the process finishes, shift to the *Browse* tab and double-click on the new gtopo30\_shade2 raster to display it in QGIS.
- As explained above, move the shaded relief raster below the gtopo30 raster in the table of contents, then check the transparency of the colored gtopo30 layer. You should see that the 3-D effect stands out more strongly compared with the first shaded relief map.

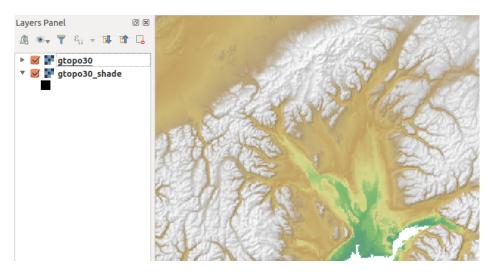


Рис. 17.9: Displaying shaded relief created with the GRASS module r.shaded.relief

#### Raster statistics in a vector map

The next example shows how a GRASS module can aggregate raster data and add columns of statistics for each polygon in a vector map.

- Again using the Alaska data, refer to *Importing data into a GRASS LOCATION* to import the trees shapefile from the shapefiles directory into GRASS.
- Now an intermediate step is required: centroids must be added to the imported trees map to make it a complete GRASS area vector (including both boundaries and centroids).
- From the Toolbox, choose  $Vector \rightarrow Manage\ features$ , and open the module **v.centroids**.
- Enter as the output vector map 'forest areas' and run the module.
- Now load the forest\_areas vector and display the types of forests deciduous, evergreen, mixed in different colors: In the layer *Properties* window, *Symbology* tab, choose from *Legend type* 'Unique value' and set the *Classification field* to 'VEGDESC'. (Refer to the explanation of the symbology tab in *Style Menu* of the vector section.)
- Next, reopen the GRASS Toolbox and open  $Vector \rightarrow Vector \ update$  by other maps.
- Click on the v.rast.stats module. Enter gtopo30 and forest\_areas.
- Only one additional parameter is needed: Enter *column prefix* elev, and click [Run]. This is a computationally heavy operation, which will run for a long time (probably up to two hours).
- Finally, open the forest\_areas attribute table, and verify that several new columns have been added, including elev\_min, elev\_max, elev\_mean, etc., for each forest polygon.

## 17.14.3 Customizing the GRASS Toolbox

Nearly all GRASS modules can be added to the GRASS Toolbox. An XML interface is provided to parse the pretty simple XML files that configure the modules' appearance and parameters inside the Toolbox.

A sample XML file for generating the module v.buffer (v.buffer.qgm) looks like this:

The parser reads this definition and creates a new tab inside the Toolbox when you select the module. A more detailed description for adding new modules, changing a module's group, etc., can be found on the QGIS wiki at  $\frac{\text{http://hub.qgis.org/projects/quantum-gis/wiki/Adding\_New\_Tools\_to\_the\_GRASS\_Toolbox}.$ 

## QGIS processing framework

## 18.1 Introduction

This chapter introduces the QGIS processing framework, a geoprocessing environment that can be used to call native and third-party algorithms from QGIS, making your spatial analysis tasks more productive and easy to accomplish.

In the following sections, we will review how to use the graphical elements of this framework and make the most out of each one of them.

There are four basic elements in the framework GUI, which are used to run algorithms for different purposes. Choosing one tool or another will depend on the kind of analysis that is to be performed and the particular characteristics of each user and project. All of them (except for the batch processing interface, which is called from the toolbox or the algorithm execution dialog, as we will see) can be accessed from the *Processing* menu item. (You will see more than four entries. The remaining ones are not used to execute algorithms and will be explained later in this chapter.)

- The toolbox. The main element of the GUI, it is used to execute a single algorithm or run a batch process based on that algorithm.
- The graphical modeler. Several algorithms can be combined graphically using the modeler to define a workflow, creating a single process that involves several subprocesses.
- The history manager. All actions performed using any of the aforementioned elements are stored in a history file and can be later easily reproduced using the history manager.
- The batch processing interface. This interface allows you to execute batch processes and automate the execution of a single algorithm on multiple datasets.

In the following sections, we will review each one of these elements in detail.

## 18.2 The toolbox

The *Toolbox* is the main element of the processing GUI, and the one that you are more likely to use in your daily work. It shows the list of all available algorithms grouped in different blocks, and it is the access point to run them, whether as a single process or as a batch process involving several executions of the same algorithm on different sets of inputs.

The toolbox contains all the available algorithms, divided into so-called "Providers".

Providers can be (de)activated in the settings dialog. A label in the bottom part of the toolbox will remind you of that whenever there are inactive providers. Use the link in the label to open the settings window and set up providers. We will discuss the settings dialog later in this manual.

By default only, providers that do not rely on third-party applications (that is, those that only require QGIS elements to be run) are active. Algorithms requiring external applications might need additional configuration. Configuring providers is explained in a later chapter in this manual.

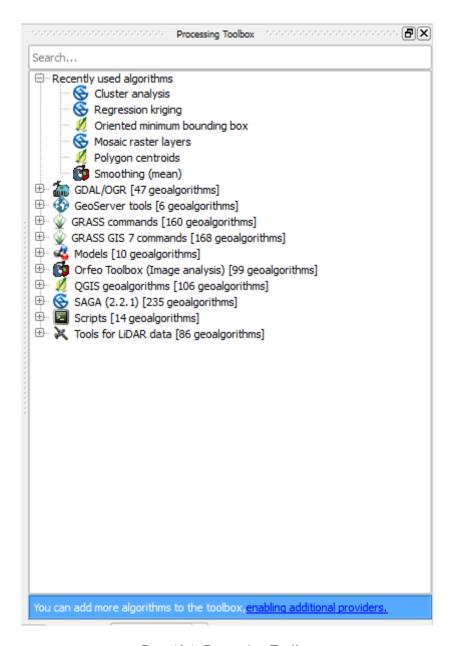


Рис. 18.1: Processing Toolbox

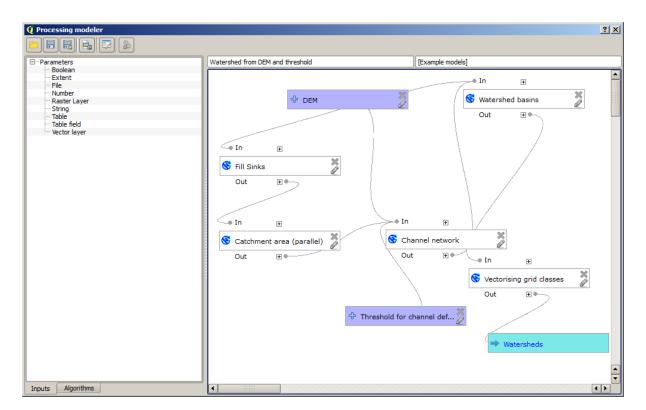


Рис. 18.2: Processing Modeler

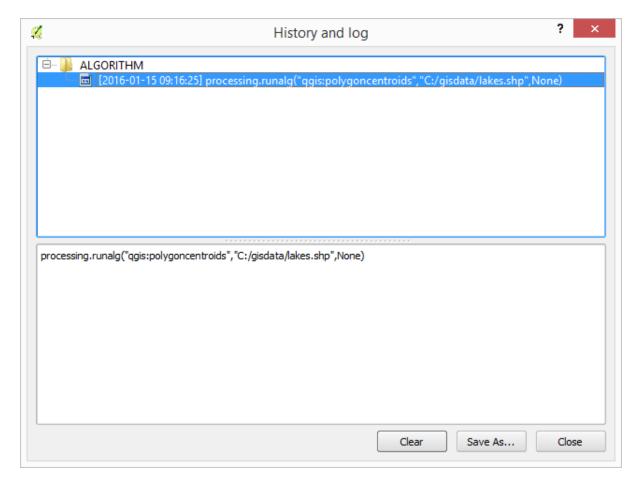


Рис. 18.3: Processing History

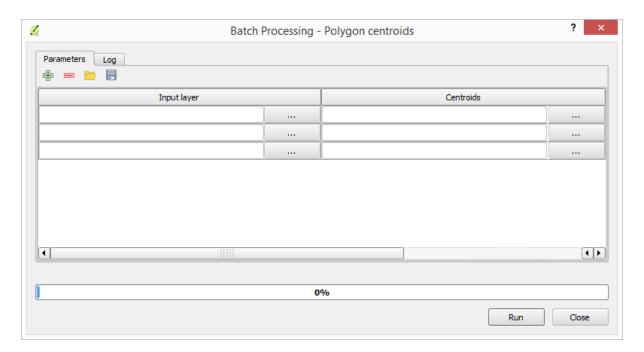


Рис. 18.4: Batch Processing interface

In the upper part of the toolbox, you will find a text box. To reduce the number of algorithms shown in the toolbox and make it easier to find the one you need, you can enter any word or phrase on the text box. Notice that, as you type, the number of algorithms in the toolbox is reduced to just those that contain the text you have entered in their names.

If there are algorithms that match your search but belong to a provider that is not active, an additional label will be shown in the lower part of the toolbox.

If you click on the link in that label, the list of algorithms will also include those from inactive providers, which will be shown in light gray. A link to active each inactive provider is also shown.

To execute an algorithm, just double-click on its name in the toolbox.

#### 18.2.1 The algorithm dialog

Once you double-click on the name of the algorithm that you want to execute, a dialog similar to that in the figure below is shown (in this case, the dialog corresponds to the 'Polygon centroids' algorithm).

This dialog is used to set the input values that the algorithm needs to be executed. It shows a list of input values and configuration parameters to be set. It of course has a different content, depending on the requirements of the algorithm to be executed, and is created automatically based on those requirements.

Although the number and type of parameters depend on the characteristics of the algorithm, the structure is similar for all of them. The parameters found in the table can be of one of the following types.

- A raster layer, to select from a list of all such layers available (currently opened) in QGIS. The selector contains as well a button on its right-hand side, to let you select filenames that represent layers currently not loaded in QGIS.
- A vector layer, to select from a list of all vector layers available in QGIS. Layers not loaded in QGIS can be selected as well, as in the case of raster layers, but only if the algorithm does not require a table field selected from the attributes table of the layer. In that case, only opened layers can be selected, since they need to be open so as to retrieve the list of field names available.

You will see a button by each vector layer selector, as shown in the figure below.

If the algorithm contains several of them, you will be able to toggle just one of them. If the button corresponding to a vector input is toggled, the algorithm will be executed iteratively on each one of its

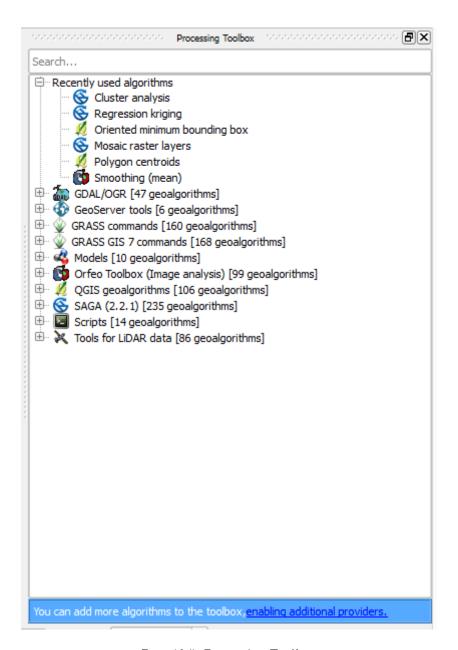


Рис. 18.5: Processing Toolbox

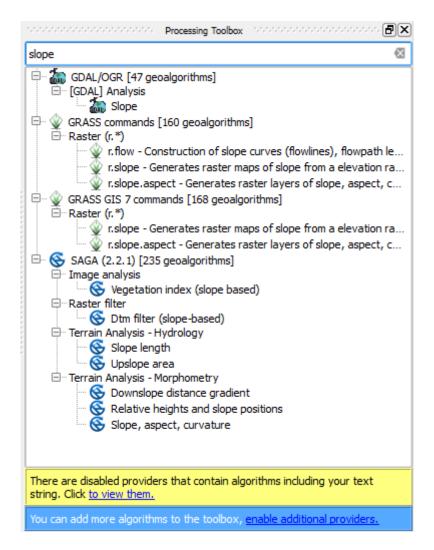


Рис. 18.6: Processing Toolbox showing search results

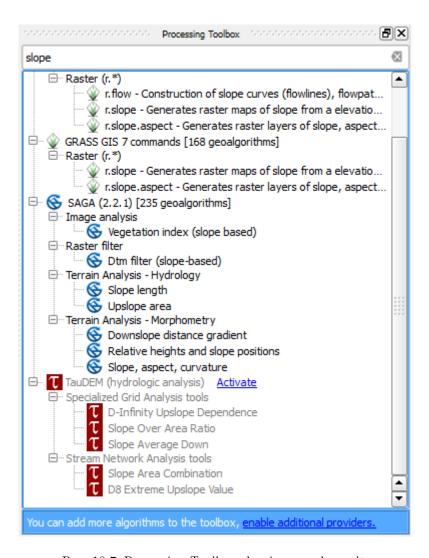


Рис. 18.7: Processing Toolbox showing search results

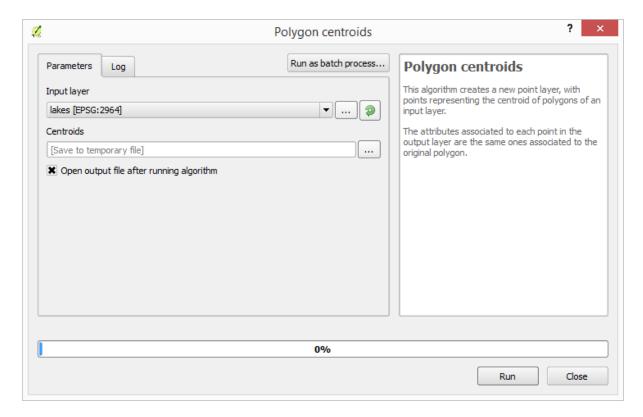


Рис. 18.8: Parameters Dialog



Рис. 18.9: Vector iterator button

features, instead of just once for the whole layer, producing as many outputs as times the algorithm is executed. This allows for automating the process when all features in a layer have to be processed separately.

- A table, to select from a list of all available in QGIS. Non-spatial tables are loaded into QGIS like vector layers, and in fact they are treated as such by the program. Currently, the list of available tables that you will see when executing an algorithm that needs one of them is restricted to tables coming from files in dBase (.dbf) or Comma-Separated Values (.csv) formats.
- An option, to choose from a selection list of possible options.
- A numerical value, to be introduced in a text box. You will find a button by its side. Clicking on it, you will see a dialog that allows you to enter a mathematical expression, so you can use it as a handy calculator. Some useful variables related to data loaded into QGIS can be added to your expression, so you can select a value derived from any of these variables, such as the cell size of a layer or the northernmost coordinate of another one.

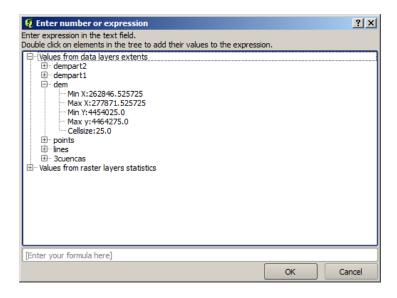


Рис. 18.10: Number Selector

- A range, with min and max values to be introduced in two text boxes.
- A text string, to be introduced in a text box.
- A field, to choose from the attributes table of a vector layer or a single table selected in another parameter.
- A coordinate reference system. You can type the EPSG code directly in the text box, or select it from the CRS selection dialog that appears when you click on the button on the right-hand side.
- An extent, to be entered by four numbers representing its xmin, xmax, ymin, ymax limits. Clicking on the button on the right-hand side of the value selector, a pop-up menu will appear, giving you two options: to select the value from a layer or the current canvas extent, or to define it by dragging directly onto the map canvas.

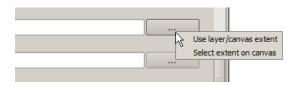


Рис. 18.11: Extent selector

If you select the first option, you will see a window like the next one.

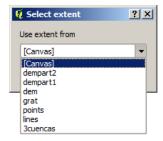


Рис. 18.12: Extent List

If you select the second one, the parameters window will hide itself, so you can click and drag onto the canvas. Once you have defined the selected rectangle, the dialog will reappear, containing the values in the extent text box.

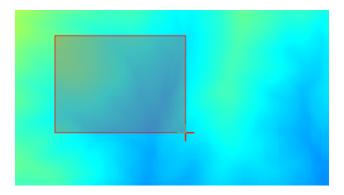


Рис. 18.13: Extent Drag

• A list of elements (whether raster layers, vector layers or tables), to select from the list of such layers available in QGIS. To make the selection, click on the small button on the left side of the corresponding row to see a dialog like the following one.

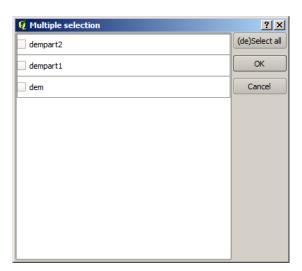


Рис. 18.14: Multiple Selection

• A small table to be edited by the user. These are used to define parameters like lookup tables or convolution kernels, among others.

Click on the button on the right side to see the table and edit its values.

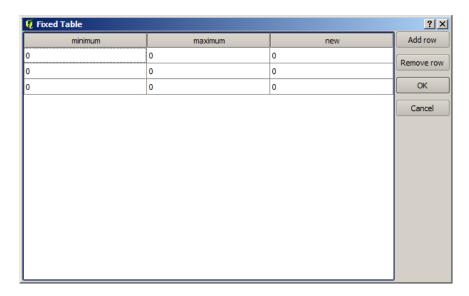


Рис. 18.15: Fixed Table

Depending on the algorithm, the number of rows can be modified or not by using the buttons on the right side of the window.

Along with the parameters tab, you will find another tab named 'Log'. Information provided by the algorithm during its execution is written in this tab, and allow you to track the execution and be aware and have more details about the algorithm as it runs. Notice that not all algorithms write information to this tab, and many of them might run silently without producing any output other than the final files.

On the right hand side of the dialog you wil find a short description of the algorithm, which will help you understand its purpose and its basic ideas. If such a description is not available, the description panel will not be shown.

Some algorithms might have a more detailed help file, which might include description of every parameter it uses, or examples. In that case, you will find a *Help* tab in the parameters dialog.

#### A note on projections

Algorithms that are run from the processing framework — this is also true of most of the external applications whose algorithms are exposed through it— do not perform any reprojection on input layers and assume that all of them are already in a common coordinate system and ready to be analyzed. Whenever you use more than one layer as input to an algorithm, whether vector or raster, it is up to you to make sure that they are all in the same coordinate system.

Note that, due to QGIS's on-the-fly reprojecting capabilities, although two layers might seem to overlap and match, that might not be true if their original coordinates are used without reprojecting them onto a common coordinate system. That reprojection should be done manually, and then the resulting files should be used as input to the algorithm. Also, note that the reprojection process can be performed with the algorithms that are available in the processing framework itself.

By default, the parameters dialog will show a description of the CRS of each layer along with its name, making it easy to select layers that share the same CRS to be used as input layers. If you do not want to see this additional information, you can disable this functionality in the Processing settings dialog, unchecking the *Show CRS* option.

If you try to execute an algorithm using as input two or more layers with unmatching CRSs, a warning dialog will be shown.

You still can execute the algorithm, but be aware that in most cases that will produce wrong results, such as empty layers due to input layers not overlapping.

## 18.2.2 Data objects generated by algorithms

Data objects generated by an algorithm can be of any of the following types:

- A raster layer
- A vector layer
- A table
- An HTML file (used for text and graphical outputs)

These are all saved to disk, and the parameters table will contain a text box corresponding to each one of these outputs, where you can type the output channel to use for saving it. An output channel contains the information needed to save the resulting object somewhere. In the most usual case, you will save it to a file, but in the case of vector layers, and when they are generated by native algorithms (algorithms not using external applications) you can also save to a PostGIS or Spatialite database, or a memory layer.

To select an output channel, just click on the button on the right side of the text box, and you will see a small context menu with the available options.

In the most usual case, you will select saving to a file. If you select that option, you will be prompted with a save file dialog, where you can select the desired file path. Supported file extensions are shown in the file format selector of the dialog, depending on the kind of output and the algorithm.

The format of the output is defined by the filename extension. The supported formats depend on what is supported by the algorithm itself. To select a format, just select the corresponding file extension (or add it, if you are directly typing the file path instead). If the extension of the file path you entered does not match any of the supported formats, a default extension will be appended to the file path, and the file format corresponding to that extension will be used to save the layer or table. Default extensions are .dbf for tables, .tif for raster layers and .shp for vector layers. These can be modified in the setting dialog, selecting any other of the formats supported by QGIS.

If you do not enter any filename in the output text box (or select the corresponding option in the context menu), the result will be saved as a temporary file in the corresponding default file format, and it will be deleted once you exit QGIS (take care with that, in case you save your project and it contains temporary layers).

You can set a default folder for output data objects. Go to the settings dialog (you can open it from the *Processing* menu), and in the *General* group, you will find a parameter named *Output folder*. This output folder is used as the default path in case you type just a filename with no path (i.e., myfile.shp) when executing an algorithm.

When running an algorithm that uses a vector layer in iterative mode, the entered file path is used as the base path for all generated files, which are named using the base name and appending a number representing the index of the iteration. The file extension (and format) is used for all such generated files.

Apart from raster layers and tables, algorithms also generate graphics and text as HTML files. These results are shown at the end of the algorithm execution in a new dialog. This dialog will keep the results produced by any algorithm during the current session, and can be shown at any time by selecting  $Processing \rightarrow Results\ viewer$  from the QGIS main menu.

Some external applications might have files (with no particular extension restrictions) as output, but they do not belong to any of the categories above. Those output files will not be processed by QGIS (opened or included into the current QGIS project), since most of the time they correspond to file formats or elements not supported by QGIS. This is, for instance, the case with LAS files used for LiDAR data. The files get created, but you won't see anything new in your QGIS working session.

For all the other types of output, you will find a checkbox that you can use to tell the algorithm whether to load the file once it is generated by the algorithm or not. By default, all files are opened.

Optional outputs are not supported. That is, all outputs are created. However, you can uncheck the corresponding checkbox if you are not interested in a given output, which essentially makes it behave like an optional output (in other words, the layer is created anyway, but if you leave the text box empty, it will be saved to a temporary file and deleted once you exit QGIS).

## 18.2.3 Configuring the processing framework

As has been mentioned, the configuration menu gives access to a new dialog where you can configure how algorithms work. Configuration parameters are structured in separate blocks that you can select on the left-hand side of the dialog.

Along with the aforementioned *Output folder* entry, the *General* block contains parameters for setting the default rendering style for output layers (that is, layers generated by using algorithms from any of the framework GUI components). Just create the style you want using QGIS, save it to a file, and then enter the path to that file in the settings so the algorithms can use it. Whenever a layer is loaded by SEXTANTE and added to the QGIS canvas, it will be rendered with that style.

Rendering styles can be configured individually for each algorithm and each one of its outputs. Just right-click on the name of the algorithm in the toolbox and select *Edit rendering styles*. You will see a dialog like the one shown next.

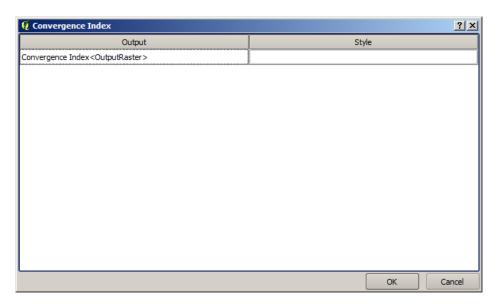


Рис. 18.16: Rendering Styles

Select the style file (.qml) that you want for each output and press [OK].

Other configuration parameters in the *General* group are listed below:

- Use filename as layer name. The name of each resulting layer created by an algorithm is defined by the algorithm itself. In some cases, a fixed name might be used, meaning that the same output name will be used, no matter which input layer is used. In other cases, the name might depend on the name of the input layer or some of the parameters used to run the algorithm. If this checkbox is checked, the name will be taken from the output filename instead. Notice that, if the output is saved to a temporary file, the filename of this temporary file is usually a long and meaningless one intended to avoid collision with other already existing filenames.
- Keep dialog open after running algorithm. Once an algorithm has finished execution and its output layers are loaded into the QGIS project, the algorithm dialog is closed. If you want to keep it open (to run the algorithm again with different parameters, or to better check the output that is written to the log tab), check this option
- Use only selected features. If this option is selected, whenever a vector layer is used as input for an algorithm, only its selected features will be used. If the layer has no selected features, all features will be used.
- Pre-execution script file and Post-execution script file. These parameters refer to scripts written using the processing scripting functionality, and are explained in the section covering scripting and the console.

Apart from the *General* block in the settings dialog, you will also find a block for algorithm providers. Each entry in this block contains an *Activate* item that you can use to make algorithms appear or not in the toolbox. Also, some algorithm providers have their own configuration items, which we will explain later when covering particular algorithm providers.

## 18.3 The graphical modeler

The graphical modeler allows you to create complex models using a simple and easy-to-use interface. When working with a GIS, most analysis operations are not isolated, but rather part of a chain of operations instead. Using the graphical modeler, that chain of processes can be wrapped into a single process, so it is as more convenient to execute as a single process later on a different set of inputs. No matter how many steps and different algorithms it involves, a model is executed as a single algorithm, thus saving time and effort, especially for larger models.

The modeler can be opened from the processing menu.

The modeler has a working canvas where the structure of the model and the workflow it represents are shown. On the left part of the window, a panel with two tabs can be used to add new elements to the model.

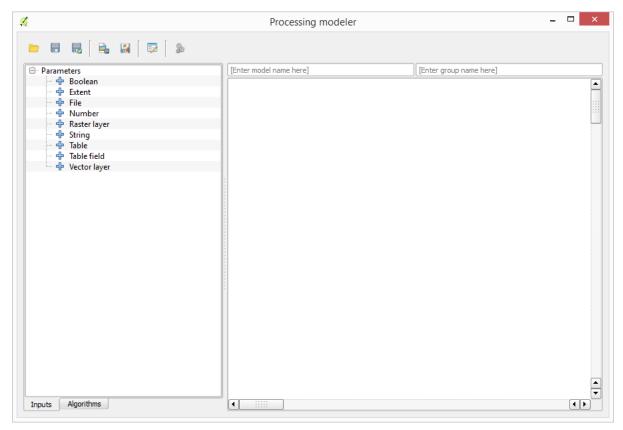


Рис. 18.17: Modeler

Creating a model involves two steps:

- 1. Definition of necessary inputs. These inputs will be added to the parameters window, so the user can set their values when executing the model. The model itself is an algorithm, so the parameters window is generated automatically as it happens with all the algorithms available in the processing framework.
- 2. Definition of the workflow. Using the input data of the model, the workflow is defined by adding algorithms and selecting how they use those inputs or the outputs generated by other algorithms already in the model.

## 18.3.1 Definition of inputs

The first step to create a model is to define the inputs it needs. The following elements are found in the *Inputs* tab on the left side of the modeler window:

- Raster layer
- Vector layer
- String
- Table field
- Table
- Extent
- Number
- Boolean
- File

Double-clicking on any of these elements, a dialog is shown to define its characteristics. Depending on the parameter itself, the dialog may contain just one basic element (the description, which is what the user will see when executing the model) or more of them. For instance, when adding a numerical value, as can be seen in the next figure, apart from the description of the parameter, you have to set a default value and a range of valid values.

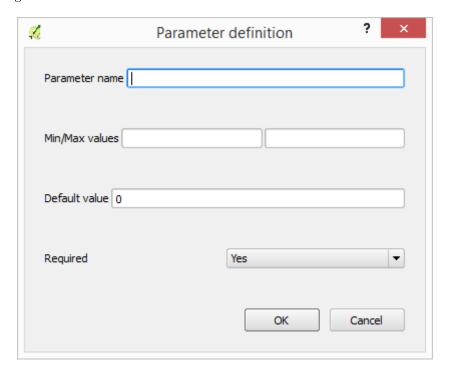


Рис. 18.18: Model Parameters

For each added input, a new element is added to the modeler canvas.



Рис. 18.19: Model Parameters

You can also add inputs by dragging the input type from the list and dropping it in the modeler canvas, in the position where you want to place it.

#### 18.3.2 Definition of the workflow

Once the inputs have been defined, it is time to define the algorithms to apply on them. Algorithms can be found in the *Algorithms* tab, grouped much in the same way as they are in the toolbox.

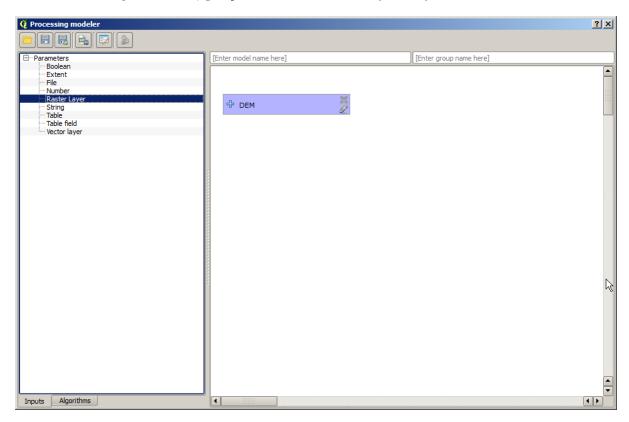


Рис. 18.20: Model Parameters

To add an algorithm to a model, double-click on its name or drag and drop it, just like it was done when adding inputs. An execution dialog will appear, with a content similar to the one found in the execution panel that is shown when executing the algorithm from the toolbox. The one shown next corresponds to the SAGA 'Convergence index' algorithm.

As you can see, some differences exist. Instead of the file output box that was used to set the file path for output layers and tables, a simple text box is used here. If the layer generated by the algorithm is just a temporary result that will be used as the input of another algorithm and should not be kept as a final result, just do not edit that text box. Typing anything in it means that the result is final and the text that you supply will be the description for the output, which will be the output the user will see when executing the model.

Selecting the value of each parameter is also a bit different, since there are important differences between the context of the modeler and that of the toolbox. Let's see how to introduce the values for each type of parameter.

- Layers (raster and vector) and tables. These are selected from a list, but in this case, the possible values are not the layers or tables currently loaded in QGIS, but the list of model inputs of the corresponding type, or other layers or tables generated by algorithms already added to the model.
- Numerical values. Literal values can be introduced directly in the text box. But this text box is also a list that can be used to select any of the numerical value inputs of the model. In this case, the parameter will take the value introduced by the user when executing the model.

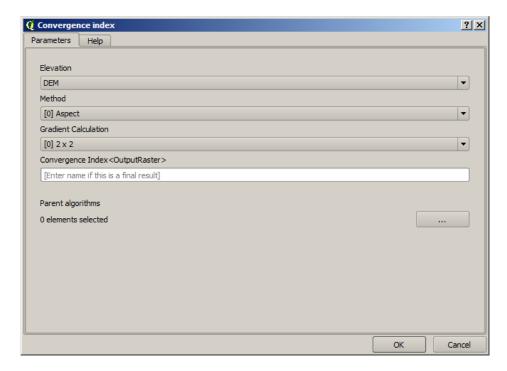


Рис. 18.21: Model Parameters

- String. As in the case of numerical values, literal strings can be typed, or an input string can be selected.
- Table field. The fields of the parent table or layer cannot be known at design time, since they depend on the selection of the user each time the model is executed. To set the value for this parameter, type the name of a field directly in the text box, or use the list to select a table field input already added to the model. The validity of the selected field will be checked at run time.

In all cases, you will find an additional parameter named *Parent algorithms* that is not available when calling the algorithm from the toolbox. This parameter allows you to define the order in which algorithms are executed by explicitly defining one algorithm as a parent of the current one, which will force the parent algorithm to be executed before the current one.

When you use the output of a previous algorithm as the input of your algorithm, that implicitly sets the previous algorithm as parent of the current one (and places the corresponding arrow in the modeler canvas). However, in some cases an algorithm might depend on another one even if it does not use any output object from it (for instance, an algorithm that executes a SQL sentence on a PostGIS database and another one that imports a layer into that same database). In that case, just select the previous algorithm in the *Parent algorithms* parameter and the two steps will be executed in the correct order.

Once all the parameters have been assigned valid values, click on **[OK]** and the algorithm will be added to the canvas. It will be linked to all the other elements in the canvas, whether algorithms or inputs, that provide objects that are used as inputs for that algorithm.

Elements can be dragged to a different position within the canvas, to change the way the module structure is displayed and make it more clear and intuitive. Links between elements are updated automatically. You can zoom in and out by using the mouse wheel.

You can run your algorithm any time by clicking on the [Run] button. However, in order to use the algorithm from the toolbox, it has to be saved and the modeler dialog closed, to allow the toolbox to refresh its contents.

## 18.3.3 Saving and loading models

Use the [Save] button to save the current model and the [Open] button to open any model previously saved. Models are saved with the .model extension. If the model has been previously saved from the modeler window, you will not be prompted for a filename. Since there is already a file associated with that model, the same file will be used for any subsequent saves.

Before saving a model, you have to enter a name and a group for it, using the text boxes in the upper part of the window.

Models saved on the models folder (the default folder when you are prompted for a filename to save the model) will appear in the toolbox in the corresponding branch. When the toolbox is invoked, it searches the models folder for files with the .model extension and loads the models they contain. Since a model is itself an algorithm, it can be added to the toolbox just like any other algorithm.

The models folder can be set from the Processing configuration dialog, under the *Modeler* group.

Models loaded from the models folder appear not only in the toolbox, but also in the algorithms tree in the *Algorithms* tab of the modeler window. That means that you can incorporate a model as a part of a bigger model, just as you add any other algorithm.

## 18.3.4 Editing a model

You can edit the model you are currently creating, redefining the workflow and the relationships between the algorithms and inputs that define the model itself.

If you right-click on an algorithm in the canvas representing the model, you will see a context menu like the one shown next:

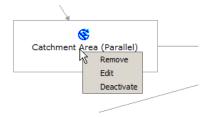


Рис. 18.22: Modeler Right Click

Selecting the *Remove* option will cause the selected algorithm to be removed. An algorithm can be removed only if there are no other algorithms depending on it. That is, if no output from the algorithm is used in a different one as input. If you try to remove an algorithm that has others depending on it, a warning message like the one you can see below will be shown:

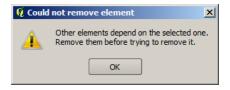


Рис. 18.23: Cannot Delete Algorithm

Selecting the *Edit* option will show the parameters dialog of the algorithm, so you can change the inputs and parameter values. Not all input elements available in the model will appear in this case as available inputs. Layers or values generated at a more advanced step in the workflow defined by the model will not be available if they cause circular dependencies.

Select the new values and then click on the [OK] button as usual. The connections between the model elements will change accordingly in the modeler canvas.

A model can be run partially, by deactivating some of its algorithms. To do it, select the *Deactivate* option in the context menu that appears when right-clicking on an algorithm element. The selected algorithm, and all the ones in the model that depend on it will be displayed in grey and will not be executed as part of the model.

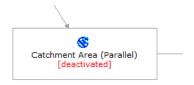


Рис. 18.24: Model With Deactivated Algorithms

When right-clicking on an algorithm that is not active, you will instead see a *Activate* menu option that you can use to activate it back.

## 18.3.5 Editing model help files and meta-information

You can document your models from the modeler itself. Just click on the [Edit model help] button and a dialog like the one shown next will appear.

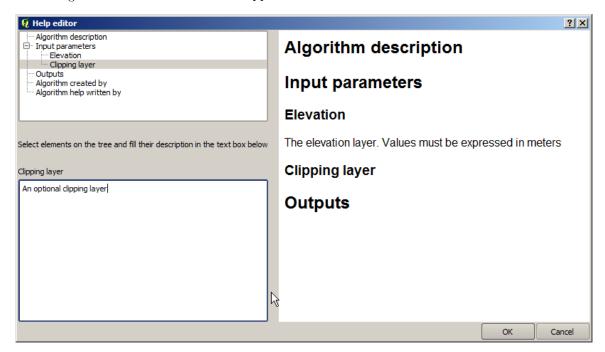


Рис. 18.25: Help Edition

On the right-hand side, you will see a simple HTML page, created using the description of the input parameters and outputs of the algorithm, along with some additional items like a general description of the model or its author. The first time you open the help editor, all these descriptions are empty, but you can edit them using the elements on the left-hand side of the dialog. Select an element on the upper part and then write its description in the text box below.

Model help is saved as part of the model itself.

#### 18.3.6 Exporting a model as a Python script

As we will see in a later chapter, Processing algorithms can be called from the QGIS Python console, and new Processing algorithms can be created as well using Python. A quick way of creating such a Python

script is to create a model and then to export is as a Python file.

To do so, click on the *Export as Python script* button. Select the output file in the file chooser dialog, and Processing will write in it the Python commands that perform the same operations defined in the current model.

## 18.3.7 About available algorithms

You might notice that some algorithms that can be be executed from the toolbox do not appear in the list of available algorithms when you are designing a model. To be included in a model, an algorithm must have a correct semantic, so as to be properly linked to others in the workflow. If an algorithm does not have such a well-defined semantic (for instance, if the number of output layers cannot be known in advance), then it is not possible to use it within a model, and thus, it does not appear in the list of algorithms that you can find in the modeler dialog.

Additionally, you will see some algorithms in the modeler that are not found in the toolbox. These algorithms are meant to be used exclusively as part of a model, and they are of no interest in a different context. The 'Calculator' algorithm is an example of that. It is just a simple arithmetic calculator that you can use to modify numerical values (entered by the user or generated by some other algorithm). This tool is really useful within a model, but outside of that context, it doesn't make too much sense.

## 18.4 The batch processing interface

#### 18.4.1 Introduction

All algorithms (including models) can be executed as a batch process. That is, they can be executed using not just a single set of inputs, but several of them, executing the algorithm as many times as needed. This is useful when processing large amounts of data, since it is not necessary to launch the algorithm many times from the toolbox.

To execute an algorithm as a batch process, right-click on its name in the toolbox and select the *Execute* as batch process option in the pop-up menu that will appear.



Рис. 18.26: Batch Processing Right Click

If you have the execution dialog of the algorithm open, you can also start the batch processing interface from there, clicking on the Run as batch process... button.

#### 18.4.2 The parameters table

Executing a batch process is similar to performing a single execution of an algorithm. Parameter values have to be defined, but in this case we need not just a single value for each parameter, but a set of them instead, one for each time the algorithm has to be executed. Values are introduced using a table like the one shown next.

Each line of this table represents a single execution of the algorithm, and each cell contains the value of one of the parameters. It is similar to the parameters dialog that you see when executing an algorithm from the toolbox, but with a different arrangement.

By default, the table contains just two rows. You can add or remove rows using the buttons on the lower part of the window.

Once the size of the table has been set, it has to be filled with the desired values.

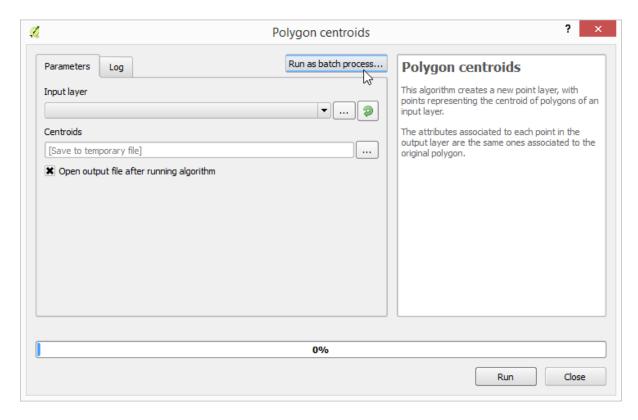


Рис. 18.27: Batch Processing From Algorithm Dialog

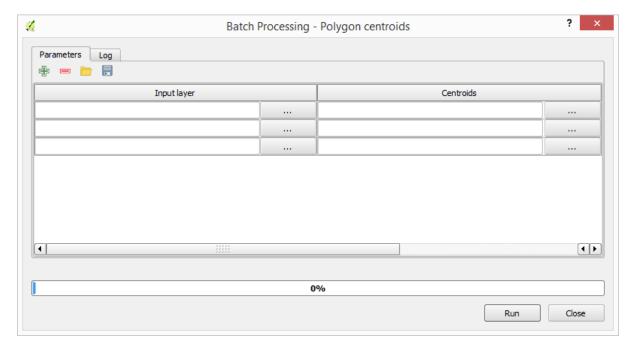


Рис. 18.28: Batch Processing

## 18.4.3 Filling the parameters table

For most parameters, setting the value is trivial. Just type the value or select it from the list of available options, depending on the parameter type.

Filenames for input data objects are introduced directly typing or, more conveniently, clicking on the button on the right hand of the cell, which will show a context menu with two option: one for selecting from the layers currently opened and another to select from the filesystem. This second option, when selected, shows a typical file chooser dialog. Multiple files can be selected at once. If the input parameter represents a single data object and several files are selected, each one of them will be put in a separate row, adding new ones if needed. If the parameter represents a multiple input, all the selected files will be added to a single cell, separated by semicolons (;).

Layer identifiers can be directly typed in the parameter text box. You can enter the full path to a file or the name of a layer that is currently loaded in the current QGIS project. The name of the layer will be automatically resolved to its source path. Notice that, if several layers have the same name, this might cause unexpected results due to ambiguity.

Output data objects are always saved to a file and, unlike when executing an algorithm from the toolbox, saving to a temporary file or database is not permitted. You can type the name directly or use the file chooser dialog that appears when clicking on the accompanying button.

Once you select the file, a new dialog is shown to allow for autocompletion of other cells in the same column (same parameter).

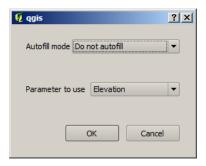


Рис. 18.29: Batch Processing Save

If the default value ('Do not autocomplete') is selected, it will just put the selected filename in the selected cell from the parameters table. If any of the other options is selected, all the cells below the selected one will be automatically filled based on a defined criteria. This way, it is much easier to fill the table, and the batch process can be defined with less effort.

Automatic filling can be done by simply adding correlative numbers to the selected file path, or by appending the value of another field at the same row. This is particularly useful for naming output data objects according to input ones.

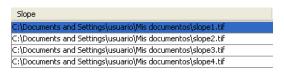


Рис. 18.30: Batch Processing File Path

# 18.4.4 Executing the batch process

To execute the batch process once you have introduced all the necessary values, just click on [OK]. Progress of the global batch task will be shown in the progress bar in the lower part of the dialog.

# 18.5 Using processing algorithms from the console

The console allows advanced users to increase their productivity and perform complex operations that cannot be performed using any of the other GUI elements of the processing framework. Models involving several algorithms can be defined using the command-line interface, and additional operations such as loops and conditional sentences can be added to create more flexible and powerful workflows.

There is not a processing console in QGIS, but all processing commands are available instead from the QGIS built-in Python console. That means that you can incorporate those commands into your console work and connect processing algorithms to all the other features (including methods from the QGIS API) available from there.

The code that you can execute from the Python console, even if it does not call any specific processing method, can be converted into a new algorithm that you can later call from the toolbox, the graphical modeler or any other component, just like you do with any other algorithm. In fact, some algorithms that you can find in the toolbox are simple scripts.

In this section, we will see how to use processing algorithms from the QGIS Python console, and also how to write algorithms using Python.

## 18.5.1 Calling algorithms from the Python console

The first thing you have to do is to import the processing functions with the following line:

```
>>> import processing
```

Now, there is basically just one (interesting) thing you can do with that from the console: execute an algorithm. That is done using the runalg() method, which takes the name of the algorithm to execute as its first parameter, and then a variable number of additional parameters depending on the requirements of the algorithm. So the first thing you need to know is the name of the algorithm to execute. That is not the name you see in the toolbox, but rather a unique command—line name. To find the right name for your algorithm, you can use the alglist() method. Type the following line in your console:

#### >>> processing.alglist()

You will see something like this.

```
Accumulated Cost (Anisotropic)----->saga:accumulatedcost(anisotropic)
Accumulated Cost (Isotropic)----->saga:accumulatedcost(isotropic)
Add Coordinates to points----->saga:addcoordinatestopoints
Add Grid Values to Points----->saga:addgridvaluestopoints
Add Grid Values to Shapes----->saga:addgridvaluestoshapes
Add Polygon Attributes to Points----->saga:addpolygonattributestopoints
Aggregate---->saga:aggregate
Aggregate Point Observations----->saga:aggregatepointobservations
Aggregation Index----->saga:aggregationindex
Analytical Hierarchy Process----->saga:analyticalhierarchyprocess
Analytical Hillshading----->saga:analyticalhillshading
Average With Mask 1----->saga:averagewithmask1
Average With Mask 2----->saga:averagewithmask2
Average With Thereshold 1----->saga:averagewiththereshold1
Average With Thereshold 2----->saga:averagewiththereshold2
Average With Thereshold 3----->saga:averagewiththereshold3
B-Spline Approximation----->saga:b-splineapproximation
```

That's a list of all the available algorithms, alphabetically ordered, along with their corresponding command-line names.

You can use a string as a parameter for this method. Instead of returning the full list of algorithms, it will only display those that include that string. If, for instance, you are looking for an algorithm to calculate slope from a DEM, type alglist("slope") to get the following result:

```
DTM Filter (slope-based)------>saga:dtmfilter(slope-based)

Downslope Distance Gradient---->saga:downslopedistancegradient

Relative Heights and Slope Positions---->saga:relativeheightsandslopepositions

Slope Length----->saga:slopelength

Slope, Aspect, Curvature----->saga:slopeaspectcurvature

Upslope Area---->saga:upslopearea

Vegetation Index[slope based]----->saga:vegetationindex[slopebased]
```

This result might change depending on the algorithms you have available.

It is easier now to find the algorithm you are looking for and its command-line name, in this case saga:slopeaspectcurvature.

Once you know the command-line name of the algorithm, the next thing to do is to determine the right syntax to execute it. That means knowing which parameters are needed and the order in which they have to be passed when calling the runalg() method. There is a method to describe an algorithm in detail, which can be used to get a list of the parameters that an algorithm requires and the outputs that it will generate. To get this information, you can use the alghelp(name\_of\_the\_algorithm) method. Use the command-line name of the algorithm, not the full descriptive name.

Calling the method with saga:slopeaspectcurvature as parameter, you get the following description:

Now you have everything you need to run any algorithm. As we have already mentioned, there is only one single command to execute algorithms: runalg(). Its syntax is as follows:

The list of parameters and outputs to add depends on the algorithm you want to run, and is exactly the list that the alghelp() method gives you, in the same order as shown.

Depending on the type of parameter, values are introduced differently. The next list gives a quick review of how to introduce values for each type of input parameter:

- Raster Layer, Vector Layer or Table. Simply use a string with the name that identifies the data object to use (the name it has in the QGIS Table of Contents) or a filename (if the corresponding layer is not opened, it will be opened but not added to the map canvas). If you have an instance of a QGIS object representing the layer, you can also pass it as parameter. If the input is optional and you do not want to use any data object, use None.
- Selection. If an algorithm has a selection parameter, the value of that parameter should be entered using an integer value. To know the available options, you can use the algoptions() command, as shown in the following example:

```
>>> processing.algoptions("saga:slopeaspectcurvature")
METHOD(Method)
    0 - [0] Maximum Slope (Travis et al. 1975)
    1 - [1] Maximum Triangle Slope (Tarboton 1997)
    2 - [2] Least Squares Fitted Plane (Horn 1981, Costa-Cabral & Burgess 1996)
    3 - [3] Fit 2.Degree Polynom (Bauer, Rohdenburg, Bork 1985)
    4 - [4] Fit 2.Degree Polynom (Heerdegen & Beran 1982)
    5 - [5] Fit 2.Degree Polynom (Zevenbergen & Thorne 1987)
    6 - [6] Fit 3.Degree Polynom (Haralick 1983)
```

In this case, the algorithm has one such parameter, with seven options. Notice that ordering is zero-based.

- Multiple input. The value is a string with input descriptors separated by semicolons (;). As in the case of single layers or tables, each input descriptor can be the data object name, or its file path.
- Table Field from XXX. Use a string with the name of the field to use. This parameter is case-sensitive.
- Fixed Table. Type the list of all table values separated by commas (,) and enclosed between quotes ("). Values start on the upper row and go from left to right. You can also use a 2-D array of values representing the table.
- CRS. Enter the EPSG code number of the desired CRS.
- Extent. You must use a string with xmin, xmax, ymin and ymax values separated by commas (,).

Boolean, file, string and numerical parameters do not need any additional explanations.

Input parameters such as strings, booleans, or numerical values have default values. To use them, specify None in the corresponding parameter entry.

For output data objects, type the file path to be used to save it, just as it is done from the toolbox. If you want to save the result to a temporary file, use None. The extension of the file determines the file format. If you enter a file extension not supported by the algorithm, the default file format for that output type will be used, and its corresponding extension appended to the given file path.

Unlike when an algorithm is executed from the toolbox, outputs are not added to the map canvas if you execute that same algorithm from the Python console. If you want to add an output to the map canvas, you have to do it yourself after running the algorithm. To do so, you can use QGIS API commands, or, even easier, use one of the handy methods provided for such tasks.

The runalg method returns a dictionary with the output names (the ones shown in the algorithm description) as keys and the file paths of those outputs as values. You can load those layers by passing the corresponding file paths to the load() method.

# 18.5.2 Additional functions for handling data

Apart from the functions used to call algorithms, importing the processing package will also import some additional functions that make it easier to work with data, particularly vector data. They are just convenience functions that wrap some functionality from the QGIS API, usually with a less complex syntax. These functions should be used when developing new algorithms, as they make it easier to operate with input data.

Below is a list of some of these commands. More information can be found in the classes under the processing/tools package, and also in the example scripts provided with QGIS.

- getObject(obj): Returns a QGIS object (a layer or table) from the passed object, which can be a filename or the name of the object in the QGIS Layers List
- values(layer, fields): Returns the values in the attributes table of a vector layer, for the passed fields. Fields can be passed as field names or as zero-based field indices. Returns a dict of lists, with the passed field identifiers as keys. It considers the existing selection.
- features(layer): Returns an iterator over the features of a vector layer, considering the existing selection.
- uniqueValues(layer, field): Returns a list of unique values for a given attribute. Attributes can be passed as a field name or a zero-based field index. It considers the existing selection.

## 18.5.3 Creating scripts and running them from the toolbox

You can create your own algorithms by writing the corresponding Python code and adding a few extra lines to supply additional information needed to define the semantics of the algorithm. You can find a

Create new script menu under the Tools group in the Script algorithms block of the toolbox. Double-click on it to open the script editing dialog. That's where you should type your code. Saving the script from there in the scripts folder (the default folder when you open the save file dialog) with .py extension will automatically create the corresponding algorithm.

The name of the algorithm (the one you will see in the toolbox) is created from the filename, removing its extension and replacing low hyphens with blank spaces.

Let's have a look at the following code, which calculates the Topographic Wetness Index (TWI) directly from a DEM.

As you can see, the calculation involves three algorithms, all of them coming from SAGA. The last one calculates the TWI, but it needs a slope layer and a flow accumulation layer. We do not have these layers, but since we have the DEM, we can calculate them by calling the corresponding SAGA algorithms.

The part of the code where this processing takes place is not difficult to understand if you have read the previous sections in this chapter. The first lines, however, need some additional explanation. They provide the information that is needed to turn your code into an algorithm that can be run from any of the GUI components, like the toolbox or the graphical modeler.

These lines start with a double Python comment symbol (##) and have the following structure:

```
[parameter_name] = [parameter_type] [optional_values]
```

Here is a list of all the parameter types that are supported in processing scripts, their syntax and some examples.

- raster. A raster layer.
- vector. A vector layer.
- table. A table.
- number. A numerical value. A default value must be provided. For instance, depth=number 2.4.
- string. A text string. As in the case of numerical values, a default value must be added. For instance, name=string Victor.
- boolean. A boolean value. Add True or False after it to set the default value. For example, verbose=boolean True.
- multiple raster. A set of input raster layers.
- multiple vector. A set of input vector layers.
- field. A field in the attributes table of a vector layer. The name of the layer has to be added after the field tag. For instance, if you have declared a vector input with mylayer=vector, you could use myfield=field mylayer to add a field from that layer as parameter.
- folder. A folder.
- file. A filename.

The parameter name is the name that will be shown to the user when executing the algorithm, and also the variable name to use in the script code. The value entered by the user for that parameter will be assigned to a variable with that name. When showing the name of the parameter to the user, the name will be edited to improve its appearance, replacing low hyphens with spaces. So, for instance, if you want the user to see a parameter named A numerical value, you can use the variable name A\_numerical\_value.

Layers and table values are strings containing the file path of the corresponding object. To turn them into a QGIS object, you can use the processing.getObjectFromUri() function. Multiple inputs also have a string value, which contains the file paths to all selected object, separated by semicolons (;).

Outputs are defined in a similar manner, using the following tags:

- output raster
- output vector
- output table
- output html
- output file
- output number
- output string

The value assigned to the output variables is always a string with a file path. It will correspond to a temporary file path in case the user has not entered any output filename.

When you declare an output, the algorithm will try to add it to QGIS once it is finished. That is why, although the runalg() method does not load the layers it produces, the final TWI layer will be loaded (using the case of our previous example), since it is saved to the file entered by the user, which is the value of the corresponding output.

Do not use the load() method in your script algorithms, just when working with the console line. If a layer is created as output of an algorithm, it should be declared as such. Otherwise, you will not be able to properly use the algorithm in the modeler, since its syntax (as defined by the tags explained above) will not match what the algorithm really creates.

Hidden outputs (numbers and strings) do not have a value. Instead, you have to assign a value to them. To do so, just set the value of a variable with the name you used to declare that output. For instance, if you have used this declaration,

## ##average=output number

the following line will set the value of the output to 5:

#### average = 5

In addition to the tags for parameters and outputs, you can also define the group under which the algorithm will be shown, using the group tag.

If your algorithm takes a long time to process, it is a good idea to inform the user. You have a global named progress available, with two possible methods: setText(text) and setPercentage(percent) to modify the progress text and the progress bar.

Several examples are provided. Please check them to see real examples of how to create algorithms using the processing framework classes. You can right-click on any script algorithm and select  $Edit\ script$  to edit its code or just to see it.

# 18.5.4 Documenting your scripts

As in the case of models, you can create additional documentation for your scripts, to explain what they do and how to use them. In the script editing dialog, you will find an **[Edit script help]** button. Click on it and it will take you to the help editing dialog. Check the section about the graphical modeler to know more about this dialog and how to use it.

Help files are saved in the same folder as the script itself, adding the .help extension to the filename. Notice that you can edit your script's help before saving the script for the first time. If you later close the script editing dialog without saving the script (i.e., you discard it), the help content you wrote will be lost. If your script was already saved and is associated to a filename, saving the help content is done automatically.

## 18.5.5 Pre- and post-execution script hooks

Scripts can also be used to set pre- and post-execution hooks that are run before and after an algorithm is run. This can be used to automate tasks that should be performed whenever an algorithm is executed.

The syntax is identical to the syntax explained above, but an additional global variable named alg is available, representing the algorithm that has just been (or is about to be) executed.

In the *General* group of the processing configuration dialog, you will find two entries named *Pre-execution* script file and *Post-execution* script file where the filename of the scripts to be run in each case can be entered.

# 18.6 The history manager

## 18.6.1 The processing history

Every time you execute an algorithm, information about the process is stored in the history manager. Along with the parameters used, the date and time of the execution are also saved.

This way, it is easy to track and control all the work that has been developed using the Processing framework, and to reproduce it.

The history manager is a set of registry entries grouped according to their date of execution, making it easier to find information about an algorithm executed at any particular moment.

Process information is kept as a command-line expression, even if the algorithm was launched from the toolbox. This makes it also useful for those learning how to use the command-line interface, since they can call an algorithm using the toolbox and then check the history manager to see how that same algorithm could be called from the command line.

Apart from browsing the entries in the registry, you can also re-execute processes by simply double-clicking on the corresponding entry.

### 18.6.2 The processing log

The history dialog only contains the execution calls, but not the information produced by the algorithm when executed. That information is written to the QGIS log, in a *Processing* tab.

Third-party algorithms are usually executed by calling their command-line interfaces, which communicate with the user via the console. Although that console is not shown, a full dump of it is written to the log each time you run one of those algorithms. To avoid cluttering the log with that information, you can disable it for each provider, looking for the corresponding option in the provider entry of the settings dialog.

Some algorithms, even if they can produce a result with the given input data, might add comments or additional information to log if they detect potential problems with the data, in order to warn you. Make sure you check those messages in the log if you are having unexpected results.

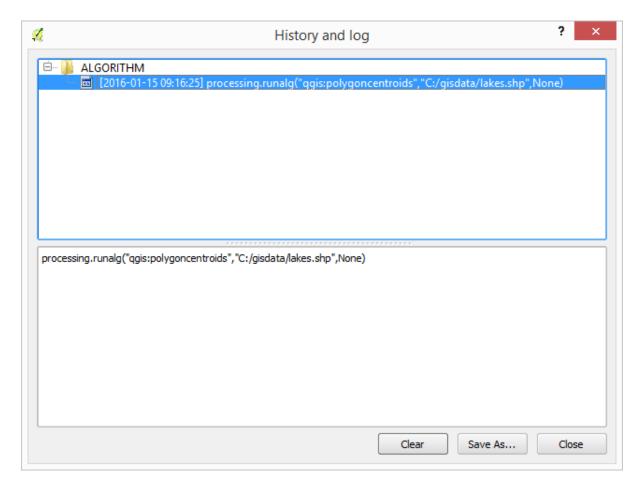


Рис. 18.31: History 🤊

# 18.7 Writing new Processing algorithms as python scripts

You can create your own algorithms by writing the corresponding Python code and adding a few extra lines to supply additional information needed to define the semantics of the algorithm. You can find a Create new script menu under the Tools group in the Script algorithms block of the toolbox. Double-click on it to open the script edition dialog. That's where you should type your code. Saving the script from there in the scripts folder (the default one when you open the save file dialog), with .py extension, will automatically create the corresponding algorithm.

The name of the algorithm (the one you will see in the toolbox) is created from the filename, removing its extension and replacing underscores with blank spaces.

Let's have the following code, which calculates the Topographic Wetness Index (TWI) directly from a DEM

As you can see, it involves 3 algorithms, all of them coming from SAGA. The last one of them calculates the TWI, but it needs a slope layer and a flow accumulation layer. We do not have these, but since we have the DEM, we can calculate them by calling the corresponding SAGA algorithms.

The part of the code where this processing takes place is not difficult to understand if you have read the previous chapter. The first lines, however, need some additional explanation. They provide the information that is needed to turn your code into an algorithm that can be run from any of the GUI components, like the toolbox or the graphical modeler.

These lines start with a double Python comment symbol (##) and have the following structure

```
[parameter_name] = [parameter_type] [optional_values]
```

Here is a list of all the parameter types that are supported in processing scripts, their syntax and some examples.

- raster. A raster layer
- vector. A vector layer
- table. A table
- number. A numerical value. A default value must be provided. For instance, depth=number 2.4
- string. A text string. As in the case of numerical values, a default value must be added. For instance, name=string Victor
- longstring. Same as string, but a larger text box will be shown, so it is better suited for long strings, such as for a script expecting a small code snippet.
- boolean. A boolean value. Add True or False after it to set the default value. For example, verbose=boolean True.
- multiple raster. A set of input raster layers.
- multiple vector. A set of input vector layers.
- field. A field in the attributes table of a vector layer. The name of the layer has to be added after the field tag. For instance, if you have declared a vector input with mylayer=vector, you could use myfield=field mylayer to add a field from that layer as parameter.
- extent. A spatial extent defined by xmin, xmax, ymin, ymax

292

- folder. A folder
- file. A filename
- crs. A Coordinate Reference System
- selection. A dropdown menu that allows the user to select from a pre-populated list. For example units=selection sq\_km;sq\_miles;sq\_degrees
- name. Name of the script. This will be displayed as the algorithm name in the processing toolbox. For example My Algorithm Name=name
- group. Folder name where the script will appear in the Processing Toolbox. For Example, adding Utils=groups will put the script within a Utils folder within Scripts.

The parameter name is the name that will be shown to the user when executing the algorithm, and also the variable name to use in the script code. The value entered by the user for that parameter will be assigned to a variable with that name.

When showing the name of the parameter to the user, the name will be edited to improve its appearance, replacing underscores with spaces. So, for instance, if you want the user to see a parameter named A numerical value, you can use the variable name A\_numerical\_value.

Layers and tables values are strings containing the filepath of the corresponding object. To turn them into a QGIS object, you can use the processing.getObjectFromUri() function. Multiple inputs also have a string value, which contains the filepaths to all selected objects, separated by semicolons (;).

Outputs are defined in a similar manner, using the following tags:

- output raster
- output vector
- output table
- output html
- output file
- output number
- output string
- output extent

The value assigned to the output variables is always a string with a filepath. It will correspond to a temporary filepath in case the user has not entered any output filename.

In addition to the tags for parameters and outputs, you can also define the group under which the algorithm will be shown, using the group tag.

The last tag that you can use in your script header is ##nomodeler. Use that when you do not want your algorithm to be shown in the modeler window. This should be used for algorithms that do not have a clear syntax (for instance, if the number of layers to be created is not known in advance, at design time), which make them unsuitable for the graphical modeler

# 18.8 Handing data produced by the algorithm

When you declare an output representing a layer (raster, vector or table), the algorithm will try to add it to QGIS once it is finished. That is the reason why, although the runalg() method does not load the layers it produces, the final TWI layer will be loaded, since it is saved to the file entered by the user, which is the value of the corresponding output.

Do not use the load() method in your script algorithms, but just when working with the console line. If a layer is created as output of an algorithm, it should be declared as such. Otherwise, you will not be able to properly use the algorithm in the modeler, since its syntax (as defined by the tags explained above) will not match what the algorithm really creates.

Hidden outputs (numbers and strings) do not have a value. Instead, it is you who has to assign a value to them. To do so, just set the value of a variable with the name you used to declare that output. For instance, if you have used this declaration,

```
##average=output number
```

the following line will set the value of the output to 5:

```
average = 5
```

# 18.9 Communicating with the user

If your algorithm takes a long time to process, it is a good idea to inform the user. You have a global named progress available, with two available methods: setText(text) and setPercentage(percent) to modify the progress text and the progress bar.

If you have to provide some information to the user, not related to the progress of the algorithm, you can use the setInfo(text) method, also from the progress object.

If your script has some problem, the correct way of propagating it is to raise an exception of type GeoAlgorithmExecutionException(). You can pass a message as argument to the constructor of the exception. Processing will take care of handling it and communicating with the user, depending on where the algorithm is being executed from (toolbox, modeler, Python console...)

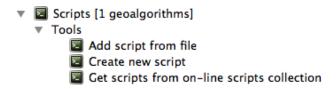
# 18.10 Documenting your scripts

As in the case of models, you can create additional documentation for your script, to explain what they do and how to use them. In the script editing dialog you will find a **[Edit script help]** button. Click on it and it will take you to the help editing dialog. Check the chapter about the graphical modeler to find out more about this dialog and how to use it.

Help files are saved in the same folder as the script itself, adding the .help extension to the filename. Note that you can edit your script's help before saving it for the first time. If you later close the script editing dialog without saving the script (i.e. you discard it), the help content you wrote will be lost. If your script was already saved and is associated with a filename, saving is done automatically.

# 18.11 Example scripts

Several examples are available in the on-line collection of scripts, which you can access by selecting the Get script from on-line script collection tool under the Scripts/tools entry in the toolbox.



Please, check them to see real examples of how to create algorithms using the processing framework classes. You can right-click on any script algorithm and select *Edit script* to edit its code or just to see it.

# 18.12 Best practices for writing script algorithms

Here's a quick summary of ideas to consider when creating your script algorithms and, especially, if you want to share with other QGIS users. Following these simple rules will ensure consistency across the different Processing elements such as the toolbox, the modeler or the batch processing interface.

- Do not load resulting layers. Let Processing handle your results and load your layers if needed.
- Always declare the outputs your algorithm creates. Avoid things such as declaring one output and then using the destination filename set for that output to create a collection of them. That will break the correct semantics of the algorithm and make it impossible to use it safely in the modeler. If you have to write an algorithm like that, make sure you add the ##nomodeler tag.
- Do not show message boxes or use any GUI element from the script. If you want to communicate with the user, use the setInfo() method or throw an GeoAlgorithmExecutionException
- As a rule of thumb, do not forget that your algorithm might be executed in a context other than the Processing toolbox.

# 18.13 Pre- and post-execution script hooks

Scripts can also be used to set pre- and post-execution hooks that are run before and after an algorithm is run. This can be used to automate tasks that should be performed whenever an algorithm is executed.

The syntax is identical to the syntax explained above, but an additional global variable named alg is available, representing the algorithm that has just been (or is about to be) executed.

In the *General* group of the processing config dialog you will find two entries named *Pre-execution script* file and *Post-execution script* file where the filename of the scripts to be run in each case can be entered.

# 18.14 Configuring external applications

The processing framework can be extended using additional applications. Currently, SAGA, GRASS, OTB (Orfeo Toolbox) and R are supported, along with some other command-line applications that provide spatial data analysis functionalities. Algorithms relying on an external applications are managed by their own algorithm provider.

This section will show you how to configure the processing framework to include these additional applications, and it will explain some particular features of the algorithms based on them. Once you have correctly configured the system, you will be able to execute external algorithms from any component like the toolbox or the graphical modeler, just like you do with any other geoalgorithm.

By default, all algorithms that rely on an external application not shipped with QGIS are not enabled. You can enable them in the settings dialog. Make sure that the corresponding application is already installed in your system.

## 18.14.1 A note for Windows users

If you are not an advanced user and you are running QGIS on Windows, you might not be interested in reading the rest of this chapter. Make sure you install QGIS in your system using the standalone installer. That will automatically install SAGA, GRASS and OTB in your system and configure them so they can be run from QGIS. All the algorithms from these providers will be ready to be run without needing any further configuration. If installing through OSGeo4W application, make sure you select for installation SAGA, GRASS and OTB as well.

If you want to know more about how these providers work, or if you want to use some algorithms not included in the simplified toolbox (such as R scripts), keep on reading.

# 18.14.2 A note on file formats

When using an external software, opening a file in QGIS does not mean that it can be opened and processed as well in that other software. In most cases, other software can read what you have opened in QGIS, but in some cases, that might not be true. When using databases or uncommon file formats, whether for raster or vector layers, problems might arise. If that happens, try to use well-known file formats that you are sure are understood by both programs, and check the console output (in the history and log dialog) to know more about what is going wrong.

Using GRASS raster layers is, for instance, one case in which you might have trouble and not be able to complete your work if you call an external algorithm using such a layer as input. For this reason, these layers will not appear as available to algorithms.

You should, however, find no problems at all with vector layers, since QGIS automatically converts from the original file format to one accepted by the external application before passing the layer to it. This adds extra processing time, which might be significant if the layer has a large size, so do not be surprised if it takes more time to process a layer from a DB connection than it does to process one of a similar size stored in a shapefile.

Providers not using external applications can process any layer that you can open in QGIS, since they open it for analysis through QGIS.

Regarding output formats, all formats supported by QGIS as output can be used, both for raster and vector layers. Some providers do not support certain formats, but all can export to common formats that can later be transformed by QGIS automatically. As in the case of input layers, if this conversion is needed, that might increase the processing time.

## 18.14.3 A note on vector layer selections

External applications may also be made aware of the selections that exist in vector layers within QGIS. However, that requires rewriting all input vector layers, just as if they were originally in a format not supported by the external application. Only when no selection exists, or the *Use only selected features* option is not enabled in the processing general configuration, can a layer be directly passed to an external application.

In other cases, exporting only selected features is needed, which causes execution times to be longer.

#### 18.14.4 SAGA

SAGA algorithms can be run from QGIS if you have SAGA installed in your system and you configure the processing framework properly so it can find SAGA executables. In particular, the SAGA command-line executable is needed to run SAGA algorithms.

If you are running Windows, both the stand-alone installer and the OSGeo4W installer include SAGA along with QGIS, and the path is automatically configured, so there is no need to do anything else.

If you have installed SAGA yourself and your QGIS installer did not include it, the path to the SAGA executable must be configured. To do this, open the configuration dialog. In the SAGA block, you will find a setting named SAGA Folder. Enter the path to the folder where SAGA is installed. Close the configuration dialog, and now you are ready to run SAGA algorithms from QGIS.

If you are running Linux, SAGA binaries are not included with Processing, so you have to download and install the software yourself. Please check the SAGA website for more information.

In this case, there is no need to configure the path to the SAGA executable, and you will not see those folder entries. Instead, you must make sure that SAGA is properly installed and its folder is added to the PATH environment variable. Just open a console and type saga\_cmd to check that the system can find where the SAGA binaries are located.

### About SAGA grid system limitations

Most SAGA algorithms that require several input raster layers require them to have the same grid system. That is, they must cover the same geographic area and have the same cell size, so their corresponding grids match. When calling SAGA algorithms from QGIS, you can use any layer, regardless of its cell size and extent. When multiple raster layers are used as input for a SAGA algorithm, QGIS resamples them to a common grid system and then passes them to SAGA (unless the SAGA algorithm can operate with layers from different grid systems).

The definition of that common grid system is controlled by the user, and you will find several parameters in the SAGA group of the settings window to do so. There are two ways of setting the target grid system:

- Setting it manually. You define the extent by setting the values of the following parameters:
  - Resampling min X
  - Resampling max X
  - Resampling min Y
  - Resampling max Y
  - Resampling cellsize

Notice that QGIS will resample input layers to that extent, even if they do not overlap with it.

• Setting it automatically from input layers. To select this option, just check the *Use min covering* grid system for resampling option. All the other settings will be ignored and the minimum extent that covers all the input layers will be used. The cell size of the target layer is the maximum of all cell sizes of the input layers.

For algorithms that do not use multiple raster layers, or for those that do not need a unique input grid system, no resampling is performed before calling SAGA, and those parameters are not used.

#### Limitations for multi-band layers

Unlike QGIS, SAGA has no support for multi-band layers. If you want to use a multiband layer (such as an RGB or multispectral image), you first have to split it into single-banded images. To do so, you can use the 'SAGA/Grid - Tools/Split RGB image' algorithm (which creates three images from an RGB image) or the 'SAGA/Grid - Tools/Extract band' algorithm (to extract a single band).

#### Limitations in cell size

SAGA assumes that raster layers have the same cell size in the X and Y axis. If you are working with a layer with different values for horizontal and vertical cell size, you might get unexpected results. In this case, a warning will be added to the processing log, indicating that an input layer might not be suitable to be processed by SAGA.

### Logging

When QGIS calls SAGA, it does so using its command-line interface, thus passing a set of commands to perform all the required operations. SAGA shows its progress by writing information to the console, which includes the percentage of processing already done, along with additional content. This output is filtered and used to update the progress bar while the algorithm is running.

Both the commands sent by QGIS and the additional information printed by SAGA can be logged along with other processing log messages, and you might find them useful to track in detail what is going on when QGIS runs a SAGA algorithm. You will find two settings, namely *Log console output* and *Log execution commands*, to activate that logging mechanism.

Most other providers that use an external application and call it through the command-line have similar options, so you will find them as well in other places in the processing settings list.

## 18.14.5 R. Creating R scripts

R integration in QGIS is different from that of SAGA in that there is not a predefined set of algorithms you can run (except for a few examples). Instead, you should write your scripts and call R commands, much like you would do from R, and in a very similar manner to what we saw in the section dedicated to processing scripts. This section shows you the syntax to use to call those R commands from QGIS and how to use QGIS objects (layers, tables) in them.

The first thing you have to do, as we saw in the case of SAGA, is to tell QGIS where your R binaries are located. You can do this using the *R folder* entry in the processing configuration dialog. Once you have set that parameter, you can start creating and executing your own R scripts.

Примітка: for Windows user, usually the R executable file is in the C:Program FilesRR-3.2 folder. Add just the folder and NOT the binary!

Once again, this is different in Linux, and you just have to make sure that the R folder is included in the PATH environment variable. If you can start R just typing R in a console, then you are ready to go.

To add a new algorithm that calls an R function (or a more complex R script that you have developed and you would like to have available from QGIS), you have to create a script file that tells the processing framework how to perform that operation and the corresponding R commands to do so.

R script files have the extension .rsx, and creating them is pretty easy if you just have a basic knowledge of R syntax and R scripting. They should be stored in the R scripts folder. You can set this folder in the R settings group (available from the processing settings dialog), just like you do with the folder for regular processing scripts.

Let's have a look at a very simple script file, which calls the R method spsample to create a random grid within the boundary of the polygons in a given polygon layer. This method belongs to the maptools package. Since almost all the algorithms that you might like to incorporate into QGIS will use or generate spatial data, knowledge of spatial packages like maptools and, especially, sp, is mandatory.

```
##polyg=vector
##numpoints=number 10
##output=output vector
##sp=group
pts=spsample(polyg,numpoints,type="random")
output=SpatialPointsDataFrame(pts, as.data.frame(pts))
```

The first lines, which start with a double Python comment sign (##), tell QGIS the inputs of the algorithm described in the file and the outputs that it will generate. They work with exactly the same syntax as the Processing scripts that we have already seen, so they will not be described here again.

Please have a look at the R Intro and the R Syntax Training Manual Chapters to have more information on how to write your own R scripts-

When you declare an input parameter, QGIS uses that information for two things: creating the user interface to ask the user for the value of that parameter and creating a corresponding R variable that can later be used as input for R commands.

In the above example, we are declaring an input of type vector named polyg. When executing the algorithm, QGIS will open in R the layer selected by the user and store it in a variable also named polyg. So, the name of a parameter is also the name of the variable that we can use in R for accessing the value of that parameter (thus, you should avoid using reserved R words as parameter names).

Spatial elements such as vector and raster layers are read using the readOGR() and brick() commands (you do not have to worry about adding those commands to your description file – QGIS will do it), and they are stored as Spatial\*DataFrame objects. Table fields are stored as strings containing the name of the selected field.

Tables are opened using the read.csv() command. If a table entered by the user is not in CSV format, it will be converted prior to importing it into R.

Additionally, raster files can be read using the readGDAL() command instead of brick() by using the ##usereadgdal.

If you are an advanced user and do not want QGIS to create the object representing the layer, you can use the ##passfilenames tag to indicate that you prefer a string with the filename instead. In this case, it is up to you to open the file before performing any operation on the data it contains.

With the above information, we can now understand the first line of our first example script (the first line not starting with a Python comment).

```
pts=spsample(polyg,numpoints,type="random")
```

The variable polygon already contains a SpatialPolygonsDataFrame object, so it can be used to call the spsample method, just like the numpoints one, which indicates the number of points to add to the created sample grid.

Since we have declared an output of type vector named out, we have to create a variable named out and store a Spatial\*DataFrame object in it (in this case, a SpatialPointsDataFrame). You can use any name for your intermediate variables. Just make sure that the variable storing your final result has the same name that you used to declare it, and that it contains a suitable value.

In this case, the result obtained from the spsample method has to be converted explicitly into a SpatialPointsDataFrame object, since it is itself an object of class ppp, which is not a suitable class to be returned to QGIS.

If your algorithm generates raster layers, the way they are saved will depend on whether or not you have used the ##dontuserasterpackage option. If you have used it, layers are saved using the writeGDAL() method. If not, the writeRaster() method from the raster package will be used.

If you have used the ##passfilenames option, outputs are generated using the raster package (with writeRaster()), even though it is not used for the inputs.

If your algorithm does not generate any layer, but rather a text result in the console instead, you have to indicate that you want the console to be shown once the execution is finished. To do so, just start the command lines that produce the results you want to print with the > ('greater') sign. The output of all other lines will not be shown. For instance, here is the description file of an algorithm that performs a normality test on a given field (column) of the attributes of a vector layer:

```
##layer=vector
##field=field layer
##nortest=group
library(nortest)
>lillie.test(layer[[field]])
```

The output of the last line is printed, but the output of the first is not (and neither are the outputs from other command lines added automatically by QGIS).

If your algorithm creates any kind of graphics (using the plot() method), add the following line:

```
##showplots
```

This will cause QGIS to redirect all R graphical outputs to a temporary file, which will be opened once R execution has finished.

Both graphics and console results will be shown in the processing results manager.

For more information, please check the script files provided with Processing. Most of them are rather simple and will greatly help you understand how to create your own scripts.

Примітка: rgdal and raster libraries are loaded by default, so you do not have to add the corresponding library() commands (you just have to make sure that those two packages are installed in your R distribution). However, other additional libraries that you might need have to be explicitly loaded by typing, library(ggplot2). If the package is not already installed on your machine, Processing will download and install it. In this way the package will be also available in R Standalone. Be aware that if the package has to be downloaded, the first time you run the script it might take a long time.

#### 18.14.6 GRASS

Configuring GRASS is not much different from configuring SAGA. First, the path to the GRASS folder has to be defined, but only if you are running Windows. Additionally, a shell interpreter (usually msys.exe, which can be found in most GRASS for Windows distributions) has to be defined and its path set up as well.

By default, the processing framework tries to configure its GRASS connector to use the GRASS distribution that ships along with QGIS. This should work without problems in most systems, but if you experience problems, you might have to configure the GRASS connector manually. Also, if you want to use a different GRASS installation, you can change that setting and point to the folder where the other version is installed. GRASS 6.4 is needed for algorithms to work correctly.

If you are running Linux, you just have to make sure that GRASS is correctly installed, and that it can be run without problem from a console.

GRASS algorithms use a region for calculations. This region can be defined manually using values similar to the ones found in the SAGA configuration, or automatically, taking the minimum extent that covers all the input layers used to execute the algorithm each time. If the latter approach is the behavior you prefer, just check the *Use min covering region* option in the GRASS configuration parameters.

### 18.14.7 GDAL

No additional configuration is needed to run GDAL algorithms. Since they are already incorporated into QGIS, the algorithms can infer their configuration from it.

## 18.14.8 Orfeo Toolbox

Orfeo Toolbox (OTB) algorithms can be run from QGIS if you have OTB installed in your system and you have configured QGIS properly, so it can find all necessary files (command-line tools and libraries).

As in the case of SAGA, OTB binaries are included in the stand-alone installer for Windows, but they are not included if you are running Linux, so you have to download and install the software yourself. Please check the OTB website for more information.

Once OTB is installed, start QGIS, open the processing configuration dialog and configure the OTB algorithm provider. In the *Orfeo Toolbox (image analysis)* block, you will find all settings related to OTB. First, ensure that algorithms are enabled.

Then, configure the path to the folder where OTB command-line tools and libraries are installed:

- Usually OTB applications folder points to /usr/lib/otb/applications and OTB command line tools folder is /usr/bin.
- If you use any of the installers that include OTB, such as OSGeo4W, there is no need for further configuration. Processing will detect the path automatically and will not show the corresponding configuration entries. Otherwise, fill the OTB applications folder and OTB command line tools folder parameters with the to the corresponding values for your installation.

#### 18.14.9 TauDEM

TauDEM (Terrain Analysis Using Digital Elevation Models) is a tools for the extraction and analysis of hydrological information from Digital Elevation Models (DEM). TauDEM can be used from QGIS if you have it installed in your system and configured QGIS properly, so it can find all necessary files.

There are two versions of TauDEM tools: singlefile (TauDEM 5.0.6 or 5.1.2) and multifile (TauDEM 5.2.0). The difference between these versions in the supported inputs/outputs. Single files version accepts

only single raster file and write single file as output. Multifile version accepts a directory with rasters and writes directory with rasters as output. Such directory should contain rasters that will be treated as a single DEM grid.

TauDEM Processing provider supports both single- and multifile versions of TauDEM and even allows to use them simultaneously.

Примітка: While TauDEM Processing provider supports TauDEM 5.0.6, 5.1.2 and 5.2.0 we recommend to use 5.1.2 and/or 5.2.0 as this versions have some new tools available, like Gage Watershed and TWI.

#### Installing TauDEM under Windows

Please visit the TauDEM homepage and download desired version of the precompiled binaries for your platform (32-bit or 64-bit), usually this is "Command Line Executables". Also you need to download Microsoft HPC Pack 2012 MS-MPI. First install Microsoft HPC Pack 2012 MS-MPI by runing mpi\_x64.Msi for 64-bit platforms and mpi\_x86.Msi for 32-bit platforms.

Примітка: If you want to use TauDEM 5.0.6

#### Installing TauDEM under Linux

Unfortunately there are no packages for most Linux distributions, so you should compile TauDEM by yourself. As TauDEM uses MPI it is necessary to install first any MPI implementation e.g MPICH or OpenMPI. Use your favorite package manager to install MPICH or OpenMPI.

Download TauDEM 5.2.0 source code package from GitHub repository and extract archive contents. Open terminal and cd into src directory inside extracted folder. Create build directory and cd into it

mkdir build cd build

Configure your build (change install prefix if necessary) and compile

CXX=mpicxx cmake -DCMAKE\_INSTALL\_PREFIX=/usr/local .. make

When compilation finished install TauDEM tools by running

sudo make install

Примітка: Executable files will be installed into bin subdirectory inside prefix you specified at the configure stage. For example if you specified prefix /opt/taudem5.2 than binaries will be installed into /opt/taudem5.2/bin.

To use singlefile version — download source package here and perform above mentioned steps to compile and install it.

Old TauDEM 5.0.6 also available. But before compiling this version it is necessary to edit some source files.

Open the linearpart.h file, and after line

```
#include "mpi.h"
add a new line with
#include <stdint.h>
so you'll get
```

```
#include "mpi.h"
#include <stdint.h>
```

Save the changes and close the file. Now open tiffIO.h, find line #include "stdint.h" and replace quotes () with <>, so you'll get

```
#include <stdint.h>
```

Save the changes and close the file.

Now configure, compile and install TauDEM 5.0.6 using same commands as described above.

## Configuring TauDEM provider

Once TauDEM is installed, start QGIS, open the Processing options dialog from  $Processing \rightarrow Options...$  and configure the TauDEM algorithm provider. In the Providers group find TauDEM (hydrologic analysis) block, and expand it. Here you will see all settings related to TauDEM.

First, ensure that algorithms are enabled, and activate provider if necessary.

Next step is to configure MPI. The MPICH/OpenMPI bin directory setting used to define location of the mpiexec program. In most Linux distributions you can safely leave this empty, as mpiexec available in your PATH.

The Number of MPI parallel processes to use is a second setting related to MPI. It defines number of processes that will be used to execute TauDEM commands. If you don't know which value to use, it is better to leave this value unchanged.

Now we need to configure the path to the folder(s) where TauDEM command-line tools are installed. As we already mention TauDEM provider supports both single- and multifile TauDEM, so there are two settings for TauDEM folders:

- TauDEM command line tools folder used to set location of the singlefile tools
- TauDEM multifile command line tools folder used to set location of the multifile tools

If you have both TauDEM versions installed in different directories it is possible to specify both options.

The last step is to define which TauDEM version to use:

- with Enable multifile TauDEM tools option checked you will use multifile TauDEM tools from directory, specified in the TauDEM multifile command line tools folder. Multifile tools have same name as singlefile with "(multifile)" suffix added
- with Enable single TauDEM tools option checked you will use multifile TauDEM tools from directory, specified in the TauDEM command line tools folder.

It is possible to enable both tools simultaneously. In this case you will have two instances of each tool in toolbox and can use them in your analysis.

## Примітка: Be careful with developing Processing models using TauDEM!

As single- and multifile versions have different inputs, model created with singlefile algorithms will not work if only multifile algorithms are available. If you plan to share your model please specify which TauDEM version should be used or, better, provide two versions of your model: for single- and multifile TauDEM.

# 18.15 The QGIS Commander

Processing includes a practical tool that allows you to run algorithms without having to use the toolbox, but just by typing the name of the algorithm you want to run.

This tool is known as the QGIS commander, and it is just a simple text box with autocompletion where you type the command you want to run.

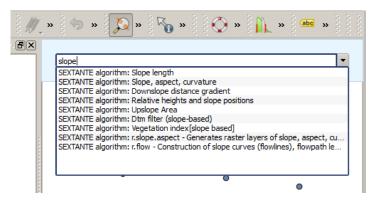


Рис. 18.32: The QGIS Commander

The Commander is started from the *Processing* menu or, more practically, by pressing Shift + Ctrl + M (you can change that default keyboard shortcut in the QGIS configuration if you prefer a different one). To close it, just press ESC. Apart from executing Processing algorithms, the Commander gives you access to most of the functionality in QGIS, which means that it gives you a practical and efficient way of running QGIS tasks and allows you to control QGIS with reduced usage of buttons and menus.

Moreover, the Commander is configurable, so you can add your custom commands and have them just a few keystrokes away, making it a powerful tool to help you become more productive in your daily work with QGIS.

### 18.15.1 Available commands

The commands available in the Commander fall in the following categories:

- Processing algorithms. These are shown as Processing algorithm: <name of the algorithm>.
- Menu items. These are shown as Menu item: <menu entry text>. All menus items available from the QGIS interface are available, even if they are included in a submenu.
- Python functions. You can create short Python functions that will be then included in the list of available commands. They are shown as Function: <function name>.

To run any of the above, just start typing and then select the corresponding element from the list of available commands that appears after filtering the whole list of commands with the text you have entered.

In the case of calling a Python function, you can select the entry in the list, which is prefixed by Function: (for instance, Function: removeall), or just directly type the function name (removeall in the previous example). There is no need to add brackets after the function name.

## 18.15.2 Creating custom functions

Custom functions are added by entering the corresponding Python code in the <code>commands.py</code> file that is found in the <code>.qgis2/processing/commander</code> directory in your user folder. It is just a simple Python file where you can add the functions that you need.

The file is created with a few example functions the first time you open the Commander. If you haven't launched the Commander yet, you can create the file yourself. To edit the commands file, use your favourite text editor. You can also use a built-in editor by calling the edit command from the Commander. It will open the editor with the commands file, and you can edit it directly and then save your changes.

For instance, you can add the following function, which removes all layers:

```
from qgis.gui import *

def removeall():
    mapreg = QgsMapLayerRegistry.instance()
    mapreg.removeAllMapLayers()
```

Once you have added the function, it will be available in the Commander, and you can invoke it by typing removeal1. There is no need to do anything apart from writing the function itself.

Functions can receive parameters. Add \*args to your function definition to receive arguments. When calling the function from the Commander, parameters have to be passed separated by spaces.

Here is an example of a function that loads a layer and takes a parameter with the filename of the layer to load.

```
import processing
def load(*args):
   processing.load(args[0])
```

If you want to load the layer in /home/myuser/points.shp, type in the Commander text box:

```
''load /home/myuser/points.shp''
```

# **Print Composer**

With the Print Composer you can create nice maps and atlasses that can be printed or saved as PDF-file, an image or an SVG-file. This is a powerful way to share geographical information produced with QGIS that can be included in reports or published.

# 19.1 Overview of the Print Composer

The Print Composer provides growing layout and printing capabilities. It allows you to add elements such as the QGIS map canvas, text labels, images, legends, scale bars, basic shapes, arrows, attribute tables and HTML frames. You can size, group, align, position and rotate each element and adjust their properties to create your layout. The layout can be printed or exported to image formats, PostScript, PDF or to SVG (export to SVG is not working properly with some recent Qt4 versions; you should try and check individually on your system). You can save the layout as a template and load it again in another session. Finally, generating several maps based on a template can be done through the atlas generator.

## 19.1.1 Sample Session

Before you start to work with the Print Composer, you need to load some raster or vector layers in the QGIS map canvas and adapt their properties to suit your own convenience. After everything is rendered and symbolized to your liking, click the New Print Composer icon in the toolbar or choose  $File \rightarrow New$  Print Composer. You will be prompted to choose a title for the new Composer.

To demonstrate how to create a map please follow the next instructions.

- 1. On the left side, select the Add new map 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.
- 2. Select the Add new scalebar toolbar button and click with the left mouse button on the Print Composer canvas. A scalebar will be added to the canvas.
- 3. Select the Add new legend toolbar button and draw a rectangle on the canvas holding down the left mouse button. Inside the drawn rectangle the legend will be drawn.
- 4. Select the Select/Move item icon to select the map on the canvas and move it a bit.
- 5. While the map item is still selected you can also change the size of the map item. Click while holding down the left mouse button, in a white little rectangle in one of the corners of the map item and drag it to a new location to change it's size.
- 6. Click the *Item Properties* tab on the left lower panel and find the setting for the orientation. Change the value of the setting *Map orientation* to '15.00° '. You should see the orientation of the map item change.

- 7. Now, you can print or export your print composition to image formats, PDF or to SVG with the export tools in Composer menu.
- 8. Finally, you can save your print composition within the project file with the Save Project button.

You can add multiple elements to the Composer. It is also possible to have more than one map view or legend or scale bar in the Print Composer canvas, on one or several pages. Each element has its own properties and, in the case of the map, its own extent. If you want to remove any elements from the Composer canvas you can do that with the Delete or the Backspace key.

## 19.1.2 The Composer Manager

The Composer Manager is the main window to manage print composers in the project. It helps you add new print composer, duplicate an existing one, rename or delete it. To open the composer manager dialog, click on the Composer Manager button in the toolbar or choose  $Composer \rightarrow Composer Manager$ . It can also be reached from the main window of QGIS with  $Project \rightarrow Composer Manager$ .

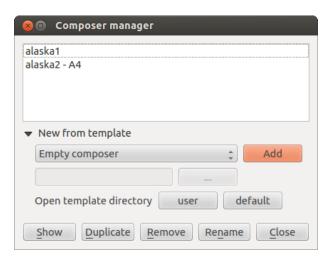


Рис. 19.1: The Print Composer Manager

The composer manager lists in its upper part all the available print composers in the project. The bottom part shows tools that help to:

- show the selected composer(s): you can open multiple print composers in one-click
- duplicate the selected composer (available only if one print composer is selected): it creates a new composer using the selected composer as template. You'll be prompted to choose a new title for the new composer
- rename the composer (also available only if one print composer is selected): You'll be prompted to choose a new title for the composer. Note that you can also rename the composer by double-clicking on its title in the upper part
- remove the composer: the selected print composer(s) will be deleted from the project.

With the Composer Manager, it's also possible to create new print composers as an empty composer or from a saved template. By default, QGIS will look for templates in user directory ( $^{\sim}$ /.qgis2/composer\_templates) or application's one (ApplicationFolder/composer\_templates). QGIS will retrieve all the available templates and propose them in the combobox. The selected template will be used to create a new composer when clicking Add button. You can also save composer templates in another folder. Choosing specific in the template list offers the ability to select such template and use it to create a new print composer.

## 19.1.3 Menus, tools and panels of the print composer

Opening the Print Composer provides you with a blank canvas that represents the paper surface when using the print option. Initially you find buttons on the left beside the canvas to add map composer items: the current QGIS map canvas, text labels, images, legends, scale bars, basic shapes, arrows, attribute tables and HTML frames. In this toolbar you also find toolbar buttons to navigate, zoom in on an area and pan the view on the composer and toolbar buttons to select a map composer item and to move the contents of the map item.

Figure composer overview shows the initial view of the Print Composer before any elements are added.

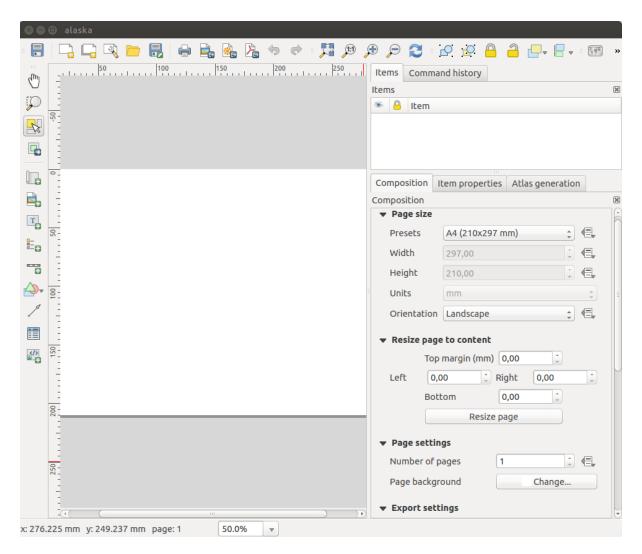


Рис. 19.2: Print Composer

On the right beside the canvas you find two panels. The upper panel holds the tabs *Items* and *Command History* and the lower panel holds the tabs *Composition*, *Item properties* and *Atlas generation*.

- The *Items* tab provides a list of all map composer items added to the canvas.
- The Command history tab displays a history of all changes applied to the Print Composer layout. With a mouse click, it is possible to undo and redo layout steps back and forth to a certain status.
- The *Composition* tab allows you to set paper size, orientation, the page background, number of pages and print quality for the output file in dpi. Furthermore, you can also activate the *Print as raster* checkbox. This means all items will be converted to raster before printing or saving as PostScript or PDF. In this tab, you can also customize settings for grid and smart guides.

- The *Item Properties* tab displays the properties for the selected item. Click the Select/Move item icon to select an item (e.g., legend, scale bar or label) on the canvas. Then click the *Item Properties* tab and customize the settings for the selected item.
- The Atlas generation tab allows you to enable the generation of an atlas for the current Composer and gives access to its parameters.

In the bottom part of the Print Composer window, you can find a status bar with mouse position, current page number, a combo box to set the zoom level, the number of selected items if applicable and, in the case of atlas generation, the number of features.

In the upper part of the Print composer window, you can find menus and other toolbars. All Print Composer tools are available in menus and as icons in a toolbar. See a list of tools in table composer 1.

The toolbars and the tabs can be switched off and on using the right mouse button over any toolbar or through  $View \rightarrow Toolbars$  or  $View \rightarrow Panels$ .

### **Tools**

lcon	Purpose	lcon	Purpose
	Save Project	*	New Composer
	Duplicate Composer	A.	Composer Manager
	Load from template		Save as template
	Print or export as PostScript		Export to an image format
*	Export print composition to SVG	<b>}</b>	Export as PDF
4	Revert last change		Restore last change
200	Zoom to full extent	1:1	Zoom to 100%
	Zoom in	$\bigcirc$	Zoom out
	Refresh View		
<b>%</b>	Pan		Zoom to specific region
	Select/Move item in print composition	<b>\$</b>	Move content within an item
	Add new map from QGIS map canvas		Add image to print composition
T	Add label to print composition		Add new legend to print composition
•	Add scale bar to print composition		Add basic shape to print composition
<b>7</b> 0	Add arrow to print composition		Add attribute table to print composition
<b>3</b> (2)	Add an HTML frame		
	Group items of print composition		Ungroup items of print composition
	Lock Selected Items		Unlock All items
	Raise selected items		Lower selected items
	Move selected items to top		Move selected items to bottom
	Align selected items left		Align selected items right
	Align selected items center		Align selected items center vertical
	Align selected items top		Align selected items bottom
	Preview Atlas	<b> </b>	First Feature
<b>4</b>	Previous Feature		Next Feature
	Last feature		Print Atlas
<b>₽</b>	Export Atlas as Image		Atlas Settings

Table Composer 1: Print Composer Tools

## Composer Menu

With the  $Composer \rightarrow Save\ Project$  action, you can save the project file directly from the print composer window. The Composer menu also provides actions to:

- $\bullet$  Create a new and blank print composer with  $\hfill \hfill \h$
- Open the Composer Manager...

• Print Composers...: Open an existing print composer

Once the layout is designed, with Save as template and Add items from template icons, you can save the current state of a Print Composer session as a .qpt template and load its item again in another session. In the Composer menu, there are also powerful ways to share geographical information produced with QGIS that can be included in reports or published. These tools are Export as Image..., Export as PDF..., Export as SVG... and Print...

## Settings Menu

From  $Settings \rightarrow Composer \ Options$  you can set some options that will be used as default on any composer during your work.

- Compositions defaults let you specify the default font to use.
- With *Grid appearance*, you can set the grid style and its color. There are three types of grid: **Dots**, **Solid** lines and **Crosses**.
- Grid and guide defaults defines spacing, offset and tolerance of the grid.

### Edit Menu

#### Copy/Cut and Paste Items

The print composer includes actions to use the common Copy/Cut/Paste functionality for the items in the layout. As usual first you need to select the items using one of the options seen above; at this point the actions can be found in the Edit menu. When using the Paste action, the elements will be pasted according to the current mouse position. Using the  $Edit \rightarrow Paste$  in Place action or pressing Ctrl+Shift+V will paste the items into the current page, at the same position they were in their initial page. It ensures to copy/paste items at the same place, from page to page.

Примітка: HTML items can not be copied in this way. As a workaround, use the [Add Frame] button in the *Item Properties* tab.

#### View Menu

#### **Navigation Tools**

To navigate in the canvas layout, the Print Composer provides some general tools:

- Zoom In
- 💂 🔎 Zoom Out
- Zoom Full
- Zoom to 100%
- Refresh view (if you find the view in an inconsistent state)
- Show Grid behind items.
- Snap Grid to snap items on the grid.
- Show Guides to help user to align items. These are red line that you can click in the rule (above or at the left side of the layout) and drag and drop to the desired location.

- Snap Guides: allows user to snap items to the guides,
- Smart Guides: uses other composer items as guides to dynamically snap to as user moves or reshapes an item.
- Clear Guides to remove all current guides.
- Show Bounding box around the items.
- Show Rules around the layout.
- Show Pages or set up pages to transparent. Often composer is used to create non-print layouts, e.g. for inclusion in presentations or other documents, and it's desirable to export the composition using a totally transparent background. It's sometimes referred to as "infinite canvas" in other editing packages.
- $\bullet$   $\it Toggle~Full~Screen$  makes the composer window to full screen.
- Hide Panels hides/shows the right panel
- Panels lists all panels available to hide/show them.
- *Toolbars* same as above for toolbars.

You can change the zoom level also using the mouse wheel or the combo box in the status bar. If you need to switch to pan mode while working in the Composer area, you can hold the Spacebar or the mouse wheel. With Ctrl+Spacebar, you can temporarily switch to Zoom In mode, and with Ctrl+Shift+Spacebar, to Zoom Out mode.

#### **Hide and Show Panels**

To maximise the space available to interact with a composition you can use  $View \rightarrow \square$  Hide panels or press F10.

Примітка: It's also possible to switch to a full screen mode to have more space to interact by pressing F11 or using  $View \rightarrow \square$  Toggle full screen.

### **Composition Tab**

### Page size and settings

In the Composition tab, you can define the global settings of the current composition.

You can choose one of the *Presets* formats for your paper sheet, or enter your custom width, height and units. You can also choose the page *Orientation* to use.

Composition can be divided into several pages. For instance, a first page can show a map canvas, and a second page can show the attribute table associated with a layer, while a third one shows an HTML frame linking to your organization website. Set the *Number of pages* to the desired value, you can also custom the *Page Background* with the color or the symbol you want.

The Page size options apply to all the pages in the composition. However, you can modify the values using the data defined override options (see *Data Defined Override Buttons*).

A custom page size can also be set, using the *Resize page* tool. This creates an unique page composition, resizes the page to fit the current contents of the composition (with optional margins).

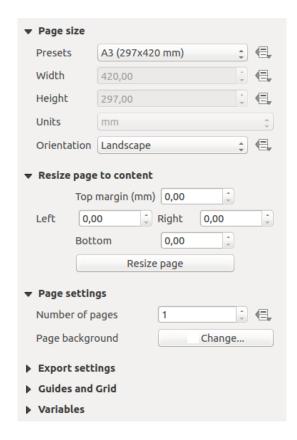


Рис. 19.3: Composition settings in the Print Composer

#### **Export settings**

You can define a resolution to use for all exported maps in *Export resolution*. This setting can however be overridden each time you are exporting a map. When checked, f print as raster means all elements will be rasterized before printing or saving as PostScript or PDF.

While exporting to an image file format, you can choose to generate a world file by checking  $\ensuremath{^{\square}}$  World file on and select a map item. The world file is created beside the exported map, has same name and contains information to easily georeference it.



Рис. 19.4: Export Settings in the Print Composer

## Grid and guides

You can put some reference marks on your composition paper sheet to help you place some items. These marks can be:

• simple lines (called **Guides**) put at the position you want. To do that, ensure that *Show Rulers* and *Show Guides* in *View* menu are checked. Then, click and drag from within the ruler to the paper sheet. A vertical or horizontal line is added to the paper and you can set its position following the coordinates displayed at the left bottom of the composer dialog.

### • or regular **Grid**.

Whether grids or guides should be shown is set in *View* menu. There, you can also decide if they might be used to snap composer items. The *Grid and guides* section lets you customize grid settings like *Grid spacing*, *Grid offset* and *Snap tolerance* to your need. The tolerance is the maximum distance below which an item is snapped to a grid or a guide.

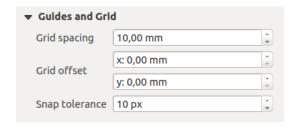


Рис. 19.5: Snapping to grids in the Print Composer

In the  $Options \rightarrow Composer$  menu in QGIS main canvas, you can also set the spacing, offset and snap tolerance of the grid as much as its style and color. These options are applied by default to any new print composer.

#### Command History Tab: Revert and Restore actions

During the layout process, it is possible to revert and restore changes. This can be done with the revert and restore tools:

- , 句 Revert last change
- Restore last change

This can also be done by mouse click within the *Command history* tab (see figure\_composer\_1). The History tab lists the last actions done within the composer. Just select the point you want to revert to and once you do new action all the actions done after the selected one will be removed.



Рис. 19.6: Command history in the Print Composer

### Items Tab

The *Items* tab offers some options to manage selection and visibility of items. All the items added to the print composer canvas are shown in a list and selecting an item makes the corresponding row selected in the list as well as selecting a row does select the corresponding item in the print composer canvas. This is thus a handy way to select an item placed behind another one. Note that a selected row is shown as bold.

For any selected item, you can:

• set it visible or not,

- lock or unlock its position,
- order its Z position. You can move up and down each item in the list with a click and drag. The upper item in the list will be brought to the foreground in the print composer canvas. By default, a newly created item is placed in the foreground.
- change the name by double-clicking the text.

Once you have found the correct position for an item, you can lock it by ticking the box in column. Locked items are **not** selectable on the canvas. Locked items can be unlocked by selecting the item in the *Items* tab and unchecking the tickbox or you can use the icons on the toolbar.

# 19.2 Composer Items

## 19.2.1 Composer Items Common Options

Composer items have a set of common properties you will find on the bottom of the *Item Properties* tab: Position and size, Rotation, Frame, Background, Item ID and Rendering (See figure composer common 1).

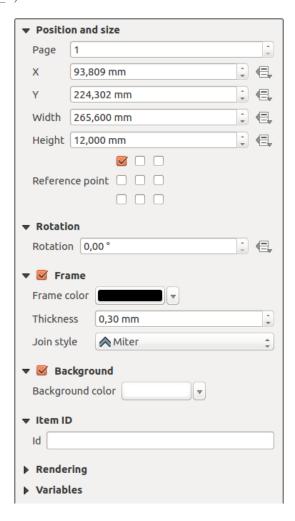


Рис. 19.7: Common Item properties Dialogs

• The *Position and size* dialog lets you define the size and position of the frame which contains the item. You can also choose which *Reference point* will be set at the **X** and **Y** coordinates previously defined.

- The *Rotation* sets the rotation of the element (in degrees).
- The Frame shows or hides the frame around the item. Click on the [Color] and [Thickness] buttons to adjust those properties.
- Use the *Background color* menu for setting a background color. Click on the [Color...] button to display a dialog where you can pick a color or choose from a custom setting. Transparency can be adjusted through atlering the alpha field settings.
- Use the *Item ID* to create a relationship to other Print Composer items. This is used with QGIS server and other potential web clients. You can set an ID on an item (for example, a map or a label), and then the web client can send data to set a property (e.g., label text) for that specific item. The GetProjectSettings command will list the items and IDs which are available in a layout.
- Rendering mode helps you set whether and how the item can be displayed.

#### Примітка:

- If you checked **S** Use live-updating color chooser dialogs in the QGIS general options, the color button will update as soon as you choose a new color from **Color Dialog** windows. If not, you need to close the **Color Dialog**.
- The Data defined override icon next to a field means that you can associate the field with data in the map item or use expressions. These are particularly helpful with atlas generation (See Data Defined Override Buttons).

#### Rendering mode

QGIS now allows advanced rendering for Composer items just like vector and raster layers.

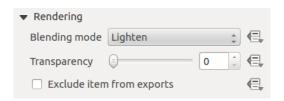


Рис. 19.8: Rendering mode

- Blending mode: With this tool you can achieve effects which would otherwise only be achieved using graphic rendering software. The pixels of your overlaying and underlaying items can be mixed according to the mode set (see Blending Modes for description of each effect).
- Transparency: You can make the underlying item in the Composer visible with this tool. Use the slider to adapt the visibility of your item to your needs. You can also make a precise definition of the percentage of visibility in the menu beside the slider.
- **Exclude** item from exports: You can decide to make an item invisible in all exports. After activating this checkbox, the item will not be included in export to PDF, print etc..

## Size and position

Each item inside the Composer can be moved and resized to create a perfect layout. For both operations the first step is to activate the Select/Move item tool and to click on the item; you can then move it using the mouse while holding the left button. If you need to constrain the movements to the horizontal or the vertical axis, just hold the Shift button on the keyboard while moving the mouse. If you need better precision, you can move a selected item using the Arrow keys on the keyboard; if the movement is too slow, you can speed up it by holding Shift.

A selected item will show squares on its boundaries; moving one of them with the mouse, will resize the item in the corresponding direction. While resizing, holding Shift will maintain the aspect ratio. Holding Alt will resize from the item center.

The correct position for an item can be obtained using the grid snapping or smart guides. Guides are set by clicking and dragging within the ruler area. To move a guide, click on the ruler, level with the guide and drag it to a new position. To delete a guide move it off the canvas. If you need to disable the snap on the fly, hold Ctrl while moving the mouse.

You can choose multiple items with the Select/Move item button. Just hold the Shift button and click on all the items you need. You can then resize/move this group like a single item.

Once you have found the correct position for an item, you can lock it by using the items on the toolbar or ticking the box next to the item in the *Items* tab. Locked items are **not** selectable on the canvas.

Locked items can be unlocked by selecting the item in the *Items* tab and unchecking the tickbox or you can use the icons on the toolbar.

To unselect an item, just click on it holding the Shift button.

Inside the *Edit* menu, you can find actions to select all the items, to clear all selections or to invert the current selection.

## Alignment

Raising or lowering the visual hierarchy for elements are inside the Raise selected items pull-down menu. Choose an element on the Print Composer canvas and select the matching functionality to raise or lower the selected element compared to the other elements. This order is shown in the *Items* tab. You can also raise or lower objects in the *Items* tab by clicking and dragging an object's label in this list.

There are several alignment options available within the Align selected items pull-down menu (see figure\_composer\_common\_3). To use an alignment function, you first select the elements then click on the matching alignment icon. All selected elements will then be aligned to their common bounding box. When moving items on the Composer canvas, alignment helper lines appear when borders, centers or corners are aligned.

### 19.2.2 The Map Item

Click on the Add new map toolbar button in the Print Composer toolbar to add the QGIS map canvas. Now, drag a rectangle onto the Composer canvas with the left mouse button to add the map. To display the current map, you can choose between three different modes in the map *Item Properties* tab:

- **Rectangle** is the default setting. It only displays an empty box with a message 'Map will be printed here'.
- Cache renders the map in the current screen resolution. If you zoom the Composer window in or out, the map is not rendered again but the image will be scaled.
- Render means that if you zoom the Composer window in or out, the map will be rendered again, but for space reasons, only up to a maximum resolution.

Cache is the default preview mode for newly added Print Composer maps.

You can resize the map item by clicking on the Select/Move item button, selecting the element, and dragging one of the blue handles in the corner of the map. This button also helps to move the map to another place. Select the item and while holding the left mouse button, move to the new place and release the mouse button. After you have found the right place for an item, you can lock the item position within

the Print Composer canvas. Select the map item and use the toolbar Lock Selected Items or the *Items* tab to Lock the item. A locked item can only be selected using the *Items* tab. Once selected you can use

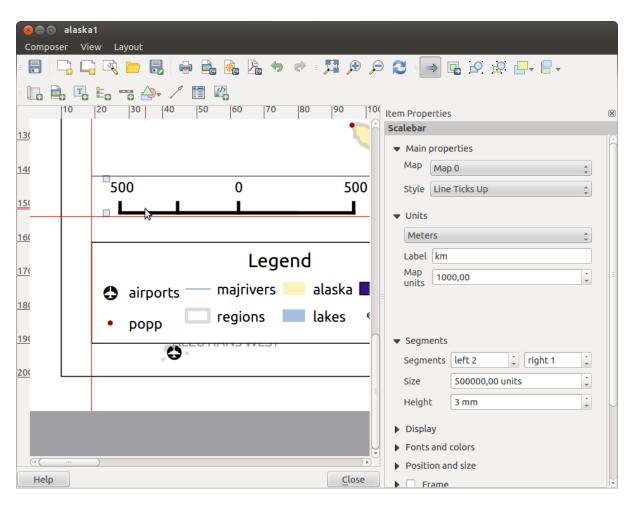


Рис. 19.9: Alignment helper lines in the Print Composer

the *Items* tab to unlock individual items. The Unlock All Items icon will unlock all locked composer items. With the map selected, you can now adapt more properties in the map *Item Properties* tab.

To move layers within the map element, select the map element, click the Move item content icon and move the layers within the map item frame with the left mouse button.

## Main properties

The *Main properties* dialog of the map *Item Properties* tab provides the following functionalities (see figure composer map 1):

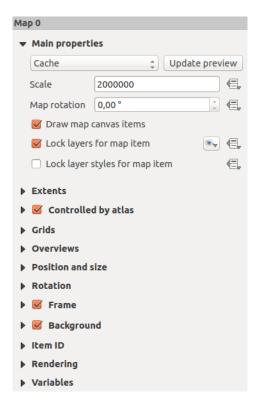


Рис. 19.10: Map Item properties Tab

- The **Preview** area allows you to define the preview modes 'Rectangle', 'Cache' and 'Render', as described above. If you change the view on the QGIS map canvas by changing vector or raster properties, you can update the Print Composer view by selecting the map element in the Print Composer and clicking the **[Update preview]** button.
- The field Scale 1,00  $\diamondsuit$  sets a manual scale.
- The field *Map rotation* 1.00 allows you to rotate the map element content clockwise in degrees. The rotation of the map view can be imitated here. Note that a correct coordinate frame can only be added with the default value 0 and that once you defined a *Map rotation* it currently cannot be changed.
- If Draw map canvas items lets you show annotations that may be placed on the map canvas in the main QGIS window.
- You can choose to lock the layers shown on a map item. Check **Lock layers for map item**. After this is checked, any layer that would be displayed or hidden in the main QGIS window will not appear or be hidden in the map item of the Composer. But style and labels of a locked layer are still refreshed according to the main QGIS interface. You can prevent this by using **Lock layer styles** for map item.

• The button allows you to add quickly all the presets views you have prepared in QGIS. Clicking on the button you will see the list of all the preset views: just select the preset you want to display. The map canvas will automatically lock the preset layers by enabling the Lock layers for map item: if you want to unselect the preset, just uncheck the and press the button. See Layers Panel to find out how to create presets views.

Locked layers in the map can also be *data-defined*, using the icon beside the option. When used, this overrides the selection set in the drop-down list. You need to pass a list of layers separated by character. The following example locks the map item to use only layers layer 1 and layer 2:

```
concat ('layer 1', '|', 'layer 2')
```

#### **Extents**

The *Extents* dialog of the map item tab provides the following functionalities (see figure composer map 2):

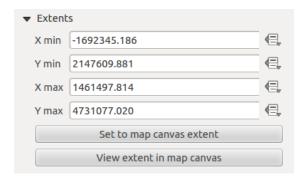


Рис. 19.11: Map Extents Dialog

• The Map extents area allows you to specify the map extent using X and Y min/max values and by clicking the [Set to map canvas extent] button. This button sets the map extent of the composer map item to the extent of the current map view in the main QGIS application. The button [View extent in map canvas] does exactly the opposite, it updates the extent of the map view in the QGIS application to the extent of the composer map item.

If you change the view on the QGIS map canvas by changing vector or raster properties, you can update the Print Composer view by selecting the map element in the Print Composer and clicking the [Update preview] button in the map Item Properties tab (see figure composer map 1).

#### Grids

The *Grids* dialog of the map *Item Properties* tab provides the possibility to add several grids to a map item.

- With the plus and minus button you can add or remove a selected grid.
- With the up and down button you can move a grid in the list and set the drawing priority.

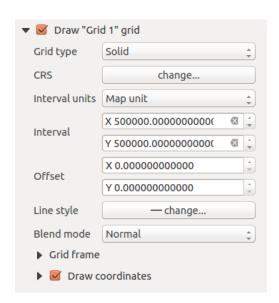
When you double click on the added grid you can give it another name.

After you have added a grid, you can activate the checkbox Draw grid to overlay a grid onto the map element. Expand this option to provide a lot of configuration options, see Figure composer map 4.

As grid type, you can specify to use a 'Solid', 'Cross', 'Markers' or 'Frame and annotations only'. 'Frame and annotations only' is especially useful when working with rotated maps or reprojected grids. In the divisions section of the Grid Frame Dialog mentioned below you then have a corresponding setting. Symbology of the grid and its rendering mode can be chosen. See *Rendering mode*. Furthermore, you



Рис. 19.12: Map Grids Dialog



 ${\it Puc.}$ 19.13: Draw Grid Dialog

can define an interval in the X and Y directions, an X and Y offset, and the width used for the cross or line grid type.



Рис. 19.14: Grid Frame Dialog

- There are different options to style the frame that holds the map. Following options are available: No Frame, Zebra, Interior ticks, Exterior ticks, Interior and Exterior ticks and Lineborder.
- With 'Latitude/Y only' and 'Longitude/X only' setting in the divisions section you have the possibility to prevent a mix of latitude/y and longitude/x coordinates showing on a side when working with rotated maps or reprojected grids.
- Advanced rendering mode is also available for grids.
- The Draw coordinates checkbox allows you to add coordinates to the map frame. You can choose the annotation numeric format, the options range from decimal to degrees, minute and seconds, with or without suffix, aligned or not and a custom format using the expression dialog. You can choose which annotation to show. The options are: show all, latitude only, longitude only, or disable(none). This is useful when the map is rotated. The annotation can be drawn inside or outside the map frame. The annotation direction can be defined as horizontal, vertical ascending or vertical descending. Finally, you can define the annotation font, the annotation font color, the annotation distance from the map frame and the precision of the drawn coordinates.

#### Overviews

The Overviews dialog of the map Item Properties tab provides the following functionalities:

You can choose to create an overview map, which shows the extents of the other map(s) that are available in the composer. First you need to create the map(s) you want to include in the overview map and the map you want to use as the overview map, just like a normal map.

Then expand *Overviews* option and press the green plus icon-button to add an overview. Initially this overview is named 'Overview 1' (see Figure\_composer\_map\_7). You can change the name when you double-click on the overview item in the list named 'Overview 1' and change it to another name.

- With the plus and minus button you can add or remove an overview.
- With the up and down button you can move an overview in the list and set the drawing priority.

When you select the overview item in the list you can customize it.

• The *Draw* "<name\_overview>" overview needs to be activated to draw the extent of selected map frame.

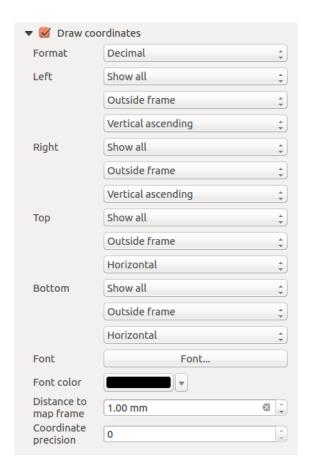


Рис. 19.15: Grid Draw Coordinates dialog

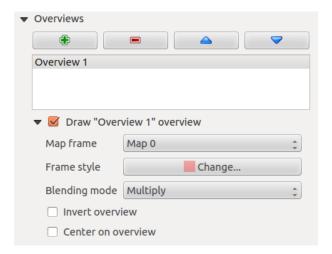


Рис. 19.16: Map Overviews Dialog

- The *Map frame* combo list can be used to select the map item whose extents will be drawn on the present map item.
- The Frame Style allows you to change the style of the overview frame.
- The Blending mode allows you to set different transparency blend modes.
- The Invert overview creates a mask around the extents when activated: the referenced map extents are shown clearly, whereas everything else is blended with the frame color.
- The Center on overview puts the extent of the overview frame in the center of the overview map. You can only activate one overview item to center, when you have added several overviews.

#### 19.2.3 The Label Item

To add a label, click the Add label icon, place the element with the left mouse button on the Print Composer canvas and position and customize its appearance in the label *Item Properties* tab.

The *Item Properties* tab of a label item provides the following functionality for the label item (see Figure composer label):

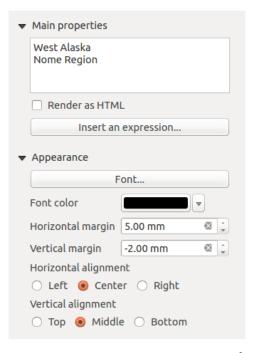


Рис. 19.17: Label Item properties Tab 🛆

#### Main properties

- The main properties dialog is where the text (HTML or not) or the expression needed to fill the label is added to the Composer canvas.
- Labels can be interpreted as HTML code: check Render as HTML. You can now insert a URL, a clickable image that links to a web page or something more complex.
- You can also insert an expression. Click on [Insert an expression] to open a new dialog. Build an expression by clicking the functions available in the left side of the panel. Two special categories can be useful, particularly associated with the atlas functionality: geometry functions and records functions. At the bottom, a preview of the expression is shown.

#### **Appearance**

- Define *Font* by clicking on the **[Font...]** button or a *Font color* selecting a color using the color selection tool.
- You can specify different horizontal and vertical margins in mm. This is the margin from the edge of the composer item. The label can be positioned outside the bounds of the label e.g. to align label items with other items. In this case you have to use negative values for the margin.
- Using the Alignment is another way to position your label. Note that when e.g. using the Horizontal alignment in Center Position the Horizontal margin feature is disabled.

## 19.2.4 The Legend Item

To add a map legend, click the Add new legend icon, place the element with the left mouse button on the Print Composer canvas and position and customize the appearance in the legend *Item Properties* tab.

The *Item properties* of a legend item tab provides the following functionalities (see figure composer legend 1):

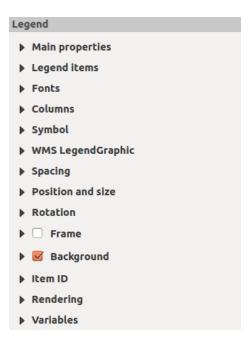


Рис. 19.18: Legend Item properties Tab

#### Main properties

The *Main properties* dialog of the legend *Item Properties* tab provides the following functionalities (see figure composer legend 2):

In Main properties you can:

- Change the title of the legend.
- Set the title alignment to Left, Center or Right.
- You can choose which Map item the current legend will refer to in the select list.
- You can wrap the text of the legend title on a given character.

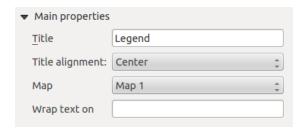


Рис. 19.19: Legend Main properties Dialog

## Legend items

The *Legend items* dialog of the legend *Item Properties* tab provides the following functionalities (see figure \_composer\_legend \_3):



Рис. 19.20: Legend Legend Items Dialog

- The legend will be updated automatically if Auto-update is checked. When Auto-update is unchecked this will give you more control over the legend items. The icons below the legend items list will be activated.
- The legend items window lists all legend items and allows you to change item order, group layers, remove and restore items in the list, edit layer names and add a filter.
  - The item order can be changed using the **[Up]** and **[Down]** buttons or with 'drag-and-drop' functionality. The order can not be changed for WMS legend graphics.
  - Use the [Add group] button to add a legend group.
  - Use the [plus] and [minus] button to add or remove layers.
  - The [Edit] button is used to edit the layer, groupname or title. First you need to select the legend item.
  - The [Sigma] button adds a feature count for each vector layer.
  - Use the [filter] button to filter the legend by map content, only the legend items visible in the map will be listed in the legend.

After changing the symbology in the QGIS main window, you can click on [Update All] to adapt the changes in the legend element of the Print Composer.

#### Fonts, Columns, Symbol

The Fonts, Columns and Symbol dialogs of the legend Item Properties tab provide the following functionalities (see figure composer legend 4):

• You can change the font of the legend title, group, subgroup and item (layer) in the legend item. Click on a category button to open a **Select font** dialog.

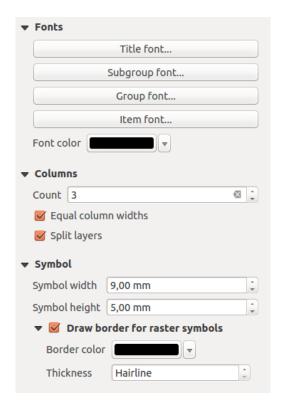


Рис. 19.21: Legend Fonts, Columns and Symbol Dialogs

- You provide the labels with a **Color** using the advanced color picker, however the selected color will be given to all font items in the legend..
- Legend items can be arranged over several columns. Set the number of columns in the *Count* field.
  - $\blacksquare$  Equal column widths sets how legend columns should be adjusted.
  - The **Split layers** option allows a categorized or a graduated layer legend to be divided between columns.
- You can also change the width and height of the legend symbol, set a color and a thickness in case of raster layer symbol.

#### WMS LegendGraphic and Spacing

The WMS LegendGraphic and Spacing dialogs of the legend Item Properties tab provide the following functionalities (see figure composer legend 5):

When you have added a WMS layer and you insert a legend composer item, a request will be sent to the WMS server to provide a WMS legend. This Legend will only be shown if the WMS server provides the GetLegendGraphic capability. The WMS legend content will be provided as a raster image.

WMS LegendGraphic is used to be able to adjust the Legend width and the Legend height of the WMS legend raster image.

Spacing around title, group, subgroup, symbol, icon label, box space or column space can be customized through this dialog.

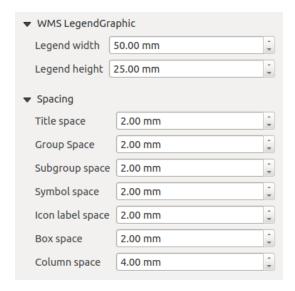


Рис. 19.22: WMS LegendGraphic and Spacing Dialogs

## 19.2.5 The Scale Bar Item

To add a scale bar, click the Add new scalebar icon, place the element with the left mouse button on the Print Composer canvas and position and customize the appearance in the scale bar *Item Properties* tab.

The *Item properties* of a scale bar item tab provides the following functionalities (see figure composer scalebar 1):

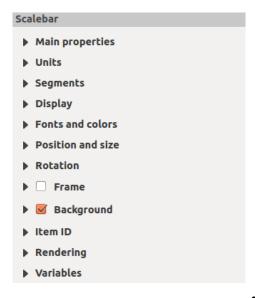


Рис. 19.23: Scale Bar Item properties Tab 🚨

#### Main properties

The *Main properties* dialog of the scale bar *Item Properties* tab provides the following functionalities (see figure composer scalebar 2):

- First, choose the map the scale bar will be attached to.
- Then, choose the style of the scale bar. Six styles are available:



Рис. 19.24: Scale Bar Main properties Dialog 🗘

- Single box and Double box styles, which contain one or two lines of boxes alternating colors.
- Middle, Up or Down line ticks.
- Numeric, where the scale ratio is printed (i.e., 1:50000).

#### **Units and Segments**

The *Units* and *Segments* dialogs of the scale bar *Item Properties* tab provide the following functionalities (see figure composer scalebar 3):

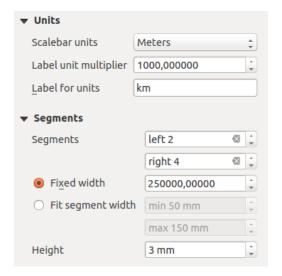


Рис. 19.25: Scale Bar Units and Segments Dialogs 🚨



In these two dialogs, you can set how the scale bar will be represented.

- Select the units you want to use with Scalebar units. There are four possible choices: Map Units, the default one and Meters, Feet or Nautical Miles which may force unit conversions.
- The Label unit multiplier specifies how many scalebar units per labeled unit. Eg, if your scalebar units are set to "meters", a multiplier of 1000 will result in the scale bar labels in "kilometers".
- The Label for units field defines the text used to describe the units of the scale bar, eg "m" or "km". This should be matched to reflect the multiplier above.
- You can define how many Segments will be drawn on the left and on the right side of the scale bar.
- You can set how long each segment will be (fixed width), or limit the scale bar size in mm with Fit segment width option. In the latter case, each time the map scale changes, the scale bar is resized (and its label updated) to fit the range set.
- Height is used to define the height of the bar.

#### **Display**

The Display dialog of the scale bar Item Properties tab provide the following functionalities (see figure composer scalebar 4):

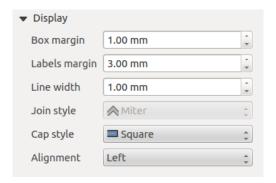


Рис. 19.26: Scale Bar Display 🚨



You can define how the scale bar will be displayed in its frame.

- Box margin: space between text and frame borders
- Labels margin: space between text and scale bar drawing
- Line width: line width of the scale bar drawing
- Join style: Corners at the end of scalebar in style Bevel, Rounded or Square (only available for Scale bar style Single Box & Double Box)
- Cap style: End of all lines in style Square, Round or Flat (only available for Scale bar style Line Ticks Up, Down and Middle)
- Alignment: Puts text on the left, middle or right side of the frame (works only for Scale bar style Numeric)

#### Fonts and colors

The Fonts and colors dialog of the scale bar Item Properties tab provide the following functionalities (see figure\_composer\_scalebar\_5):

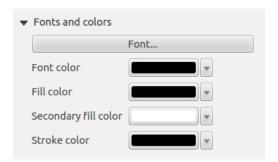


Рис. 19.27: Scale Bar Fonts and colors Dialogs 🚨



You can define the fonts and colors used for the scale bar.

- Use the [Font] button to set the font of scale bar label
- Font color: set the font color
- Fill color: set the first fill color
- Secondary fill color: set the second fill color

• Stroke color: set the color of the lines of the Scale Bar

Fill colors are only used for scale box styles Single Box and Double Box. To select a color you can use the list option using the dropdown arrow to open a simple color selection option or the more advanced color selection option, that is started when you click in the colored box in the dialog.

#### 19.2.6 The Attribute Table Item

It is possible to add parts of a vector attribute table to the Print Composer canvas: Click the Add attribute table icon, click and drag with the left mouse button on the Print Composer canvas to place and size the item. You can better position and customize its appearance in the *Item Properties* tab.

The Item properties tab of an attribute table provides the following functionalities (see figure composer table 1):

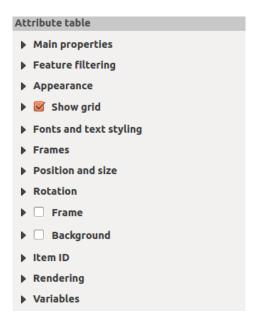


Рис. 19.28: Attribute table Item properties Tab 🚨



## Main properties

The Main properties dialog of the attribute table' provides the following functionalities (see figure\_composer table 2):



Рис. 19.29: Attribute table Main properties Dialog 🚨



- For Source you can normally select only 'Layer features'.
- With Layer you can choose from the vector layers loaded in the project.

- In case you activated the Generate an atlas option in the Atlas generation tab, there are two additional Source possible: 'Current atlas feature' (see figure composer table 2b) and 'Relation children' (see figure\_composer\_table 2c). Choosing the 'Current atlas feature' you won't see any option to choose the layer, and the table item will only show a row with the attributes from the current feature of the atlas coverage layer. Choosing 'Relation children', an option with the relation names will show up. The 'Relation children' option can only be used if you have defined a relation using your atlas coverage layer as parent, and the table will show the children rows of the atlas coverage layer's current feature (for further information about the atlas generation, see Generate an Atlas).
- The button [Refresh table data] can be used to refresh the table when the actual contents of the table has changed.



Рис. 19.30: Attribute table Main properties for 'Current atlas feature'



Рис. 19.31: Attribute table Main properties for 'Relation children' 🚨



• The button [Attributes...] starts the Select attributes menu, see figure composer table 3, that can be used to change the visible contents of the table. After making changes use the [OK] button to apply changes to the table. The upper part of the window shows the list of the attributes to display and the lower part helps to set the way the data is sorted.

In the *Columns* section you can:

- Remove an attribute, just select an attribute row by clicking anywhere in the row and press the minus button to remove the selected attribute.
- Add a new attribute use the plus button. At the end a new empty row appears and you can select empty cell of the column Attribute. You can select a field attribute from the list or you can select to build a new attribute using a regular expression (  $^{m{arepsilon}}$  button). Of course you can modify every already existing attribute by means of a regular expression.
- Use the up and down arrows to change the order of the attributes in the table.
- Select a cell in the Headings column and, to change the heading, just type in a new name.
- set a precise Alignment (mixing vertical and horizontal alignment options) for each column.
- Select a cell in the Width column and change it from Automatic to a width in mm, just type a number. When you want to change it back to Automatic, use the cross.
- The [Reset] button can always be used to restore it to the original attribute settings.

In the *Sorting* section you can:

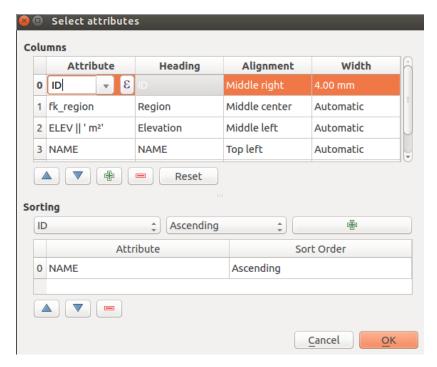


Рис. 19.32: Attribute table Select attributes Dialog 🗴

- Add an attribute to sort the table with. Select an attribute and set the sorting order to 'Ascending' or 'Descending' and press the plus button. A new line is added to the sort order list.
- select a row in the list and use the up and down button to change the sort priority on attribute level. Selecting a cell in the Sort Order column helps you change the sorting order of the attribute field.
- use the minus button to remove an attribute from the sort order list.

#### Feature filtering

The *Feature filtering* dialog of the attribute table provides the following functionalities (see figure composer table 4):

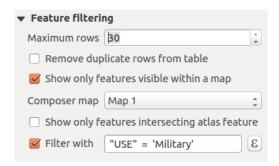


Рис. 19.33: Attribute table Feature filtering Dialog 🕹

#### You can:

- Define the *Maximum rows* to be displayed.
- Activate Remove duplicate rows from table to show unique records only.

- Activate Show only visible features within a map and select the corresponding Composer map to display the attributes of features only visible on selected map.
- Activate Mark Show only features intersecting Atlas feature is only available when Mark Generate an atlas is activated. When activated it will show a table with only the features shown on the map of that particular page of the atlas.
- Activate Filter with and provide a filter by typing in the input line or insert a regular expression using the given  $\stackrel{\triangleright}{\epsilon}$  expression button. A few examples of filtering statements you can use when you have loaded the airports layer from the Sample dataset:
  - ELEV > 500
  - NAME = 'ANIAK'
  - NAME NOT LIKE 'AN%'
  - regexp\_match( attribute( \$currentfeature, 'USE'), '[i]')

The last regular expression will include only the airports that have a letter 'i' in the attribute field 'USE'.

#### **Appearance**

The Appearance dialog of the attribute table provides the following functionalities (see figure composer table 5):

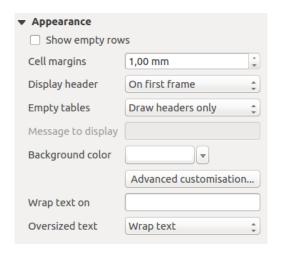


Рис. 19.34: Attribute table appearance Dialog 🚨



- Click Show empty rows to fill the attribute table with empty cells. This option can also be used to provide additional empty cells when you have a result to show!
- With Cell margins you can define the margin around text in each cell of the table.
- With Display header you can select from a list one of 'On first frame', 'On all frames' default option, or 'No header'.
- The option *Empty table* controls what will be displayed when the result selection is empty.
  - Draw headers only, will only draw the header except if you have chosen 'No header' for Display header.
  - Hide entire table, will only draw the background of the table. You can activate Don't draw background if frame is empty in Frames to completely hide the table.

- Show set message, will draw the header and adds a cell spanning all columns and display a message like 'No result' that can be provided in the option Message to display
- The option *Message to display* is only activated when you have selected **Show set message** for *Empty table*. The message provided will be shown in the table in the first row, when the result is an empty table.
- With Background color you can set the background color of the table. The Advanced customization option helps you define different background colors for each cell (see figure composer table 6)

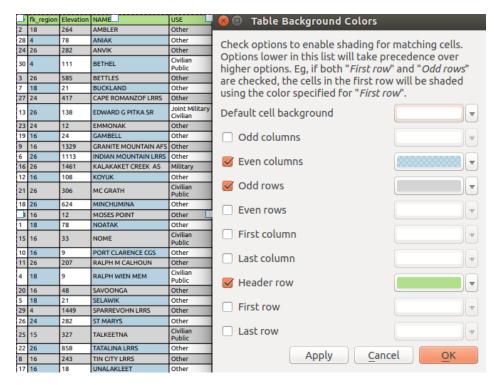


Рис. 19.35: Attribute table Advanced Background Dialog 🚨

- With the Wrap text on option, you can define a character on which the cell content will be wraped each time it is met
- With Oversized text you define the behaviour when the width set for a column is smaller than its content's length. It can be **Wrap text** or **Truncate text**.

## Show grid

The *Show grid* dialog of the attribute table provides the following functionalities (see figure\_composer\_table\_7):



Рис. 19.36: Attribute table Show grid Dialog 🛆

- Activate Show grid when you want to display the grid, the outlines of the table cells.
- With Line width you can set the thickness of the lines used in the grid.

• The Color of the grid can be set using the color selection dialog.

#### Fonts and text styling

The Fonts and text styling dialog of the attribute table provides the following functionalities (see figure composer table 8):

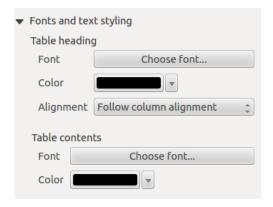


Рис. 19.37: Attribute table Fonts and text styling Dialog 🚨



- You can define Font and Color for Table heading and Table contents.
- For Table heading you can additionally set the Alignment to Follow column alignment or override this setting by choosing Left, Center or Right. The column alignment is set using the Select Attributes dialog (see Figure composer table 3).

#### **Frames**

The Frames dialog of the attribute table provides the following functionalities (see figure\_composer\_table 9):

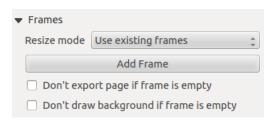


Рис. 19.38: Attribute table Frames Dialog 🚨



- With Resize mode you can select how to render the attribute table contents:
  - Use existing frames displays the result in the first frame and added frames only.
  - Extend to next page will create as many frames (and corresponding pages) as necessary to display the full selection of attribute table. Each frame can be moved around on the layout. If you resize a frame, the resulting table will be divided up between the other frames. The last frame will be trimmed to fit the table.
  - Repeat until finished will also create as many frames as the Extend to next page option, except all frames will have the same size.

- Use the [Add Frame] button to add another frame with the same size as selected frame. The result of the table that will not fit in the first frame will continue in the next frame when you use the Resize mode *Use existing frames*.
- Activate *Don't export page if frame is empty* prevents the page to be exported when the table frame has no contents. This means all other composer items, maps, scalebars, legends etc. will not be visible in the result
- Activate Don't draw background if frame is empty prevents the background to be drawn when the table frame has no contents.

## 19.2.7 The Image Item

To add an image, click the Add image icon and drag a rectangle onto the Composer canvas with the left mouse button. You can then position and customize its appearance in the image *Item Properties* tab.

The image *Item Properties* tab provides the following functionalities (see figure composer image 1):

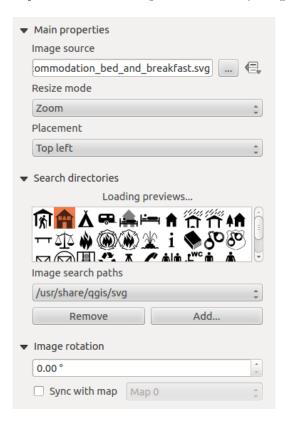


Рис. 19.39: Image Item properties Tab

You first have to select the image you want to display. There are several ways to set the *image source* in the **Main properties** area.

- 1. Use the browse button of *image source* to select a file on your computer using the browse dialog. The browser will start in the SVG-libraries provided with QGIS. Besides SVG, you can also select other image formats like .png or .jpg.
- 2. You can enter the source directly in the *image source* text field. You can even provide a remote URL-address to an image.
- 3. From the **Search directories** area you can also select an image from *loading previews* ... to set the image source.

4. Use the data defined button 🗐 to set the image source from a record or using a regular expression.

With the *Resize mode* option, you can set how the image is displayed when the frame is changed, or choose to resize the frame of the image item so it matches the original size of the image.

You can select one of the following modes:

- Zoom: Enlarges the image to the frame while maintaining aspect ratio of picture.
- Stretch: Stretches image to fit inside the frame, ignores aspect ratio.
- Clip: Use this mode for raster images only, it sets the size of the image to original image size without scaling and the frame is used to clip the image, so only the part of the image inside the frame is visible.
- Zoom and resize frame: Enlarges image to fit frame, then resizes frame to fit resultant image.
- Resize frame to image size: Sets size of frame to match original size of image without scaling.

Selected resize mode can disable the item options 'Placement' and 'Image rotation'. The *Image rotation* is active for the resize mode 'Zoom' and 'Clip'.

With *Placement* you can select the position of the image inside it's frame. The **Search directories** area allows you to add and remove directories with images in SVG format to the picture database. A preview of the pictures found in the selected directories is shown in a pane and can be used to select and set the image source.

It is possible to change SVG fill/outline color and outline width when using parameterized SVG files such as those included with QGIS. If you add a SVG file you should add the following tags in order to add support for transparency:

- $\bullet \ \textit{fill-opacity} = "param(\textit{fill-opacity})"$
- stroke-opacity="param(outline-opacity)"

You can read this blog post to see an example.

Images can be rotated with the  $Image\ rotation$  field. Activating the  $Sync\ with\ map$  checkbox synchronizes the rotation of the image (i.e., a rotated north arrow) with the rotation applied to the selected map item.

It is also possible to select a north arrow directly. If you first select a north arrow image from **Search directories** and then use the browse button of the field *Image source*, you can now select one of the north arrow from the list as displayed in figure\_composer\_image\_2.

Примітка: Many of the north arrows do not have an 'N' added in the north arrow, this is done on purpose for languages that do not use an 'N' for North, so they can use another letter.

#### 19.2.8 The HTML Frame Item

It is possible to add a frame that displays the contents of a website or even create and style your own HTML page and display it!

Click the Add HTML frame icon, place the element by dragging a rectangle holding down the left mouse button on the Print Composer canvas and position and customize the appearance in the *Item Properties* tab (see figure\_composer\_html\_1).

#### **HTML Source**

As an HTML source, you can either set a URL and activate the URL radiobutton or enter the HTML source directly in the textbox provided and activate the Source radiobutton.

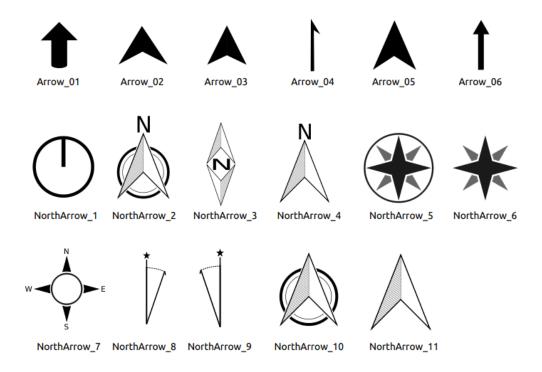


Рис. 19.40: North arrows available for selection in provided SVG library

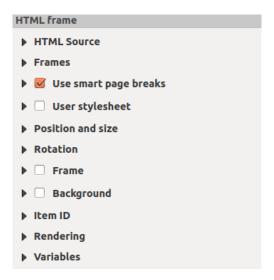


Рис. 19.41: HTML frame, the item properties Tab 🕹

The HTML Source dialog of the HTML frame Item Properties tab provides the following functionalities (see figure composer html 2):

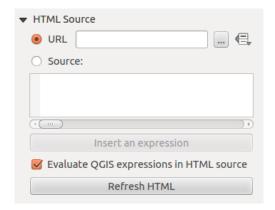


Рис. 19.42: HTML frame, the HTML Source properties 🚨

- In URL you can enter the URL of a webpage you copied from your internet browser or select an HTML file using the browse button \_\_\_\_. There is also the option to use the Data defined override button, to provide an URL from the contents of an attribute field of a table or using a regular expression.
- In Source you can enter text in the textbox with some HTML tags or provide a full HTML page.
- The [insert an expression] button can be used to insert an expression like ["Year(\$now)"] in the Source textbox to display the current year. This button is only activated when radiobutton Source is selected. After inserting the expression click somewhere in the textbox before refreshing the HTML frame, otherwise you will lose the expression.
- Activate Zualuate QGIS expressions in HTML code to see the result of the expression you have included, otherwise you will see the expression instead.
- Use the [Refresh HTML] button to refresh the HTML frame(s) to see the result of changes.

#### **Frames**

The Frames dialog of the HTML frame Item Properties tab provides the following functionalities (see figure composer html 3):

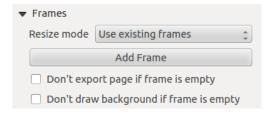


Рис. 19.43: HTML frame, the Frames properties 🕰

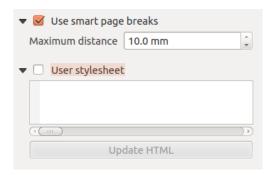


- With Resize mode you can select how to render the HTML contents:
  - Use existing frames displays the result in the first frame and added frames only.
  - Extend to next page will create as many frames (and corresponding pages) as necessary to render the height of the web page. Each frame can be moved around on the layout. If you resize a frame, the webpage will be divided up between the other frames. The last frame will be trimmed to fit the web page.

- Repeat on every page will repeat the upper left of the web page on every page in frames of the same size.
- Repeat until finished will also create as many frames as the Extend to next page option, except all frames will have the same size.
- Use the [Add Frame] button to add another frame with the same size as selected frame. If the HTML page that will not fit in the first frame it will continue in the next frame when you use Resize mode or Use existing frames.
- Activate *Don't export page if frame is empty* prevents the map layout from being exported when the frame has no HTML contents. This means all other composer items, maps, scalebars, legends etc. will not be visible in the result.
- Activate MDon't draw background if frame is empty prevents the HTML frame being drawn if the frame is empty.

#### Use smart page breaks and User style sheet

The Use smart page breaks dialog and Use style sheet dialog of the HTML frame Item Properties tab provides the following functionalities (see figure composer html 4):



Puc. 19.44: HTML frame, Use smart page breaks and User stylesheet properties 🚨



- Activate Use smart page breaks to prevent the html frame contents from breaking mid-way a line of text so it continues nice and smooth in the next frame.
- Set the Maximum distance allowed when calculating where to place page breaks in the html. This distance is the maximum amount of empty space allowed at the bottom of a frame after calculating the optimum break location. Setting a larger value will result in better choice of page break location, but more wasted space at the bottom of frames. This is only used when Use smart page breaks is activated.
- Activate User stylesheet to apply HTML styles that often is provided in cascading style sheets. An example of style code is provide below to set the color of <h1> header tag to green and set the font and fontsize of text included in paragraph tags .

```
h1 {color: #00ff00;
p {font-family: "Times New Roman", Times, serif;
   font-size: 20px;
```

• Use the [Update HTML] button to see the result of the stylesheet settings.

## 19.2.9 The Basic Shape Items

To add a basic shape (ellipse, rectangle, triangle), click the Add basic shape icon, place the element holding down the left mouse. Customize the appearance in the *Item Properties* tab.

When you also hold down the Shift key while placing the basic shape you can create a perfect square, circle or triangle.

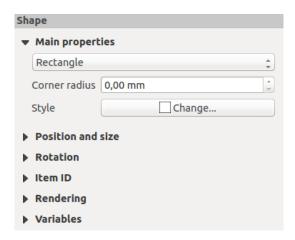


Рис. 19.45: Shape Item properties Tab 🚨

The *Shape* item properties tab allows you to select if you want to draw an ellipse, rectangle or triangle inside the given frame.

You can set the style of the shape using the advanced symbol style dialog with which you can define its outline and fill color, fill pattern, use markers etcetera.

For the rectangle shape, you can set the value of the corner radius to round of the corners.

Примітка: Unlike other items, you can not style the frame or the background color of the frame.

## 19.2.10 The Arrow Item

To add an arrow, click the Add Arrow icon, place the element holding down the left mouse button and drag a line to draw the arrow on the Print Composer canvas and position and customize the appearance in the scale bar *Item Properties* tab.

When you also hold down the Shift key while placing the arrow, it is placed in an angle of exactly 45°.

The arrow item can be used to add a line or a simple arrow that can be used, for example, to show the relation between other print composer items. To create a north arrow, the image item should be considered first. QGIS has a set of North arrows in SVG format. Furthermore you can connect an image item with a map so it can rotate automatically with the map (see *The Image Item*).

## **Item Properties**

The Arrow item properties tab allows you to configure an arrow item.

The [Line style ...] button can be used to set the line style using the line style symbol editor.

In Arrows markers you can select one of three radio buttons.

- Default: To draw a regular arrow, gives you options to style the arrow head
- None: To draw a line without arrow head

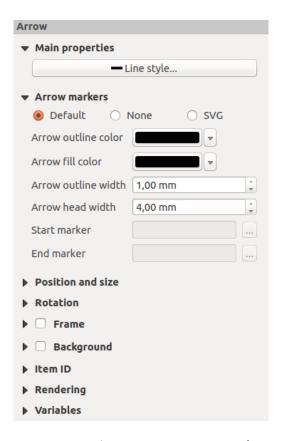


Рис. 19.46: Arrow Item properties Tab

• SVG Marker: To draw a line with an SVG Start marker and/or End marker

For Default Arrow marker you can use following options to style the arrow head.

- Arrow outline color: Set the outline color of the arrow head
- Arrow fill color: Set the fill color of the arrow head
- Arrow outline width: Set the outline width of the arrow head
- Arrow head width: Set the size of the arrow head

For SVG Marker you can use following options.

- Start marker: Choose an SVG image to draw at the beginning of the line
- End marker: Choose an SVG image to draw at the end of the line
- Arrow head width: Set the size of Start and/or End marker

SVG images are automatically rotated with the line. The color of the SVG image can not be changed.

## 19.3 Creating an Output

Figure\_composer\_output\_1 shows the Print Composer with an example print layout, including each type of map item described in the previous section.

Before printing a layout you have the possibility to view your composition without bounding boxes. This can be enabled by deactivating View -> Show bounding boxes or pressing the shortcut Ctrl+Shift+B.

The Print Composer allows you to create several output formats, and it is possible to define the resolution (print quality) and paper size:

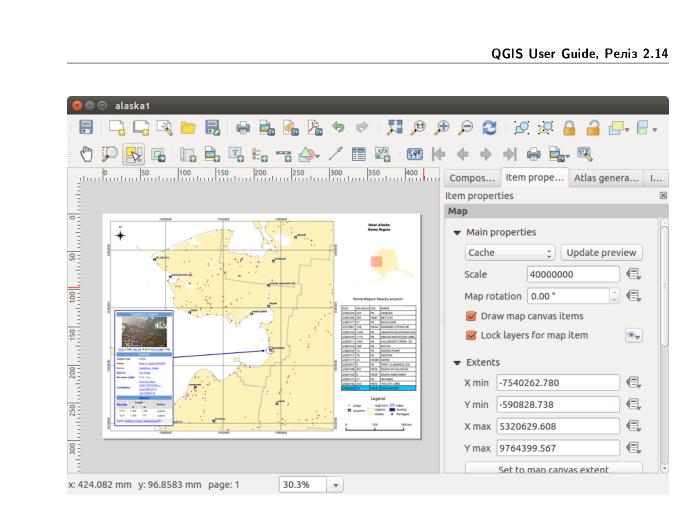


Рис. 19.47: Print Composer with map view, legend, image, scale bar, coordinates, text and HTML frame added

- The Print icon allows you to print the layout to a connected printer or a PostScript file, depending on installed printer drivers.
- The Export as image icon exports the Composer canvas in several image formats, such as PNG, BPM, TIF, JPG,...
- The Export as SVG icon saves the Print Composer canvas as an SVG (Scalable Vector Graphic).
- The Export as PDF icon saves the defined Print Composer canvas directly as a PDF.

## 19.3.1 Export as Image

Clicking the Export as image icon will ask you to enter the filename to use to export composition: in case of multi-page composition, each page will be exported to a file with the given name appended with the page number.

You can then override the print resolution (set in Composition tab) and resize exported image dimensions. By checking Crop to content option, the images output by composer will include only the area of the composition with content. There's also an option for margins to add around the item bounds if required.

If the composition includes a single page, then the output will be sized to include EVERYTHING on the composition. If it's a multi-page composition, then each page will be cropped to only include the area of that page with items.

If you need to export your layout as a **georeferenced image** (e.g., to share with other projects), you need to enable this feature under the Composition tab. Check World file on and choose the map item to use. With this option, the 'Export as image' action will create a world file along the exported image.

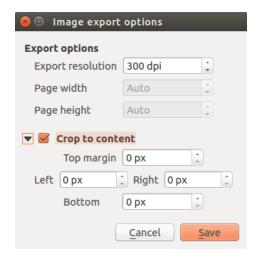


Рис. 19.48: Image Export Options

**Примітка:** Exporting big rasters can sometimes fail, even if there seems to be enough memory. This is a problem with the underlying Qt management of rasters.

### 19.3.2 Export as SVG

With Export as SVG, you also need to fill the filename (used as a basename for all files in case of multi\_page composition) and then can apply Crop to content option.

The SVG export options dialog allows also to:

- export map layers as svg groups:
- render map labels as outlines



Рис. 19.49: SVG Export Options

Примітка: Currently, the SVG output is very basic. This is not a QGIS problem, but a problem with the underlying Qt library. This will hopefully be sorted out in future versions.

### 19.3.3 Export as PDF

The Export as PDF exports all the composition into a single PDF file.

If you applied to your composition or any shown layer an advanced effect such as blend modes, transparency or symbol effects, these cannot be printed as vectors and your effects may be lost. Checking Print as a raster in Composition tab helps to keep the effects but rasterize the composition. Note that the Force layer to render as raster in the Rendering tab of Layer Properties is a layer-level alternative that avoids global composition rasterization.

#### 19.3.4 Generate an Atlas

The Print Composer includes generation functions that allow you to create map books in an automated way. The concept is to use a coverage layer, which contains geometries and fields. For each geometry in the coverage layer, a new output will be generated where the content of some canvas maps will be moved to highlight the current geometry. Fields associated with this geometry can be used within text labels.

Every page will be generated with each feature. To enable the generation of an atlas and access generation parameters, refer to the *Atlas generation* tab. This tab contains the following widgets (see figure composer atlas 1):

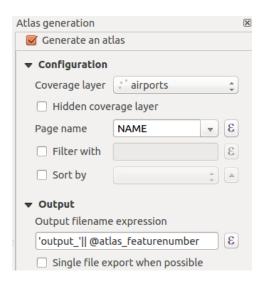


Рис. 19.50: Atlas generation tab

- **Generate** an atlas, which enables or disables the atlas generation.
- A Coverage layer combo box that allows you to choose the (vector) layer containing the features on which to iterate over.
- An optional Hidden coverage layer that, if checked, will hide the coverage layer (but not the other ones) during the generation.
- An optional *Page name* combo box to give a more explicit name to each feature page(s) when previewing atlas. You can select an attribute of the coverage layer or set an expression. If this option is empty, QGIS will use an internal ID, according to the filter and/or the sort order applied to the layer.
- An optional *Filter with* text area that allows you to specify an expression for filtering features from the coverage layer. If the expression is not empty, only features that evaluate to **True** will be selected. The button on the right allows you to display the expression builder.

• An optional Sort by that, if checked, allows you to sort features of the coverage layer. The associated combo box allows you to choose which column will be used as the sorting key. Sort order (either ascending or descending) is set by a two-state button that displays an up or a down arrow.

You also have options to set the output of the atlas:

- An Output filename expression textbox that is used to generate a filename for each geometry if needed. It is based on expressions. This field is meaningful only for rendering to multiple files.
- A Single file export when possible that allows you to force the generation of a single file if this is possible with the chosen output format (PDF, for instance). If this field is checked, the value of the Output filename expression field is meaningless.

You can use multiple map items with the atlas generation; each map will be rendered according to the coverage features. To enable atlas generation for a specific map item, you need to check  $\checkmark$  Controlled by Atlas under the item properties of the map item. Once checked, you can set:

- A Margin around feature that allows you to select the amount of space added around each geometry within the allocated map. Its value is meaningful only when using the auto-scaling mode.
- A Predefined scale (best fit). It will use the best fitting option from the list of predefined scales in your project properties settings (see Project -> Project Properties -> General -> Project Scales to configure these predefined scales).
- A Fixed scale that allows you to toggle between auto-scale and fixed-scale mode. In fixed-scale mode, the map will only be translated for each geometry to be centered. In auto-scale mode, the map's extents are computed in such a way that each geometry will appear in its entirety.

#### Labels

In order to adapt labels to the feature the atlas plugin iterates over, you can include expressions. What you should take care of is to place expression part (including functions, fields or variables) between [% and %]. For example, for a city layer with fields CITY\_NAME and ZIPCODE, you could insert this:

```
The area of [% upper(CITY_NAME) || ',' || ZIPCODE || ' is ' format_number(\frac{1000000}{2} %] km2
```

or, another combination:

```
The area of [% upper(CITY_NAME)%],[%ZIPCODE%] is [%format_number($area/1000000,2) %] km2
```

The information [% upper(CITY\_NAME) || ',' || ZIPCODE || ' is 'format\_number(\$area/1000000,2) %] is an expression used inside the label. both expressions would result in the generated atlas as:

The area of PARIS,75001 is  $1.94\ \mathrm{km2}$ 

#### **Data Defined Override Buttons**

There are several places where you can use a Data Defined Override button to override the selected setting. These options are particularly useful with Atlas Generation.

For the following examples the Regions layer of the QGIS sample dataset is used and selected for Atlas Generation. We also assume the paper format A4 (210X297) is selected in the Composition tab for field Presets.

With a *Data Defined Override* button you can dynamically set the paper orientation. When the height (north-south) of the extents of a region is greater than its width (east-west), you rather want to use *portrait* instead of *landscape* orientation to optimize the use of paper.

In the Composition you can set the field Orientation and select Landscape or Portrait. We want to set the orientation dynamically using an expression depending on the region geometry. Press the button of field Orientation, select Edit... so the Expression string builder dialog opens. Enter the following expression:

```
CASE WHEN bounds_width($atlasgeometry) > bounds_height($atlasgeometry)
THEN 'Landscape' ELSE 'Portrait' END
```

Now the paper orients itself automatically. For each Region you need to reposition the location of the composer item as well. For the map item you can use the button of field *Width* to set it dynamically using following expression:

```
(CASE WHEN bounds_width($atlasgeometry) > bounds_height($atlasgeometry) THEN 297 ELSE 210 END) - 20
```

Use the button of field *Height* to provide following expression:

```
(CASE WHEN bounds_width($atlasgeometry) > bounds_height($atlasgeometry) THEN 210 ELSE 297 END) - 20
```

When you want to give a title above the map in the center of the page, insert a label item above the map. First use the item properties of the label item to set the horizontal alignment to  $\bigcirc$  Center. Next activate from Reference point the upper middle checkbox. You can provide the following expression for field X:

```
(CASE WHEN bounds_width(\alpha) > bounds_height(\alpha) THEN 297 ELSE 210 END) / 2
```

For all other composer items you can set the position in a similar way so they are correctly positioned when the page is automatically rotated in portrait or landscape.

Information provided is derived from the excellent blog (in English and Portuguese) on the Data Defined Override options  $Multiple\_format\_map\_series\_using\_QGIS\_2.6$ .

This is just one example of how you can use the Data Defined Override option.

#### Preview and generate



Рис. 19.51: Atlas Preview toolbar

Once the atlas settings have been configured and composer items (map, table, image...) linked to it, you can create a preview of all the pages by clicking  $Atlas \rightarrow Preview \ Atlas$  or Preview Atlas icon. You can then use the arrows in the same toolbar to navigate through all the features:

First feature
Previous feature
Next feature
Last feature

You can also use the combo box to directly select and preview a specific feature. The combo box shows atlas features name according to the expression set in the atlas *Page name* option.

As for simple compositions, an atlas can be generated in different ways (see *Creating an Output* for more information). Instead of *Composer* menu, rather use tools from *Atlas* menu or Atlas toolbar.

This means that you can directly print your compositions with  $Atlas \rightarrow Print\ Atlas$ . You can also create a PDF using  $Atlas \rightarrow Export\ Atlas\ as\ PDF...$ : The user will be asked for a directory to save all the generated PDF files, except if the  $Single\ file\ export\ when\ possible\ has\ been\ selected$ . In that case, you'll be prompted to give a filename.

With  $Atlas \to Export\ Atlas\ as\ Images...$  or  $Atlas \to Export\ Atlas\ as\ SVG...$  tool, you're also prompted to select a folder. Each page of each atlas feature composition is exported to an image or SVG file.

#### Порада: Print a specific atlas feature

If you want to print or export the composition of only one feature of the atlas, simply start the preview, select the desired feature in the drop-down list and click on  $Composer \rightarrow Print$  (or export... to any supported file format).

**Plugins** 

## 20.1 QGIS Plugins

QGIS has been designed with a plugin architecture. This allows many new features and functions to be easily added to the application. Many of the features in QGIS are actually implemented as plugins.

## 20.1.1 Core and External plugins

QGIS plugins are implemented either as Core Plugins or External Plugins.

Core Plugins are maintained by the QGIS Development Team and are automatically part of every QGIS distribution. They are written in one of two languages: C++ or Python.

Most of External Plugins are currently written in Python. They are stored either in the 'Official' QGIS Repository at <a href="http://plugins.qgis.org/plugins/">http://plugins.qgis.org/plugins/</a> or in external repositories and are maintained by the individual authors. Detailed documentation about the usage, minimum QGIS version, home page, authors, and other important information are provided for the plugins in the Official repository. For other external repositories, documentation might be available with the external plugins themselves. In general, external plugins documentation is not included in this manual.

Installed external python plugins are placed under ~/.qgis2/python/plugins folder. Home directory (denoted by above ~) on Windows is usually something like C:\Documents and Settings\(user)\) (on Windows XP or earlier) or C:\Users\(user)\).

Paths to Custom C++ plugins libraries can also be added under  $Settings \rightarrow Options \rightarrow System$ .

You can manage your plugins in the plugin dialog which can be opened with Plugins > Manage and install plugins ....

When a plugin needs to be updated, and if plugins settings have been set up accordingly, QGIS main interface will display a blue link in the status bar to inform you that there are updates for your plugins waiting to be applied.

## 20.1.2 The Plugins Dialog

The menus in the Plugins dialog allow the user to install, uninstall and upgrade plugins in different ways. Each plugin has some metadata displayed in the right panel:

- $\bullet$  information on whether the plugin is experimental
- description
- rating vote(s) (you can vote for your preferred plugin!)
- tags
- some useful links to the home page, tracker and code repository

- author(s)
- version available

You can use the filter to find a specific plugin.



Here, all the available plugins are listed, including both core and external plugins. Use [Upgrade all] to look for new versions of the plugins. Furthermore, you can use [Install plugin] if a plugin is listed but not installed, [Uninstall plugin] as well as [Reinstall plugin] if a plugin is installed. An installed plugin can be temporarily de/activated using the checkbox.

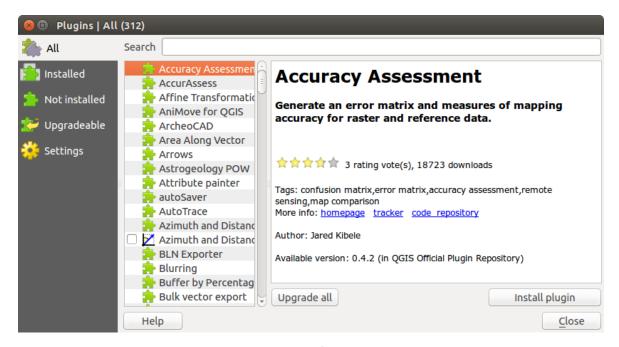
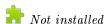


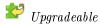
Рис. 20.1: The All menu



In this menu, you can find only the installed plugins. The external plugins can be uninstalled and reinstalled using the [Uninstall plugin] and [Reinstall plugin] buttons. You can [Upgrade all] here as well.



This menu lists all plugins available that are not installed. You can use the [Install plugin] button to implement a plugin into QGIS.



If you activated Show also experimental plugins in the Settings menu, you can use this menu to look for more recent plugin versions. This can be done with the [Upgrade plugin] or [Upgrade all] buttons. Settings

In this menu, you can use the following options:

• Check for updates on startup. Whenever a new plugin or a plugin update is available, QGIS will inform you 'every time QGIS starts', 'once a day', 'every 3 days', 'every week', 'every 2 weeks' or 'every month'.

350 Розділ 20. Plugins

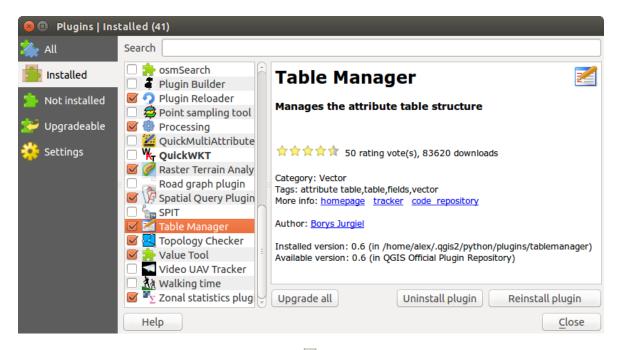


Рис. 20.2: The Installed menu



Рис. 20.3: The Not installed menu

20.1. QGIS Plugins 351

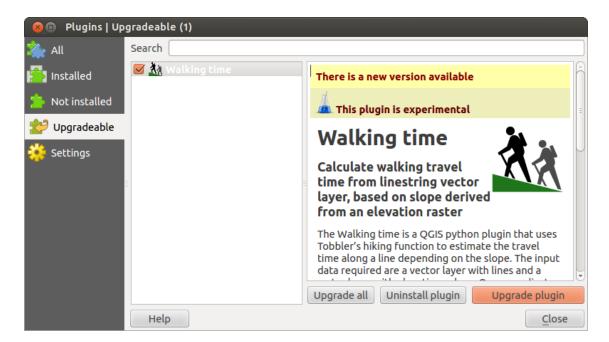


Рис. 20.4: The *Upgradeable* menu

- Show also experimental plugins. QGIS will show you plugins in early stages of development, which are generally unsuitable for production use.
- Show also deprecated plugins. These plugins are deprecated and generally unsuitable for production use.

To add external author repositories, click [Add...] in the *Plugin repositories* section. If you do not want one or more of the added repositories, they can be disabled via the [Edit...] button, or completely removed with the [Delete] button.

Note that you can use an authentication (basic authentication, PKI) to access to a plugin repository. The default QGIS repository is an open repository and you don't need any authentication. You should deploy your own plugin repository. You can get more information on QGIS authentication support in *Authentication* chapter.

The Search function is available in nearly every menu (except \*\* Settings). Here, you can look for specific plugins.

352 Розділ 20. Plugins

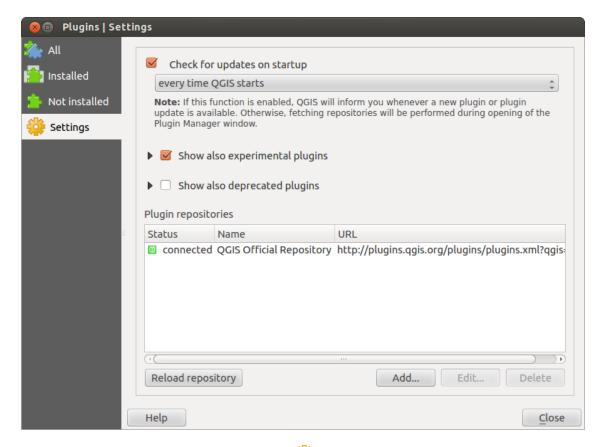


Рис. 20.5: The Settings menu

20.1. QGIS Plugins 353

# 20.2 Using QGIS Core Plugins

Icon	Plugin	Description	Manual Reference
*	Coordinate Capture	Capture mouse coordinate in different CRS	Coordinate Capture Plugin
	DB Manager	Manage your databases within QGIS	DB Manager Plugin
Å.	DXF2Shape Converter	Converts from DXF to SHP file format	Dxf2Shp Converter Plugin
<b>₩</b>	eVis	Event Visualization Tool	eVis Plugin
*	fTools	A suite of vector tools	fTools Plugin
	GDAL Tools	GDAL raster functionality	GDAL Tools Plugin
	Geometry Checker	Check and repair errors in vector geometries	Geometry Checker Plugin
	Geometry Snapper	Snap geometries to a reference layer	Geometry Snapper Plugin
#	Georeferencer GDAL	Georeference rasters with GDAL	Georeferencer Plugin
•	GPS Tools	Tools for loading and importing GPS data	GPS Plugin
<b>W</b>	GRASS	GRASS functionality	GRASS GIS Integration
6	Heatmap	Create heatmap rasters from input vector points	Heatmap Plugin
0	Interpolation plugin	Interpolation on base of vertices of a vector layer	Interpolation Plugin
CSW	Metasearch Catalogue Client	Interact with metadata catalogue services (CSW)	MetaSearch Catalogue Client
<b>W</b>	Offline Editing	Offline editing and synchronizing with database	Offline Editing Plugin
•	Oracle Spatial Georaster	Access Oracle Spatial GeoRasters	Oracle Spatial GeoRaster Plugin
	Plugin Manager	Manage core and external plugins	The Plugins Dialog
<b>©</b>	Processing	Spatial data processing framework	$QGIS\ processing \\ framework$
	Raster Terrain Analysis	Compute geomorphological features from DEMs	Raster Terrain Analysis Plugin
\ <u>\</u>	Road Graph plugin	Shortest path analysis	Road Graph Plugin
	Spatial Query	Spatial queries on vectors	Spatial Query Plugin
	Topology Checker	Find topological errors in vector layers	Topology Checker Plugin
Σ	Zonal Statistics	Calculate raster statistics for vector polygons	Zonal Statistics Plugin

# 20.3 Coordinate Capture Plugin

The coordinate capture plugin is easy to use and provides the ability to display coordinates on the map canvas for two selected coordinate reference systems (CRS).

354 Розділ 20. Plugins

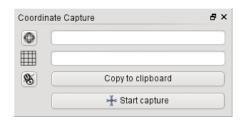


Рис. 20.6: Coordinate Capture Plugin

- 2. Click on the **Enable** on the fly projection checkbox and select a projected coordinate system of your choice (see also Working with Projections).
- 3. Activate the coordinate capture plugin in the Plugin Manager (see *The Plugins Dialog*) and ensure that the dialog is visible by going to *View* → *Panels* and ensuring that ✓ *Coordinate Capture* is enabled. The coordinate capture dialog appears as shown in Figure figure\_coordinate\_capture\_1. Alternatively, you can also go to *Vector* → *Coordinate Capture* and see if ✓ *Coordinate Capture* is enabled.
- 4. Click on the Click to the select the CRS to use for coordinate display icon and select a different CRS from the one you selected above.
- 5. To start capturing coordinates, click on [Start capture]. You can now click anywhere on the map canvas and the plugin will show the coordinates for both of your selected CRS.
- 6. To enable mouse coordinate tracking, click the bimouse tracking icon.
- 7. You can also copy selected coordinates to the clipboard.

# 20.4 DB Manager Plugin

The DB Manager Plugin is officially part of the QGIS core and is intended to be the main tool to integrate and manage spatial database formats supported by QGIS (PostGIS, SpatiaLite, Geopackage,

Oracle Spatial, Virtual layers) in one user interface. The DB Manager Plugin provides several features. You can drag layers from the QGIS Browser into the DB Manager, and it will import your layer into your spatial database. You can drag and drop tables between spatial databases and they will get imported.

The *Database* menu allows you to connect to an existing database, to start the SQL window and to exit the DB Manager Plugin. Once you are connected to an existing database, the menus *Schema* and *Table* additionally appear.

The *Schema* menu includes tools to create and delete (empty) schemas and, if topology is available (e.g., PostGIS 2), to start a *TopoViewer*.

The *Table* menu allows you to create and edit tables and to delete tables and views. It is also possible to empty tables and to move tables from one schema to another. As further functionality, you can perform a VACUUM and then an ANALYZE for each selected table. Plain VACUUM simply reclaims space and makes it available for reuse. ANALYZE updates statistics to determine the most efficient way to execute a query. Finally, you can import layers/files, if they are loaded in QGIS or exist in the file system. And you can export database tables to shape with the Export File feature.

The *Tree* window lists all existing databases supported by QGIS. With a double-click, you can connect to the database. With the right mouse button, you can rename and delete existing schemas and tables. Tables can also be added to the QGIS canvas with the context menu.

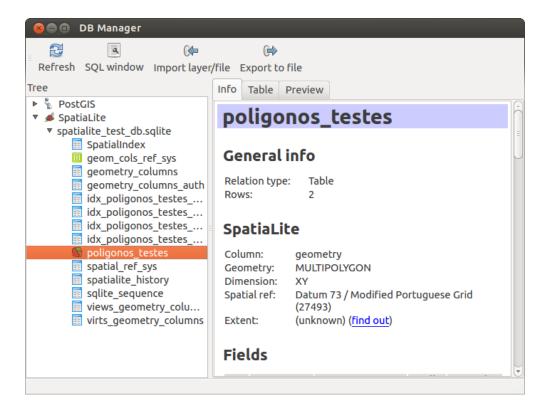


Рис. 20.7: DB Manager dialog

If connected to a database, the **main** window of the DB Manager offers three tabs. The *Info* tab provides information about the table and its geometry, as well as about existing fields, constraints and indexes. It also allows you to run Vacuum Analyze and to create a spatial index on a selected table, if not already done. The *Table* tab shows all attributes, and the *Preview* tab renders the geometries as preview.

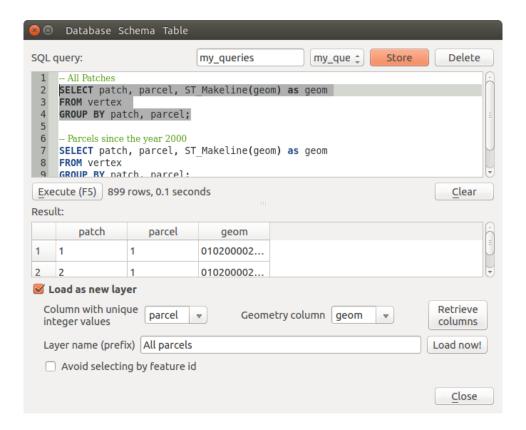
### 20.4.1 Working with the SQL Window

You can also use the DB Manager to execute SQL queries against your spatial database and then view the spatial output for queries by adding the results to QGIS as a query layer. It is possible to highlight a portion of the SQL and only that portion will be executed when you press F5 or click the *Execute (F5)* button.

# 20.5 Dxf2Shp Converter Plugin

The dxf2shape converter plugin can be used to convert vector data from DXF to shapefile format. It requires the following parameters to be specified before running:

- Input DXF file: Enter the path to the DXF file to be converted.
- Output Shp file: Enter desired name of the shapefile to be created.
- Output file type: Specify the geometry type of the output shapefile. Currently supported types are polyline, polygon, and point.
- Export text labels: When this checkbox is enabled, an additional shapefile point layer will be created, and the associated DBF table will contain information about the "TEXT" fields found in the DXF file, and the text strings themselves.



 ${\it Puc.}$  20.8: Executing SQL queries in the DB Manager SQL window

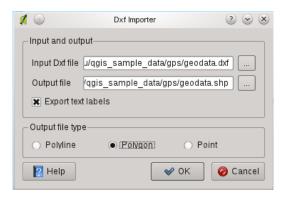


Рис. 20.9: Dxf2Shape Converter Plugin

# 20.5.1 Using the Plugin

- 1. Start QGIS, load the Dxf2Shape plugin in the Plugin Manager (see *The Plugins Dialog*) and click on the Dxf2Shape Converter icon, which appears in the QGIS toolbar menu. The Dxf2Shape plugin dialog appears, as shown in Figure\_dxf2shape\_1.
- 2. Enter the input DXF file, a name for the output shapefile and the shapefile type.
- 3. Enable the Export text labels checkbox if you want to create an extra point layer with labels.
- 4. Click **[OK]**.

# 20.6 eVis Plugin

(This section is derived from Horning, N., K. Koy, P. Ersts. 2009. eVis (v1.1.0) User's Guide. American Museum of Natural History, Center for Biodiversity and Conservation. Available from http://biodiversityinformatics.amnh.org/, and released under the GNU FDL.)

The Biodiversity Informatics Facility at the American Museum of Natural History's (AMNH) Center for Biodiversity and Conservation (CBC) has developed the Event Visualization Tool (eVis), another software tool to add to the suite of conservation monitoring and decision support tools for guiding protected area and landscape planning. This plugin enables users to easily link geocoded (i.e., referenced with latitude and longitude or X and Y coordinates) photographs, and other supporting documents, to vector data in QGIS.

eVis is now automatically installed and enabled in new versions of QGIS, and as with all plugins, it can be disabled and enabled using the Plugin Manager (see *The Plugins Dialog*).

The eVis plugin is made up of three modules: the 'Database Connection tool', 'Event ID tool', and the 'Event Browser'. These work together to allow viewing of geocoded photographs and other documents that are linked to features stored in vector files, databases, or spreadsheets.

### 20.6.1 Event Browser

The Event Browser module provides the functionality to display geocoded photographs that are linked to vector features displayed in the QGIS map window. Point data, for example, can be from a vector file that can be input using QGIS or it can be from the result of a database query. The vector feature must have attribute information associated with it to describe the location and name of the file containing the photograph and, optionally, the compass direction the camera was pointed when the image was acquired. Your vector layer must be loaded into QGIS before running the Event Browser.

#### Launch the Event Browser module

To launch the Event Browser module, click on  $Database \rightarrow eVis \rightarrow eVis \ Event \ Browser$ . This will open the  $Generic\ Event\ Browser$  window.

The *Event Browser* window has three tabs displayed at the top of the window. The *Display* tab is used to view the photograph and its associated attribute data. The *Options* tab provides a number of settings that can be adjusted to control the behavior of the eVis plugin. Lastly, the *Configure External Applications* tab is used to maintain a table of file extensions and their associated application to allow eVis to display documents other than images.

#### Understanding the Display window

To see the *Display* window, click on the *Display* tab in the *Event Browser* window. The *Display* window is used to view geocoded photographs and their associated attribute data.

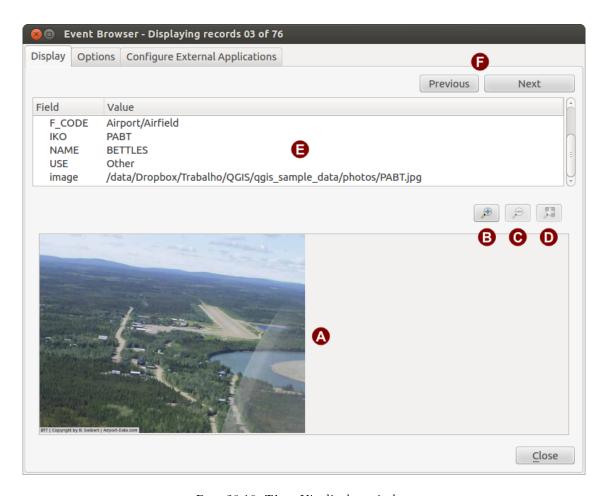


Рис. 20.10: The eVis display window

20.6. eVis Plugin 359

- 1. **Display window**: A window where the photograph will appear.
- 2. **Zoom in button**: Zoom in to see more detail. If the entire image cannot be displayed in the display window, scroll bars will appear on the left and bottom sides of the window to allow you to pan around the image.
- 3. **Zoom out button**: Zoom out to see more area.
- 4. **Zoom to full extent** button: Displays the full extent of the photograph.
- 5. Attribute information window: All of the attribute information for the point associated with the photograph being viewed is displayed here. If the file type being referenced in the displayed record is not an image but is of a file type defined in the Configure External Applications tab, then when you double-click on the value of the field containing the path to the file, the application to open the file will be launched to view or hear the contents of the file. If the file extension is recognized, the attribute data will be displayed in green.
- 6. **Navigation buttons**: Use the Previous and Next buttons to load the previous or next feature when more than one feature is selected.

#### Understanding the Options window

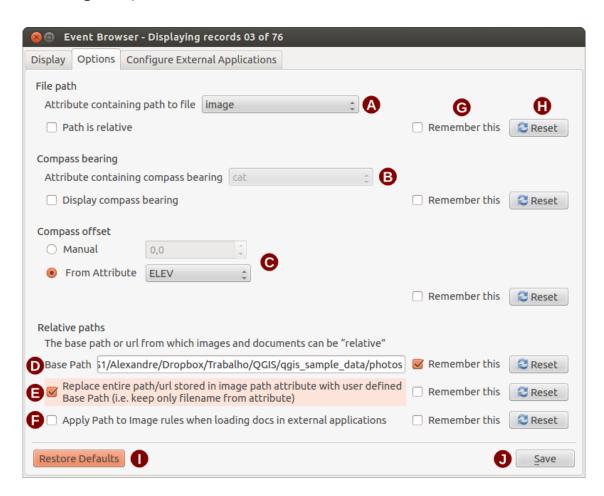


Рис. 20.11: The eVis Options window

1. **File path**: A drop-down list to specify the attribute field that contains the directory path or URL for the photographs or other documents being displayed. If the location is a relative path, then the checkbox must be clicked. The base path for a relative path can be entered in the *Base Path* text box below. Information about the different options for specifying the file location are noted in the section *Specifying the location and name of a photograph* below.

- 2. Compass bearing: A drop-down list to specify the attribute field that contains the compass bearing associated with the photograph being displayed. If compass bearing information is available, it is necessary to click the checkbox below the drop-down menu title.
- 3. Compass offset: Compass offsets can be used to compensate for declination (to adjust bearings collected using magnetic bearings to true north bearings). Click the Manual radio button to enter the offset in the text box or click the From Attribute radio button to select the attribute field containing the offsets. For both of these options, east declinations should be entered using positive values, and west declinations should use negative values.
- 4. **Directory base path**: The base path onto which the relative path defined in Figure\_eVis\_2 (A) will be appended.
- 5. **Replace path**: If this checkbox is checked, only the file name from A will be appended to the base path.
- 6. **Apply rule to all documents**: If checked, the same path rules that are defined for photographs will be used for non-image documents such as movies, text documents, and sound files. If not checked, the path rules will only apply to photographs, and other documents will ignore the base path parameter.
- 7. **Remember settings**: If the checkbox is checked, the values for the associated parameters will be saved for the next session when the window is closed or when the [Save] button below is pressed.
- 8. Reset values: Resets the values on this line to the default setting.
- 9. **Restore defaults**: This will reset all of the fields to their default settings. It has the same effect as clicking all of the [Reset] buttons.
- 10. Save: This will save the settings without closing the *Options* pane.

#### Understanding the Configure External Applications window

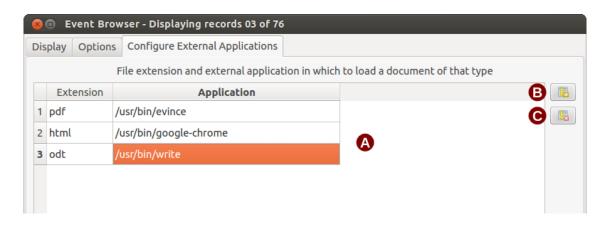


Рис. 20.12: The eVis External Applications window

- 1. **File reference table**: A table containing file types that can be opened using eVis. Each file type needs a file extension and the path to an application that can open that type of file. This provides the capability of opening a broad range of files such as movies, sound recordings, and text documents instead of only images.
- 2. **Add new file type**: Add a new file type with a unique extension and the path for the application that can open the file.
- 3. **Delete current row**: Delete the file type highlighted in the table and defined by a file extension and a path to an associated application.

20.6. eVis Plugin 361

# 20.6.2 Specifying the location and name of a photograph

The location and name of the photograph can be stored using an absolute or relative path, or a URL if the photograph is available on a web server. Examples of the different approaches are listed in Table evis examples.

X	Y	FILE	BEARING
780596	1784017	C:\Workshop\eVis_Data\groundphotos\DSC_0168.JPG	275
780596	1784017	/groundphotos/DSC_0169.JPG	80
780819	1784015	http://biodiversityinformatics.amnh.org/\	
		evis_testdata/DSC_0170.JPG	10
780596	1784017	pdf:http://www.testsite.com/attachments.php?	
		attachment id-12	76

# 20.6.3 Specifying the location and name of other supporting documents

Supporting documents such as text documents, videos, and sound clips can also be displayed or played by eVis. To do this, it is necessary to add an entry in the file reference table that can be accessed from the Configure External Applications window in the Generic Event Browser that matches the file extension to an application that can be used to open the file. It is also necessary to have the path or URL to the file in the attribute table for the vector layer. One additional rule that can be used for URLs that don't contain a file extension for the document you want to open is to specify the file extension before the URL. The format is — file extension: URL. The URL is preceded by the file extension and a colon; this is particularly useful for accessing documents from wikis and other web sites that use a database to manage the web pages (see Table evis examples).

# 20.6.4 Using the Event Browser

When the *Event Browser* window opens, a photograph will appear in the display window if the document referenced in the vector file attribute table is an image and if the file location information in the *Options* window is properly set. If a photograph is expected and it does not appear, it will be necessary to adjust the parameters in the *Options* window.

If a supporting document (or an image that does not have a file extension recognized by eVis) is referenced in the attribute table, the field containing the file path will be highlighted in green in the attribute information window if that file extension is defined in the file reference table located in the Configure External Applications window. To open the document, double-click on the green-highlighted line in the attribute information window. If a supporting document is referenced in the attribute information window and the file path is not highlighted in green, then it will be necessary to add an entry for the file's filename extension in the Configure External Applications window. If the file path is highlighted in green but does not open when double-clicked, it will be necessary to adjust the parameters in the Options window so the file can be located by eVis.

If no compass bearing is provided in the *Options* window, a red asterisk will be displayed on top of the vector feature that is associated with the photograph being displayed. If a compass bearing is provided, then an arrow will appear pointing in the direction indicated by the value in the compass bearing display field in the *Event Browser* window. The arrow will be centered over the point that is associated with the photograph or other document.

To close the *Event Browser* window, click on the [Close] button from the *Display* window.

## 20.6.5 Event ID Tool

The 'Event ID' module allows you to display a photograph by clicking on a feature displayed in the QGIS map window. The vector feature must have attribute information associated with it to describe the location and name of the file containing the photograph and, optionally, the compass direction the camera was pointed when the image was acquired. This layer must be loaded into QGIS before running the 'Event ID' tool.

#### Launch the Event ID module

To launch the 'Event ID' module, either click on the  ${}^{\text{Event ID}}$  icon or click on  $Database \rightarrow eVis \rightarrow Event ID Tool$ . This will cause the cursor to change to an arrow with an 'i' on top of it signifying that the ID tool is active.

To view the photographs linked to vector features in the active vector layer displayed in the QGIS map window, move the Event ID cursor over the feature and then click the mouse. After clicking on the feature, the *Event Browser* window is opened and the photographs on or near the clicked locality are available for display in the browser. If more than one photograph is available, you can cycle through the different features using the [**Previous**] and [**Next**] buttons. The other controls are described in the *Event Browser* section of this guide.

#### 20.6.6 Database connection

The 'Database Connection' module provides tools to connect to and query a database or other ODBC resource, such as a spreadsheet.

eVis can directly connect to the following types of databases: PostgreSQL, MySQL, and SQLite; it can also read from ODBC connections (e.g., MS Access). When reading from an ODBC database (such as an Excel spreadsheet), it is necessary to configure your ODBC driver for the operating system you are using.

#### Launch the Database Connection module

To launch the 'Database Connection' module, either click on the appropriate icon  $e^{\text{Vis Database Connection}}$  or click on  $Database \rightarrow eVis \rightarrow Database$  Connection. This will launch the Database Connection window. The window has three tabs: Predefined Queries, Database Connection, and SQL Query. The Output Console window at the bottom of the window displays the status of actions initiated by the different sections of this module.

## Connect to a database

Click on the *Database Connection* tab to open the database connection interface. Next, use the *Database Type* combo box to select the type of database that you want to connect to. If a password or username is required, that information can be entered in the *Username* and *Password* textboxes.

Enter the database host in the *Database Host* textbox. This option is not available if you selected 'MS Access' as the database type. If the database resides on your desktop, you should enter "localhost".

Enter the name of the database in the *Database Name* textbox. If you selected 'ODBC' as the database type, you need to enter the data source name.

When all of the parameters are filled in, click on the [Connect] button. If the connection is successful, a message will be written in the *Output Console* window stating that the connection was established. If a connection was not established, you will need to check that the correct parameters were entered above.

- 1. Database Type: A drop-down list to specify the type of database that will be used.
- 2. **Database Host**: The name of the database host.
- 3. Port: The port number if a MySQL or PostgreSQL database type is selected.
- 4. **Database Name**: The name of the database.
- 5. Connect: A button to connect to the database using the parameters defined above.
- 6. Output Console: The console window where messages related to processing are displayed.
- 7. Username: Username for use when a database is password protected.

20.6. eVis Plugin 363

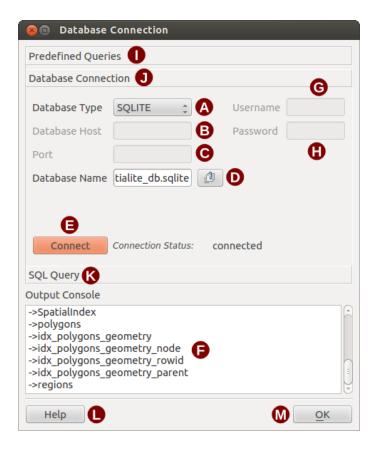


Рис. 20.13: The eVis Database connection window

- 8. **Password**: Password for use when a database is password protected.
- 9. Predefined Queries: Tab to open the "Predefined Queries" window.
- 10. Database Connection: Tab to open the "Database Connection" window.
- 11. **SQL Query**: Tab to open the "SQL Query" window.
- 12. **Help**: Displays the online help.
- 13. OK: Closes the main "Database Connection" window.

#### Running SQL queries

SQL queries are used to extract information from a database or ODBC resource. In eVis, the output from these queries is a vector layer added to the QGIS map window. Click on the SQL Query tab to display the SQL query interface. SQL commands can be entered in this text window. A helpful tutorial on SQL commands is available at <a href="http://www.w3schools.com/sql">http://www.w3schools.com/sql</a>. For example, to extract all of the data from a worksheet in an Excel file, select \* from [sheet1\$] where sheet1 is the name of the worksheet.

Click on the [Run Query] button to execute the command. If the query is successful, a Database File Selection window will be displayed. If the query is not successful, an error message will appear in the Output Console window.

In the *Database File Selection* window, enter the name of the layer that will be created from the results of the query in the *Name of New Layer* textbox.

- 1. SQL Query Text Window: A screen to type SQL queries.
- 2. Run Query: Button to execute the query entered in the SQL Query Window.
- 3. Console Window: The console window where messages related to processing are displayed.
- 4. **Help**: Displays the online help.

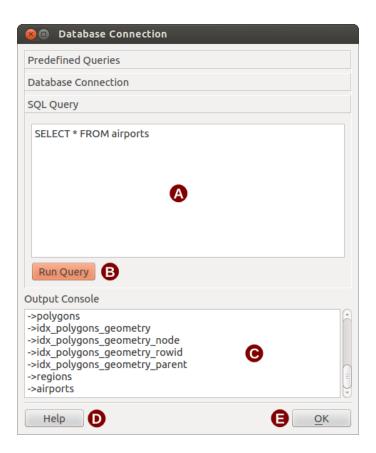


Рис. 20.14: The eVis SQL query tab

## 5. **OK**: Closes the main *Database Connection* window.

Use the X Coordinate and Y Coordinate combo boxes to select the fields from the database that stores the X (or longitude) and Y (or latitude) coordinates. Clicking on the [OK] button causes the vector layer created from the SQL query to be displayed in the QGIS map window.

To save this vector file for future use, you can use the QGIS 'Save as...' command that is accessed by right-clicking on the layer name in the QGIS map legend and then selecting 'Save as...'

#### Порада: Creating a vector layer from a Microsoft Excel Worksheet

When creating a vector layer from a Microsoft Excel Worksheet, you might see that unwanted zeros ("0") have been inserted in the attribute table rows beneath valid data. This can be caused by deleting the values for these cells in Excel using the Backspace key. To correct this problem, you need to open the Excel file (you'll need to close QGIS if you are connected to the file, to allow you to edit the file) and then use  $Edit \rightarrow Delete$  to remove the blank rows from the file. To avoid this problem, you can simply delete several rows in the Excel Worksheet using  $Edit \rightarrow Delete$  before saving the file.

#### Running predefined queries

With predefined queries, you can select previously written queries stored in XML format in a file. This is particularly helpful if you are not familiar with SQL commands. Click on the *Predefined Queries* tab to display the predefined query interface.

To load a set of predefined queries, click on the Open File icon. This opens the Open File window, which is used to locate the file containing the SQL queries. When the queries are loaded, their titles as defined in the XML file will appear in the drop-down menu located just below the Open File icon. The full description of the query is displayed in the text window under the drop-down menu.

20.6. eVis Plugin 365

Select the query you want to run from the drop-down menu and then click on the SQL Query tab to see that the query has been loaded into the query window. If it is the first time you are running a predefined query or are switching databases, you need to be sure to connect to the database.

Click on the [Run Query] button in the SQL Query tab to execute the command. If the query is successful, a Database File Selection window will be displayed. If the query is not successful, an error message will appear in the Output Console window.

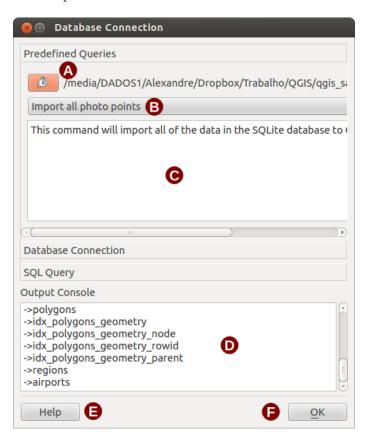


Рис. 20.15: The eVis Predefined Queries tab

- 1. **Open File**: Launches the "Open File" file browser to search for the XML file holding the predefined queries.
- 2. **Predefined Queries**: A drop-down list with all of the queries defined by the predefined queries XML file.
- 3. Query description: A short description of the query. This description is from the predefined queries XML file.
- 4. Console Window: The console window where messages related to processing are displayed.
- 5. **Help**: Displays the online help.
- 6. **OK**: Closes the main "Database Connection" window.

### XML format for eVis predefined queries

The XML tags read by eVis

Tag	Description		
query	Defines the beginning and end of a query statement.		
shortdescri-	A short description of the query that appears in the eVis drop-down menu.		
ption			
descripti-	A more detailed description of the query displayed in the Predefined Query text		
on	window.		
databasetyp	eThe database type, defined in the Database Type drop-down menu in the Database		
	Connection tab.		
databasepor	databaseport The port as defined in the Port text box in the Database Connection tab.		
databasenar	nThe database name as defined in the Database Name text box in the Database		
	Connection tab.		
databaseuse	rnamedatabase username as defined in the Username text box in the Database		
	Connection tab.		
databasepass@meddatabase password as defined in the Password text box in the Database			
	Connection tab.		
sqlstatemen	t The SQL command.		
autoconnect	utoconnect A flag ("true" or "false") to specify if the above tags should be used to automatically		
	connect to the database without running the database connection routine in the		
	Database Connection tab.		

A complete sample XML file with three queries is displayed below:

```
<?xml version="1.0"?>
<doc>
  <query>
      <shortdescription>Import all photograph points</shortdescription>
      <description>This command will import all of the data in the SQLite database to QGIS
             </description>
      <databasetype>SQLITE</databasetype>
      <databasehost />
      <databaseport />
      <databasename>C:\textbackslash Workshop/textbackslash
eVis\_Data\textbackslash PhotoPoints.db</databasename>
      <databaseusername />
      <databasepassword />
      <sqlstatement>SELECT Attributes.*, Points.x, Points.y FROM Attributes LEFT JOIN
             Points ON Points.rec_id=Attributes.point_ID</sqlstatement>
      <autoconnect>false</autoconnect>
  </query>
     <query>
      <shortdescription>Import photograph points "looking across Valley"</shortdescription>
      <description>This command will import only points that have photographs "looking across
             a valley" to QGIS</description>
      <databasetype>SQLITE</databasetype>
      <databasehost />
      <databaseport />
      <databasename>C:\Workshop\eVis_Data\PhotoPoints.db</databasename>
      <databaseusername />
      <databasepassword />
      <sqlstatement>SELECT Attributes.*, Points.x, Points.y FROM Attributes LEFT JOIN
             Points ON Points.rec_id=Attributes.point_ID where COMMENTS='Looking across
             valley'</sqlstatement>
      <autoconnect>false</autoconnect>
  </query>
  <query>
      \verb|\colored | short description| Import photograph points that mention "limestone" </short description| | short d
      <description>This command will import only points that have photographs that mention
              "limestone" to QGIS</description>
      <databasetype>SQLITE</databasetype>
      <databasehost />
      <databaseport />
      <databasename>C:\Workshop\eVis_Data\PhotoPoints.db</databasename>
```

20.6. eVis Plugin 367

# 20.7 fTools Plugin

The goal of the fTools Python plugin is to provide a one-stop resource for many common vector-based GIS tasks, without the need for additional software, libraries, or complex work-arounds. It provides a growing suite of spatial data management and analysis functions that are both fast and functional.

fTools is now automatically installed and enabled in new versions of QGIS, and as with all plugins, it can be disabled and enabled using the Plugin Manager (see *The Plugins Dialog*). When enabled, the fTools plugin adds a *Vector* menu to QGIS, providing functions ranging from Analysis and Research Tools to Geometry and Geoprocessing Tools, as well as several useful Data Management Tools.

## 20.7.1 Analysis tools

Icon	Tool	Purpose
	Distance matrix	Measure distances between two point layers, and output results as a) Square distance matrix, b) Linear distance matrix, or c) Summary of distances. Can limit distances to the k nearest features.
	Sum line length	Calculate the total sum of line lengths for each polygon of a polygon vector layer.
	Points in polygon	Count the number of points that occur in each polygon of an input polygon vector layer.
	List unique values	List all unique values in an input vector layer field.
	Basic statistics	Compute basic statistics (mean, std dev, N, sum, CV) on an input field.
0	Nearest neighbor analysis	Compute nearest neighbor statistics to assess the level of clustering in a point vector layer.
404	Mean coordi- nate(s)	Compute either the normal or weighted mean center of an entire vector layer, or multiple features based on a unique ID field.
×	Line intersections	Locate intersections between lines, and output results as a point shapefile. Useful for locating road or stream intersections, ignores line intersections with length $> 0$ .

Table Ftools 1: fTools Analysis tools

# 20.7.2 Research tools

lcon	Tool	Purpose
7	Random selection	Randomly select n number of features, or n percentage of features.
?	Random selection within subsets	Randomly select features within subsets based on a unique ID field.
	Random points	Generate pseudo-random points over a given input layer.
	Regular points	Generate a regular grid of points over a specified region and export them as a point shapefile.
#	Vector grid	Generate a line or polygon grid based on user-specified grid spacing.
<b>~</b>	Select by location	Select features based on their location relative to another layer to form a new selection, or add or subtract from the current selection.
*	Polygon from layer extent	Create a single rectangular polygon layer from the extent of an input raster or vector layer.

Table Ftools 2: fTools Research tools

# 20.7.3 Geoprocessing tools

Icon	Tool	Purpose
	Convex hull(s)	Create minimum convex hull(s) for an input layer, or based on an ID field.
	$\mathrm{Buffer}(\mathrm{s})$	Create buffer(s) around features based on distance, or distance field.
	Intersect	Overlay layers such that output contains areas where both layers intersect.
	Union	Overlay layers such that output contains intersecting and non-intersecting areas.
	Symmetrical difference	Overlay layers such that output contains those areas of the input and difference layers that do not intersect.
	Clip	Overlay layers such that output contains areas that intersect the clip layer.
	Difference	Overlay layers such that output contains areas not intersecting the clip layer.
	Dissolve	Merge features based on input field. All features with identical input values are combined to form one single feature.
	Eliminate sliver polygons	Merges selected features with the neighboring polygon with the largest area or largest common boundary.

Table Ftools 3: fTools Geoprocessing tools

20.7. fTools Plugin 369

# 20.7.4 Geometry tools

lcon	Tool	Purpose
<i>P</i> ■	Check geometry validity	Check polygons for intersections, closed holes, and fix node ordering. You can choose the engine used by the in the options dialog, digitizing tab Change the Validate geometries value. There is two engines: QGIS and GEOS which have pretty different behavior. Another tools exists which shows different result as well: Topology Checker plugin and 'must not have invalid geometries' rule.
<b>*</b>	$\begin{array}{c} \operatorname{Export}/\operatorname{Add} \\ \operatorname{geometry} \\ \operatorname{columns} \end{array}$	Add vector layer geometry info to point (XCOORD, YCOORD), line (LENGTH), or polygon (AREA, PERIMETER) layer.
(\$p)	Polygon centroids	Calculate the true centroids for each polygon in an input polygon layer.
	Delaunay triangulation Voronoi polygons	Calculate and output (as polygons) the Delaunay triangulation of an input point vector layer.  Calculate Voronoi polygons of an input point vector layer.
~	Simplify geometry Densify geometry	Generalize lines or polygons with a modified Douglas-Peucker algorithm.  Densify lines or polygons by adding vertices.
6	Multipart to singleparts	Convert multipart features to multiple singlepart features. Creates simple polygons and lines.
	Singleparts to multipart	Merge multiple features to a single multipart feature based on a unique ID field.
$\langle \rangle$	Polygons to lines	Convert polygons to lines, multipart polygons to multiple singlepart lines.
$\langle \rangle$	Lines to polygons	Convert lines to polygons, multipart lines to multiple singlepart polygons.
<b>~</b>	Extract nodes	Extract nodes from line and polygon layers and output them as points.

Table Ftools 4: fTools Geometry tools

 $\Pi$ римітка: The  $Simplify\ geometry\ tool\ can be used to remove duplicate nodes in line and polygon geometries. Just set the <math>Simplify\ tolerance$  parameter to 0 and this will do the trick.

# 20.7.5 Data management tools

Icon	Tool	Purpose
<b>*</b>	Define current projection	Specify the CRS for shapefiles whose CRS has not been defined.
	Join attributes by location	Join additional attributes to vector layer based on spatial relationship. Attributes from one vector layer are appended to the attribute table of another layer and exported as a shapefile.
V	Split vector layer	Split input layer into multiple separate layers based on input field.
0	Merge shapefiles to one	Merge several shapefiles within a folder into a new shapefile based on the layer type (point, line, area).
	Create spatial index	Create a spatial index for OGR- supported formats.

Table Ftools 5: fTools Data management tools

# 20.8 GDAL Tools Plugin

## 20.8.1 What is GDAL Tools?

The GDAL Tools plugin offers a GUI to the collection of tools in the Geospatial Data Abstraction Library, http://gdal.osgeo.org. These are raster management tools to query, re-project, warp and merge a wide variety of raster formats. Also included are tools to create a contour (vector) layer, or a shaded relief from a raster DEM, and to make a VRT (Virtual Raster Tile in XML format) from a collection of one or more raster files. These tools are available when the plugin is installed and activated.

#### The GDAL Library

The GDAL library consists of a set of command line programs, each with a large list of options. Users comfortable with running commands from a terminal may prefer the command line, with access to the full set of options. The GDAL Tools plugin offers an easy interface to the tools, exposing only the most popular options.

#### 20.8.2 List of GDAL tools

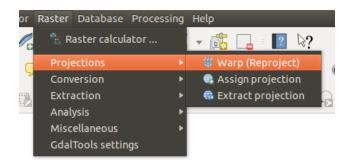


Рис. 20.16: The GDALTools menu list

#### **Projections**



This utility is an image mosaicing, reprojection and warping utility. The program can reproject to any supported projection, and can also apply GCPs stored with the image if the image is "raw" with control information. For more information, you can read on the GDAL website <a href="http://www.gdal.org/gdalwarp.html">http://www.gdal.org/gdalwarp.html</a>.



This tool allows you to assign projection to rasters that are already georeferenced but miss projection information. Also with its help, it is possible to alter existing projection definitions. Both single file and batch mode are supported. For more information, please visit the utility page at the GDAL site, <a href="http://www.gdal.org/gdalwarp.html">http://www.gdal.org/gdalwarp.html</a>.



This utility helps you to extract projection information from an input file. If you want to extract projection information from a whole directory, you can use the batch mode. It creates both .prj and .wld files.

#### Conversion



Rasterize

This program burns vector geometries (points, lines and polygons) into the raster band(s) of a raster image. Vectors are read from OGR-supported vector formats. Note that the vector data must in the same coordinate system as the raster data; on the fly reprojection is not provided. For more information see http://www.gdal.org/gdal\_rasterize.html.



Polygoni-

This utility creates vector polygons for all connected regions of pixels in the raster sharing a common pixel value. Each polygon is created with an attribute indicating the pixel value of that polygon. The utility will create the output vector datasource if it does not already exist, defaulting to ESRI shapefile format. See also <a href="http://www.gdal.org/gdal">http://www.gdal.org/gdal</a> polygonize.html.



 $\overline{Translate}$ 

This utility can be used to convert raster data between different formats, potentially performing some operations like subsetting, resampling, and rescaling pixels in the process. For more information you can read on <a href="http://www.gdal.org/gdal">http://www.gdal.org/gdal</a> translate.html.



This utility will compute an optimal pseudocolor table for a given RGB image using a median cut algorithm on a downsampled RGB histogram. Then it converts the image into a pseudocolored image using the color table. This conversion utilizes Floyd-Steinberg dithering (error diffusion) to maximize output image visual quality. The utility is also described at  $\frac{1}{2} \frac{1}{2} \frac{1}{2$ 



This utility will convert a pseudocolor band on the input file into an output RGB file of the desired format. For more information, see http://www.gdal.org/pct2rgb.html.

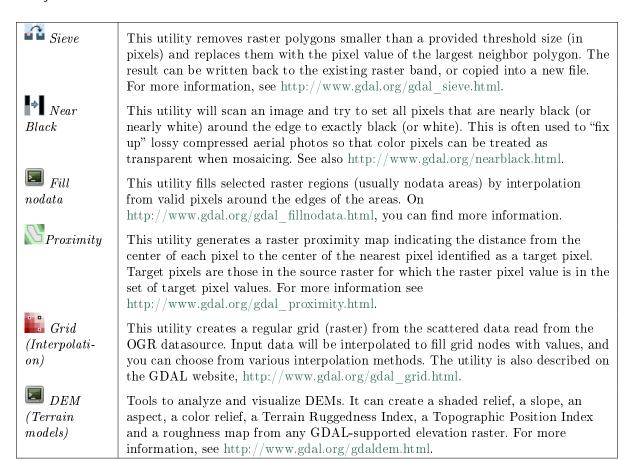
#### **Extraction**



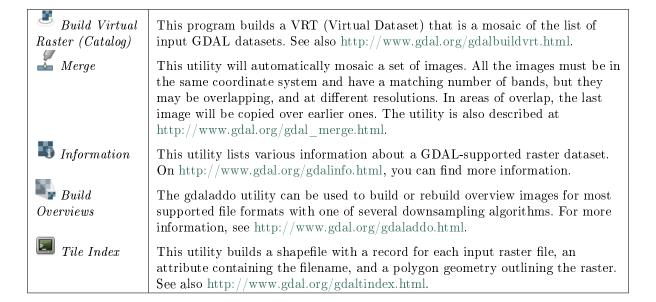
This program generates a vector contour file from the input raster elevation model (DEM). On http://www.gdal.org/gdal contour.html, you can find more information.

— Clipper This utility allows you to clip (extract subset) rasters using selected extent or based on mask layer bounds. More information can be found at <a href="http://www.gdal.org/gdal">http://www.gdal.org/gdal</a> translate.html.

#### **Analysis**



#### Miscellaneous



#### **GDAL Tools Settings**

Use this dialog to embed your GDAL variables.

# 20.9 Geometry Checker Plugin

Geometry Checker is a powerful core plugin to check and fix the geometry validity of a layer. The Geometry Checker dialog show differents grouped settings in the first tab (Settings):

- Input vector layer: to select the layer to check. A Month Only selected features checkbox can filter the geometry to the one selected.
- Geometry validity: give to the user the choice between Self intersections, Duplicate nodes, Polygon with less than 3 nodes.
- Allowed geometry types: to allow only some geometry types like point, multipoint, line, multiline, polygon and multipolygon.
- Geometry properties displays Polygons and multipolygons may not contain any holes and Multipart objects must consist of more than one part.
- Geometry conditions: user can add some condition to validate the geometries with a minimal segment length, a minimum angle between segment, a minimal polygon area and sliver polygons detection.
- *Topology checks*: checks for duplicates, for features within other features, overlaps smaller than a number, for gaps smaller than a number.
- Tolerance: you can define here the tolerance for the check.
- Output vector layer gives the choice to the user how get the result between modifiy the current layer and create a new layer.

After you are happy with the configuration, you can click on the [Run] button.

The results appear in the second tab and as an overview layer of the errors in the canvas (its name is *checker*). A table list the *geometry check result* with one error by row: the first row is an ID, the second the reason of the error, then the coordinates of the error, a value (depending on the type of the error) and finally the resolution column which indicates the resolution of the error. At the bottom of this table, you can export the error into a shapefile. At the left, you have the number of the errors and the fixed errors.

The Geometry Checker Plugin can find the following errors:

- Self intersections: a polygon with a self intersection,
- Duplicate nodes: two duplicates nodes in a segment
- Holes: hole in a polygon,
- Segment length: a segment length lower than a threshold,
- $\bullet\,$  Minimum angle: two segments with an angle lower than a threshold,
- Minimum area: polygon area lower than a treshold,
- Silver polygon: this error come from very small polygon (with small area) with a large perimeter,
- Duplicates features,
- Feature within feature,
- Overlaps: polygon overlapping,
- Gaps: gaps between polygons

The following figure shows the different checks made by the plugin.

You can select a row to see the localisation of the error. You can change this behaviour by selecting another action between error (default), Feature, Don't move, and Highlight contour of selected features.

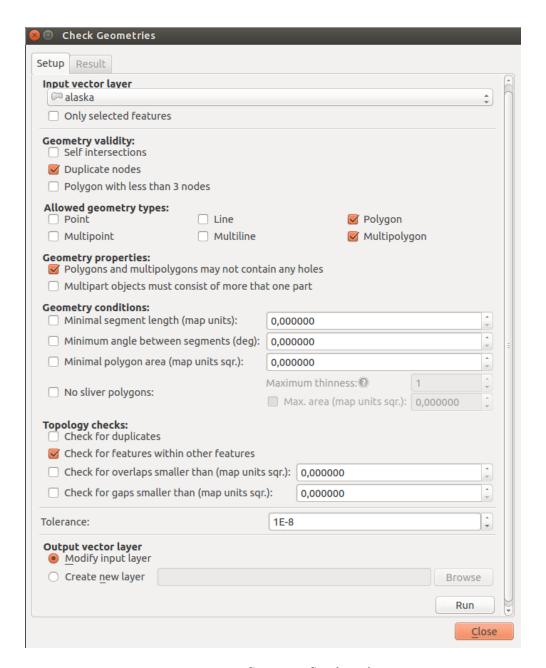
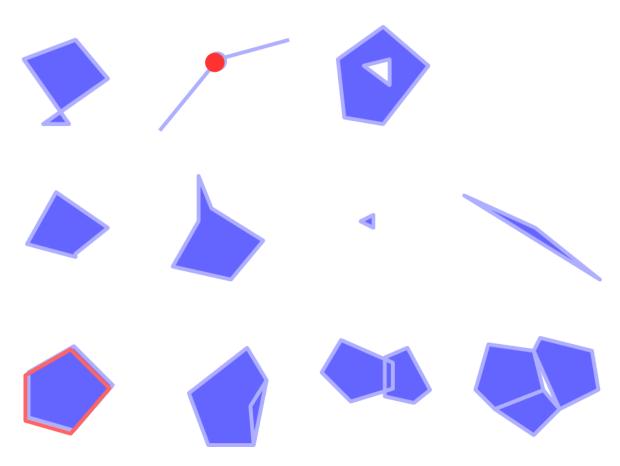


Рис. 20.17: The Geometry Checker Plugin



 $\mbox{Puc.}$  20.18: The Differents checks supported by the plugin

Below the zoom action when clicking on the table row, you can *Show the selected features in attribute table*, *Fix selected errors using default resolution* and *Fix selected errors, prompt for resolution method*. In the latter, you will see a window to choose the resolution's method among which:

- Merge with neighboring polygon with longest shared edge,
- Merge with neighboring polygon with largest area,
- Merge with neighboring polygon identical attribute value, if any, or leave as it
- Delete feature
- No action

#### Порада: Fix multiple errors

You can fix multiple errors by selecting more than one row in the table with the CTRL + click action.

The default action could be changed with the last icon *Error resolution settings*. For some type of errors, you can change the default action between some specific action or *No action*.

Finally, you can choose which attribute to use when merging features by attribute value.

# 20.10 Geometry Snapper Plugin

The Geometry Snapper tool allows to align automatically the edges and vertices of one vector layer to the edges and vertices of a second layer using a user defined tolerance.

The below interface shows the settings of this plugin. User needs to choose the layer to change (see *input vector layer*) and the *reference layers* to snap to. A *Maximum snapping distance (map units)* allows to change the snapping tolerance.

You can snap only selected feature(s) checking the Only selected features.

Output vector layer allows you to choose between Modifying input layer or Create a new layer.

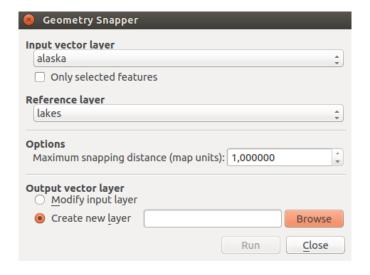


Рис. 20.19: The Geometry Snapper Plugin

# 20.11 Georeferencer Plugin

The Georeferencer Plugin is a tool for generating world files for rasters. It allows you to reference rasters to geographic or projected coordinate systems by creating a new GeoTiff or by adding a world file to the

existing image. The basic approach to georeferencing a raster is to locate points on the raster for which you can accurately determine coordinates.

#### Features

Icon	Purpose	Icon	Purpose
•	Open raster		Start georeferencing
	Generate GDAL Script	1	Load GCP Points
2	Save GCP Points As		Transformation settings
<b>₩</b>	Add Point	×	Delete Point
	Move GCP Point	4,0	Pan
<b>A</b>	Zoom In	$\wp$	Zoom Out
	Zoom To Layer	A	Zoom Last
F	Zoom Next	<b>**</b>	Link Georeferencer to QGIS
	Link QGIS to Georeferencer		Full histogram stretch
	Local histogram stretch		

Table Georeferencer 1: Georeferencer Tools

## 20.11.1 Usual procedure

As X and Y coordinates (DMS (dd mm ss.ss), DD (dd.dd) or projected coordinates (mmmm.mm)), which correspond with the selected point on the image, two alternative procedures can be used:

- The raster itself sometimes provides crosses with coordinates "written" on the image. In this case, you can enter the coordinates manually.
- Using already georeferenced layers. This can be either vector or raster data that contain the same objects/features that you have on the image that you want to georeference and with the projection that you want for your image. In this case, you can enter the coordinates by clicking on the reference dataset loaded in the QGIS map canvas.

The usual procedure for georeferencing an image involves selecting multiple points on the raster, specifying their coordinates, and choosing a relevant transformation type. Based on the input parameters and data, the plugin will compute the world file parameters. The more coordinates you provide, the better the result will be.

The first step is to start QGIS, load the Georeferencer Plugin (see *The Plugins Dialog*) and click on *Raster*  $\rightarrow$  *Georeferencer*, which appears in the QGIS menu bar. The Georeferencer Plugin dialog appears as shown in figure georeferencer 1.

For this example, we are using a topo sheet of South Dakota from SDGS. It can later be visualized together with the data from the GRASS spearfish60 location. You can download the topo sheet here: http://grass.osgeo.org/sampledata/spearfish toposheet.tar.gz.

#### Entering ground control points (GCPs)

- 1. To start georeferencing an unreferenced raster, we must load it using the button. The raster will show up in the main working area of the dialog. Once the raster is loaded, we can start to enter reference points.
- 2. Using the Add Point button, add points to the main working area and enter their coordinates (see Figure figure georeferencer 2). For this procedure you have three options:
  - Click on a point in the raster image and enter the X and Y coordinates manually.

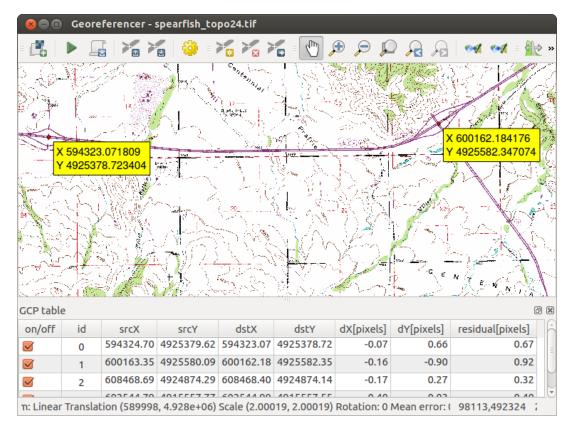


Рис. 20.20: Georeferencer Plugin Dialog 🚨

- Click on a point in the raster image and choose the From map canvas button to add the X and Y coordinates with the help of a georeferenced map already loaded in the QGIS map canvas.
- With the button, you can move the GCPs in both windows, if they are at the wrong place.
- 3. Continue entering points. You should have at least four points, and the more coordinates you can provide, the better the result will be. There are additional tools on the plugin dialog to zoom and pan the working area in order to locate a relevant set of GCP points.

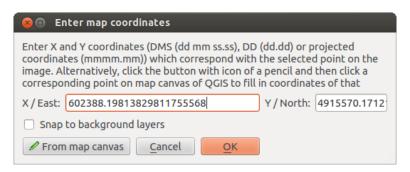


Рис. 20.21: Add points to the raster image 🚨

The points that are added to the map will be stored in a separate text file ([filename].points) usually together with the raster image. This allows us to reopen the Georeferencer plugin at a later date and add new points or delete existing ones to optimize the result. The points file contains values of the form:

mapX, mapY, pixelX, pixelY. You can use the Load GCP points and Save GCP points as buttons to manage the files.

#### Defining the transformation settings

After you have added your GCPs to the raster image, you need to define the transformation settings for the georeferencing process.

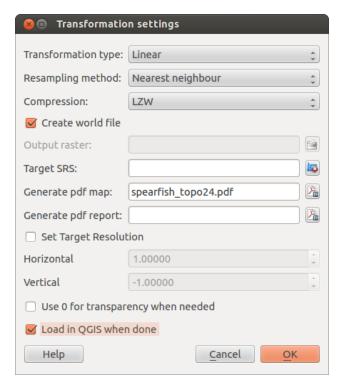


Рис. 20.22: Defining the georeferencer transformation settings 🚨

## Available Transformation algorithms

Depending on how many ground control points you have captured, you may want to use different transformation algorithms. Choice of transformation algorithm is also dependent on the type and quality of input data and the amount of geometric distortion that you are willing to introduce to the final result.

Currently, the following *Transformation types* are available:

- The Linear algorithm is used to create a world file and is different from the other algorithms, as it does not actually transform the raster. This algorithm likely won't be sufficient if you are dealing with scanned material.
- The **Helmert** transformation performs simple scaling and rotation transformations.
- The **Polynomial** algorithms 1-3 are among the most widely used algorithms introduced to match source and destination ground control points. The most widely used polynomial algorithm is the second-order polynomial transformation, which allows some curvature. First-order polynomial transformation (affine) preserves collinearity and allows scaling, translation and rotation only.
- The Thin Plate Spline (TPS) algorithm is a more modern georeferencing method, which is able to introduce local deformations in the data. This algorithm is useful when very low quality originals are being georeferenced.
- The **Projective** transformation is a linear rotation and translation of coordinates.

#### Define the Resampling method

The type of resampling you choose will likely depending on your input data and the ultimate objective of the exercise. If you don't want to change statistics of the image, you might want to choose 'Nearest neighbour', whereas a 'Cubic resampling' will likely provide a more smoothed result.

It is possible to choose between five different resampling methods:

- 1. Nearest neighbour
- 2. Linear
- 3. Cubic
- 4. Cubic Spline
- 5. Lanczos

#### Define the transformation settings

There are several options that need to be defined for the georeferenced output raster.

- The Create world file checkbox is only available if you decide to use the linear transformation type, because this means that the raster image actually won't be transformed. In this case, the Output raster field is not activated, because only a new world file will be created.
- For all other transformation types, you have to define an *Output raster*. As default, a new file ([filename]\_modified) will be created in the same folder together with the original raster image.
- As a next step, you have to define the *Target SRS* (Spatial Reference System) for the georeferenced raster (see *Working with Projections*).
- If you like, you can **generate a pdf map** and also **a pdf report**. The report includes information about the used transformation parameters, an image of the residuals and a list with all GCPs and their RMS errors.
- Furthermore, you can activate the Set Target Resolution checkbox and define the pixel resolution of the output raster. Default horizontal and vertical resolution is 1.
- The W Use 0 for transparency when needed can be activated, if pixels with the value 0 shall be visualized transparent. In our example toposheet, all white areas would be transparent.
- Finally, Load in QGIS when done loads the output raster automatically into the QGIS map canvas when the transformation is done.

#### Show and adapt raster properties

Clicking on the *Raster properties* dialog in the *Settings* menu opens the raster properties of the layer that you want to georeference.

#### Configure the georeferencer

- You can define whether you want to show GCP coordinates and/or IDs.
- As residual units, pixels and map units can be chosen.
- For the PDF report, a left and right margin can be defined and you can also set the paper size for the PDF map.
- Finally, you can activate to Show Georeferencer window docked.

#### Running the transformation

After all GCPs have been collected and all transformation settings are defined, just press the Start georeferencing button to create the new georeferenced raster.

# 20.12 Heatmap Plugin

The Heatmap plugin uses Kernel Density Estimation to create a density (heatmap) raster of an input point vector layer. The density is calculated based on the number of points in a location, with larger numbers of clustered points resulting in larger values. Heatmaps allow easy identification of "hotspots" and clustering of points.

# 20.12.1 Activate the Heatmap plugin

First this core plugin needs to be activated using the Plugin Manager (see The Plugins Dialog). After activation, the heatmap icon  $\stackrel{\triangleright}{\sim}$  can be found in the Raster Toolbar, and under the Raster  $\rightarrow$  Heatmap menu.

Select the menu  $View \rightarrow Toolbars \rightarrow Raster$  to show the Raster Toolbar if it is not visible.

# 20.12.2 Using the Heatmap plugin

Clicking the Heatmap tool button opens the Heatmap plugin dialog (see figure\_heatmap\_2). The dialog has the following options:

- Input point layer: Lists all the vector point layers in the current project and is used to select the layer to be analysed.
- Output raster: Allows you to use the \_\_\_\_ button to select the folder and filename for the output raster the Heatmap plugin generates. A file extension is not required.
- Output format: Selects the output format. Although all formats supported by GDAL can be chosen, in most cases GeoTIFF is the best format to choose.
- Radius: Is used to specify the heatmap search radius (or kernel bandwidth) in meters or map units. The radius specifies the distance around a point at which the influence of the point will be felt. Larger values result in greater smoothing, but smaller values may show finer details and variation in point density.

When the Managed checkbox is checked, additional options will be available:

- Rows and Columns: Used to change the dimensions of the output raster. These values are also linked to the Cell size X and Cell size Y values. Increasing the number of rows or columns will decrease the cell size and increase the file size of the output file. The values in Rows and Columns are also linked, so doubling the number of rows will automatically double the number of columns and the cell sizes will also be halved. The geographical area of the output raster will remain the
- Cell size X and Cell size Y: Control the geographic size of each pixel in the output raster. Changing these values will also change the number of Rows and Columns in the output raster.
- Kernel shape: The kernel shape controls the rate at which the influence of a point decreases as the distance from the point increases. Different kernels decay at different rates, so a triweight kernel gives features greater weight for distances closer to the point then the Epanechnikov kernel does. Consequently, triweight results in "sharper" hotspots, and Epanechnikov results in "smoother"

hotspots. A number of standard kernel functions are available in QGIS, which are described and illustrated on Wikipedia.

- **Decay ratio**: Can be used with Triangular kernels to further control how heat from a feature decreases with distance from the feature.
  - A value of 0 (=minimum) indicates that the heat will be concentrated in the centre of the given radius and completely extinguished at the edge.
  - A value of 0.5 indicates that pixels at the edge of the radius will be given half the heat as pixels at the centre of the search radius.
  - A value of 1 means the heat is spread evenly over the whole search radius circle. (This is equivalent to the 'Uniform' kernel.)
  - A value greater than 1 indicates that the heat is higher towards the edge of the search radius than at the centre.

The input point layer may also have attribute fields which can affect how they influence the heatmap:

- Use radius from field: Sets the search radius for each feature from an attribute field in the input layer.
- Use weight from field: Allows input features to be weighted by an attribute field. This can be used to increase the influence certain features have on the resultant heatmap.

When an output raster file name is specified, the [OK] button can be used to create the heatmap.

# 20.12.3 Tutorial: Creating a Heatmap

For the following example, we will use the airports vector point layer from the QGIS sample dataset (see Sample Data). Another excellent QGIS tutorial on making heatmaps can be found at http://www.qgistutorials.com.

In Figure Heatmap 1, the airports of Alaska are shown.

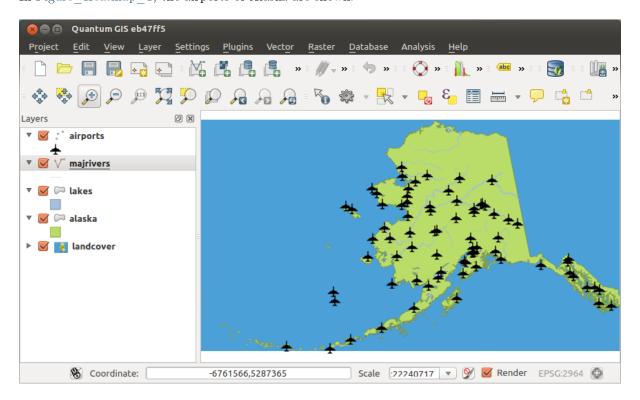


Рис. 20.23: Airports of Alaska

- 1. Select the Heatmap tool button to open the Heatmap dialog (see Figure\_Heatmap\_2).
- 2. In the *Input point layer* field, select airports from the list of point layers loaded in the current project.
- 3. Specify an output filename by clicking the \_\_\_\_ button next to the *Output raster* field. Enter the filename heatmap\_airports (no file extension is necessary).
- 4. Leave the Output format as the default format, GeoTIFF.
- 5. Change the Radius to 1000000 meters.
- 6. Click on [OK] to create and load the airports heatmap (see Figure Heatmap 3).

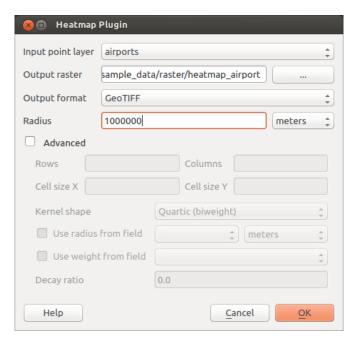


Рис. 20.24: The Heatmap Dialog

QGIS will generate the heatmap and add the results to your map window. By default, the heatmap is shaded in greyscale, with lighter areas showing higher concentrations of airports. The heatmap can now be styled in QGIS to improve its appearance.

- 1. Open the properties dialog of the heatmap\_airports layer (select the layer heatmap\_airports, open the context menu with the right mouse button and select *Properties*).
- 2. Select the Style tab.
- 3. Change the *Render type* to 'Singleband pseudocolor'.
- 4. Select a suitable *Color map* , for instance YlOrRed.
- 5. Click the [Load] button to fetch the minimum and maximum values from the raster, then click the [Classify] button.
- 6. Press [OK] to update the layer.

The final result is shown in Figure Heatmap 4.

# 20.13 Interpolation Plugin

The Interpolation plugin can be used to generate a TIN or IDW interpolation of a point vector layer. It is very simple to handle and provides an intuitive graphical user interface for creating interpolated raster

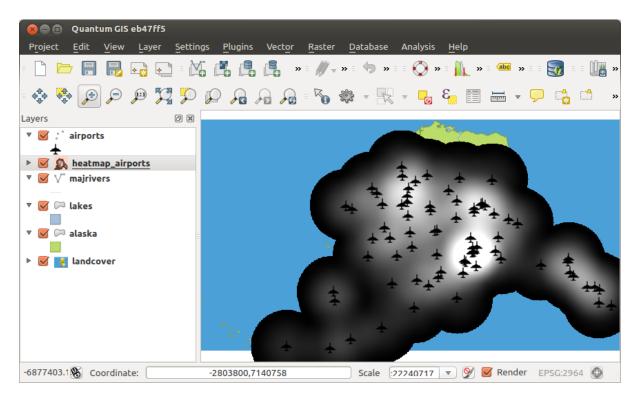


Рис. 20.25: The heatmap after loading looks like a grey surface

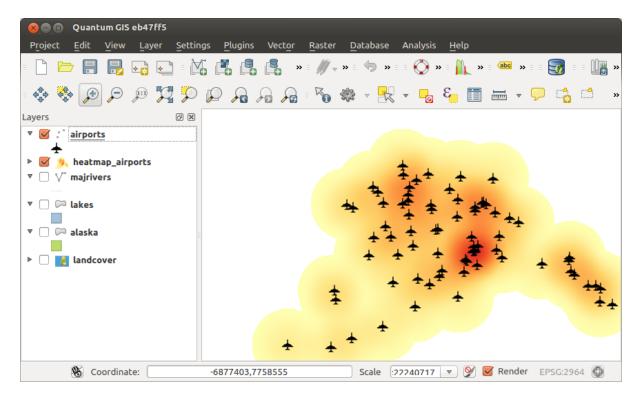


Рис. 20.26: Styled heatmap of airports of Alaska

layers (see Figure\_interpolation\_1). The plugin requires the following parameters to be specified before running:

- Input **Vector layers**: Specify the input point vector layer(s) from a list of loaded point layers. If several layers are specified, then data from all layers is used for interpolation. Note: It is possible to insert lines or polygons as constraints for the triangulation, by specifying either "points", "structure lines" or "break lines" in the *Type* combo box.
- Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation or enable the 

  \*\*Interpolation attribute: Select the attribute column to be used for interpolation attribute column to be used for interpolation attribute. 

  \*\*I
- Interpolation Method: Select the interpolation method. This can be either 'Triangulated Irregular Network (TIN)' or 'Inverse Distance Weighted (IDW)'. With the TIN method you can create a surface formed by triangles of nearest neighbor points. To do this, circumcircles around selected sample points are created and their intersections are connected to a network of non overlapping and as compact as possible triangles. The resulting surfaces are not smooth. When using the IDW method the sample points are weighted during interpolation such that the influence of one point relative to another declines with distance from the unknown point you want to create. The IDW interpolation method also has some disadvantages: the quality of the interpolation result can decrease, if the distribution of sample data points is uneven. Furthermore, maximum and minimum values in the interpolated surface can only occur at sample data points. This often results in small peaks and pits around the sample data points.
- Configure Interpolation Method: Configure the interpolation method you have chosen. For the TIN method you can choose between Linear and Clough Toucher (cubic) interpolation methods. You can also save the triangulation in shapefile format. For IDW interpolation you can set the distance coefficient.
- Number of columns/rows: Specify the number of rows and columns for the output raster file.
- Output file: Specify a name for the output raster file.
- Add result to project to load the result into the map canvas.

Note that using lines as constraints for the interpolation the triangulation (TIN method) you can either use 'structure lines' or 'break lines'. When using 'break lines' you produce sharp breaks in the surface while using 'structure lines' you produce continuous breaks. The triangulation is modified by both methods such that no edge crosses a breakline or structure line.

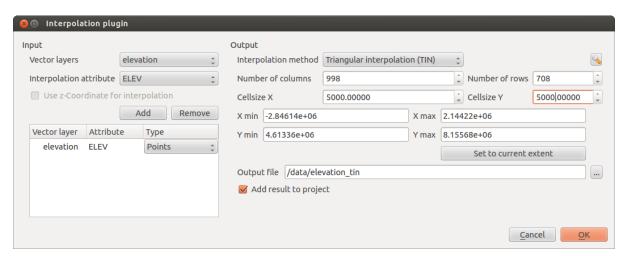


Рис. 20.27: Interpolation Plugin

### 20.13.1 Using the plugin

1. Start QGIS and load a point vector layer (e.g., elevp.csv).

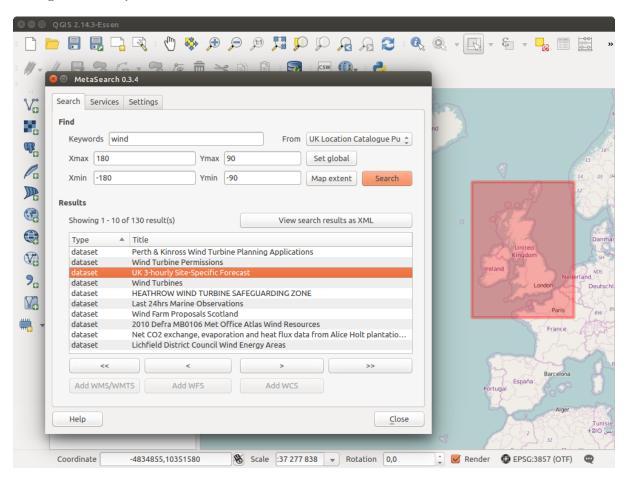
- 2. Load the Interpolation plugin in the Plugin Manager (see *The Plugins Dialog*) and click on the  $Raster \rightarrow Interpolation \rightarrow Interpolation menu, which appears in the QGIS menu bar. The Interpolation plugin dialog appears as shown in Figure interpolation 1.$
- 3. Select an input layer (e.g., elevp ) and column (e.g., ELEV) for interpolation.
- 4. Select an interpolation method (e.g., 'Triangulated Irregular Network (TIN)'), and specify a cell size of 5000 as well as the raster output filename (e.g., elevation\_tin).
- 5. Click **[OK]**.

# 20.14 MetaSearch Catalogue Client

## 20.14.1 Introduction

MetaSearch is a QGIS plugin to interact with metadata catalogue services, supporting the OGC Catalogue Service for the Web (CSW) standard.

MetaSearch provides an easy and intuitive approach and user-friendly interface to searching metadata catalogues within QGIS.



#### 20.14.2 Installation

MetaSearch is included by default with QGIS 2.0 and higher. All dependencies are included within MetaSearch.

Install MetaSearch from the QGIS plugin manager, or manually from http://plugins.qgis.org/plugins/MetaSearch.

# 20.14.3 Working with Metadata Catalogues in QGIS

### CSW (Catalogue Service for the Web)

CSW (Catalogue Service for the Web) is an OGC (Open Geospatial Consortium) specification, that defines common interfaces to discover, browse and query metadata about data, services, and other potential resources.

#### Startup

To start MetaSearch, click icon or select  $Web \to MetaSearch \to MetaSearch$  via the QGIS main menu. The MetaSearch dialog will appear. The main GUI consists of three tabs: Services, Search and Settings.

## **Managing Catalogue Services**

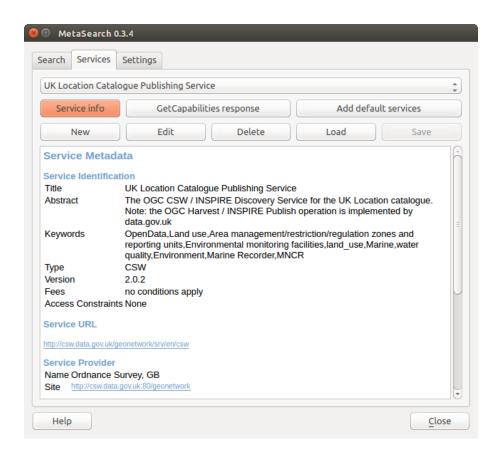


Рис. 20.28: Managing Catalogue Services

The Services tab allows the user to manage all available catalogue services. MetaSearch provides a default list of Catalogue Services, which can be added by pressing [Add default services] button.

To all listed Catalogue Service entries, click the dropdown select box.

To add a Catalogue Service entry, click the [New] button, and enter a Name for the service, as well as the URL (endpoint). Note that only the base URL is required (not a full GetCapabilities URL). Clicking [OK] will add the service to the list of entries.

To edit an existing Catalogue Service entry, select the entry you would like to edit and click the [Edit] button, and modify the Name or URL values, then click [OK].

To delete a Catalogue Service entry, select the entry you would like to delete and click the [Delete] button. You will be asked to confirm deleting the entry.

MetaSearch allows for loading and saving connections to an XML file. This is useful when you need to share settings between applications. Below is an example of the XML file format.

To load a list of entries, click the **[Load]** button. A new window will appear; click the **[Browse]** button and navigate to the XML file of entries you wish to load and click **[Open]**. The list of entries will be displayed. Select the entries you wish to add from the list and click **[Load]**.

Click the [Service info] button to displays information about the selected Catalogue Service such as service identification, service provider and contact information. If you would like to view the raw XML response, click the [GetCapabilities response] button. A separate window will open displaying Capabilities XML.

## **Searching Catalogue Services**

The Search tab allows the user to query Catalogue Services for data and services, set various search parameters and view results.

The following search parameters are available:

- Keywords: free text search keywords
- From: the Catalogue Service to perform the query against
- Bounding box: the spatial area of interest to filter on defined by *Xmax*, *Xmin*, guilabel: *Ymax*, and guilabel: *Ymin*. Click [Set global] to do a global search, click [Map extent] to do a search on the visible area only or manually enter custom values as desired

Clicking the [Search] button will search the selected Metadata Catalogue. Search results are displayed in a list and are sortable by clicking on the column title. You can navigate through search results with the directional buttons below the search results. Clicking the [View search results as XML] button opens a window with the service response in raw XML format.

Clicking a result will provides the following options:

- if the metadata record has an associated bounding box, a footprint of the bounding box will be displayed on the map
- double-clicking the record displays the record metadata with any associated access links. Clicking the links opens the link in the user's web browser
- if the record is an OGC web service (WMS/WMTS, WFS, WCS), the appropriate [Add to WMS/WMTS|WFS|WCS] buttons will be enabled for the user to add to QGIS. When clicking this button, MetaSearch will verify if this is a valid OWS. The OWS will then be added to the appropriate QGIS connection list, and the appropriate WMS/WMTS|WFS|WCS connection dialogue will then appear

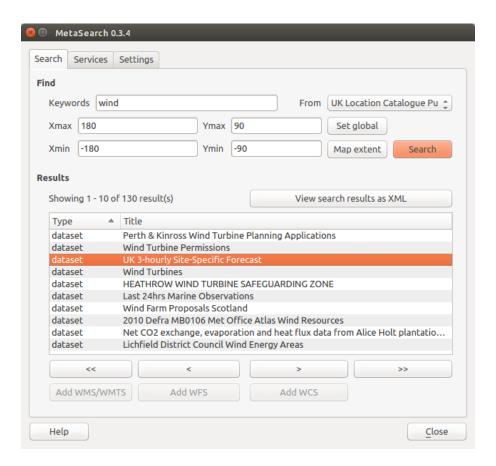


Рис. 20.29: Searching catalogue services

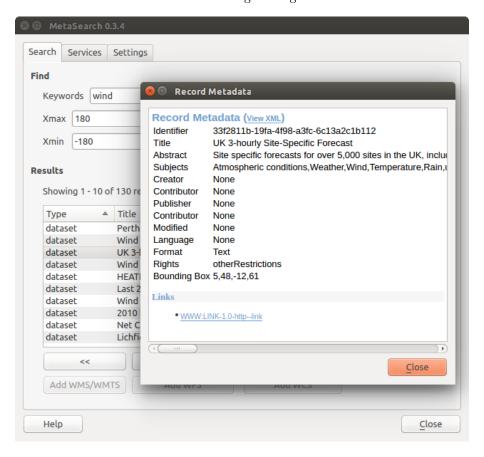


Рис. 20.30: Metadata record display

### **Settings**



Рис. 20.31: Metasearch setting

You can fine tune MetaSearch with the following settings:

- Connection naming: when adding an OWS connection (WMS/WMTS|WFS|WCS), the connection is stored with the various QGIS layer provider. Use this setting to set whether to use the name provided from MetaSearch, whether to overwrite or to use a temporary name
- Results paging: when searching metadata catalogues, the number of results to show per page. Default value is 10
- Timeout: when searching metadata catalogues, the number of seconds for blocking connection attempt. Default value is 10

# 20.15 Offline Editing Plugin

For data collection, it is a common situation to work with a laptop or a cell phone offline in the field. Upon returning to the network, the changes need to be synchronized with the master datasource (e.g., a PostGIS database). If several persons are working simultaneously on the same datasets, it is difficult to merge the edits by hand, even if people don't change the same features.

The Offline Editing Plugin automates the synchronisation by copying the content of a datasource (usually PostGIS or WFS-T) to a SpatiaLite database and storing the offline edits to dedicated tables. After being connected to the network again, it is possible to apply the offline edits to the master dataset.

### 20.15.1 Using the plugin

- Open some vector layers (e.g., from a PostGIS or WFS-T datasource).
- Save it as a project.

- Edit the layers offline.
- After being connected again, upload the changes using  $Database \rightarrow Offline \ Editing \rightarrow \ Synchronize.$

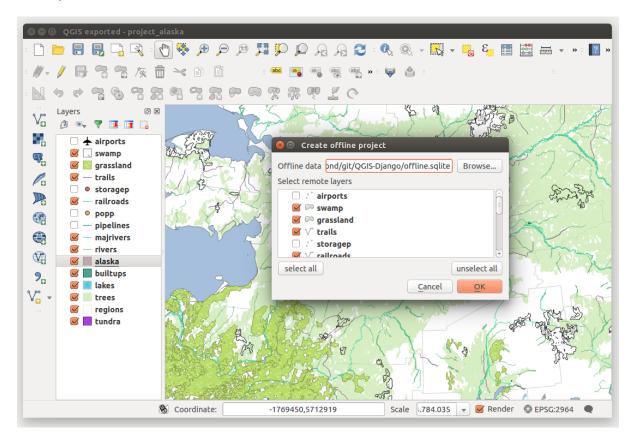


Рис. 20.32: Create an offline project from PostGIS or WFS layers

# 20.16 Oracle Spatial GeoRaster Plugin

In Oracle databases, raster data can be stored in SDO\_GEORASTER objects available with the Oracle Spatial extension. In QGIS, the Oracle Spatial GeoRaster plugin is supported by GDAL and depends on Oracle's database product being installed and working on your machine. While Oracle is proprietary software, they provide their software free for development and testing purposes. Here is one simple example of how to load raster images to GeoRaster:

\$ gdal\_translate -of georaster input\_file.tif geor:scott/tiger@orcl

This will load the raster into the default GDAL IMPORT table, as a column named RASTER.

### 20.16.1 Managing connections

Firstly, the Oracle GeoRaster Plugin must be enabled using the Plugin Manager (see *The Plugins Dialog*). The first time you load a GeoRaster in QGIS, you must create a connection to the Oracle database that contains the data. To do this, begin by clicking on the Add Oracle GeoRaster Layer toolbar button – this will open the *Select Oracle Spatial GeoRaster* dialog window. Click on [New] to open the dialog window, and specify the connection parameters (See Figure oracle raster 1):

• Name: Enter a name for the database connection.

392 Розділ 20. Plugins

- Database instance: Enter the name of the database that you will connect to.
- Username: Specify your own username that you will use to access the database.
- Password: Provide the password associated with your username that is required to access the
  database.



Рис. 20.33: Create Oracle connection dialog

Now, back on the main *Oracle Spatial GeoRaster* dialog window (see Figure\_oracle\_raster\_2), use the drop-down list to choose one connection, and use the [Connect] button to establish a connection. You may also [Edit] the connection by opening the previous dialog and making changes to the connection information, or use the [Delete] button to remove the connection from the drop-down list.

## 20.16.2 Selecting a GeoRaster

Once a connection has been established, the subdatasets window will show the names of all the tables that contain GeoRaster columns in that database in the format of a GDAL subdataset name.

Click on one of the listed subdatasets and then click on [Select] to choose the table name. Now another list of subdatasets will show with the names of GeoRaster columns on that table. This is usually a short list, since most users will not have more than one or two GeoRaster columns on the same table.

Click on one of the listed subdatasets and then click on [Select] to choose one of the table/column combinations. The dialog will now show all the rows that contain GeoRaster objects. Note that the subdataset list will now show the Raster Data Table and Raster Id pairs.

At any time, the selection entry can be edited in order to go directly to a known GeoRaster or to go back to the beginning and select another table name.

The selection data entry can also be used to enter a WHERE clause at the end of the identification string (e.g., geor:scott/tiger@orcl,gdal\_import,raster,geoid=). See http://www.gdal.org/frmt\_georaster.html for more information.

## 20.16.3 Displaying GeoRaster

Finally, by selecting a GeoRaster from the list of Raster Data Tables and Raster Ids, the raster image will be loaded into QGIS.

The Select Oracle Spatial GeoRaster dialog can be closed now and the next time it opens, it will keep the same connection and will show the same previous list of subdatasets, making it very easy to open up another image from the same context.

Примітка: GeoRasters that contain pyramids will display much faster, but the pyramids need to be generated outside of QGIS using Oracle PL/SQL or gdaladdo.

The following is an example using gdaladdo:

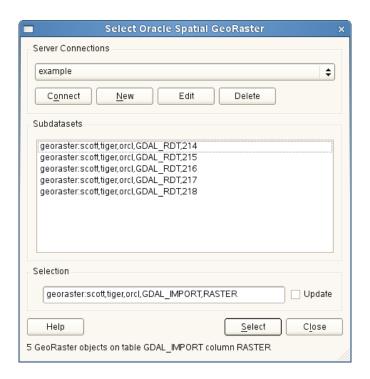


Рис. 20.34: Select Oracle GeoRaster dialog

```
gdaladdo georaster:scott/tiger@orcl,georaster\_table,georaster,georid=6 -r
nearest 2 4 6 8 16 32

This is an example using PL/SQL:

$ sqlplus scott/tiger
SQL> DECLARE
gr sdo_georaster;
BEGIN
    SELECT image INTO gr FROM cities WHERE id = 1 FOR UPDATE;
    sdo_geor.generatePyramid(gr, 'rLevel=5, resampling=NN');
    UPDATE cities SET image = gr WHERE id = 1;
    COMMIT;
END;
```

# 20.17 Raster Terrain Analysis Plugin

The Raster Terrain Analysis Plugin can be used to calculate the slope, aspect, hillshade, ruggedness index and relief for digital elevation models (DEM). It is very simple to handle and provides an intuitive graphical user interface for creating new raster layers (see Figure raster terrain 1).

Description of the analysis:

- **Slope**: Calculates the slope angle for each cell in degrees (based on first- order derivative estimation).
- Aspect: Exposition (starting with 0 for north direction, in degrees counterclockwise).
- Hillshade: Creates a shaded map using light and shadow to provide a more three-dimensional appearance for a shaded relief map. The output map is a Single band gray reflecting the gray value of the pixels.
- Ruggedness Index: A quantitative measurement of terrain heterogeneity as described by Riley et al. (1999). It is calculated for every location by summarizing the change in elevation within the

394 Розділ 20. Plugins

3x3 pixel grid.

• Relief: Creates a shaded relief map from digital elevation data. Implemented is a method to choose the elevation colors by analysing the frequency distribution. The output map is a multiband color with three bands reflecting the RGB values of the shaded relief.

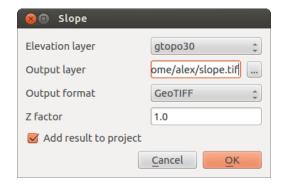


Рис. 20.35: Raster Terrain Modelling Plugin (slope calculation)

## 20.17.1 Using the plugin

- 1. Start QGIS and load the gtopo30 raster layer from the GRASS sample location.
- 2. Load the Raster Terrain Analysis plugin in the Plugin Manager (see The Plugins Dialog).
- 3. Select an analysis method from the menu (e.g.,  $Raster \rightarrow Terrain\ Analysis \rightarrow Slope$ ). The Slope dialog appears as shown in Figure raster terrain 1.
- 4. Specify an output file path, and an output file type.
- 5. Click [**OK**].

# 20.18 Road Graph Plugin

The Road Graph Plugin is a C++ plugin for QGIS that calculates the shortest path between two points on any polyline layer and plots this path over the road network.

Main features:

- Calculates path, as well as length and travel time.
- Optimizes by length or by travel time.
- Exports path to a vector layer.
- Highlights roads directions (this is slow and used mainly for debug purposes and for the settings testing).

As a roads layer, you can use any polyline vector layer in any QGIS-supported format. Two lines with a common point are considered connected. Please note, it is required to use layer CRS as project CRS while editing a roads layer. This is due to the fact that recalculation of the coordinates between different CRSs introduces some errors that can result in discontinuities, even when 'snapping' is used.

In the layer attribute table, the following fields can be used:

- Speed on road section (numeric field).
- Direction (any type that can be cast to string). Forward and reverse directions correspond to a one-way road, both directions indicate a two-way road.

If some fields don't have any value or do not exist, default values are used. You can change defaults and some plugin settings in the plugin settings dialog.

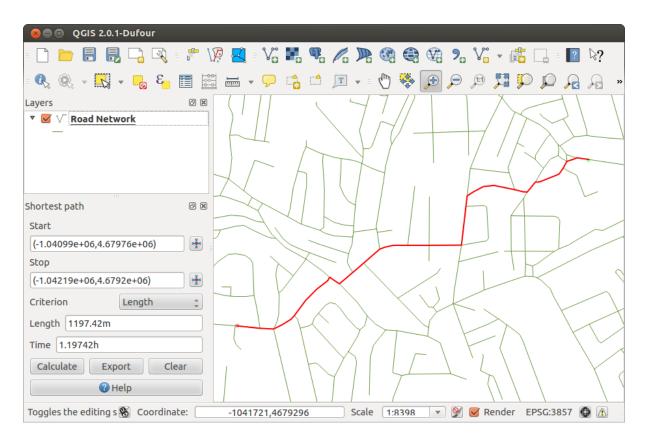


Рис. 20.36: Road Graph Plugin

## 20.18.1 Using the plugin

After plugin activation, you will see an additional panel on the left side of the main QGIS window. Now, enter some parameters into the *Road graph plugin settings* dialog in the  $Vector \rightarrow Road\ Graph$  menu (see figure road graph 2).

After setting the *Time unit*, *Distance unit* and *Topology tolerance*, you can choose the vector layer in the *Transportation layer* tab. Here you can also choose the *Direction field* and *Speed field*. In the *Default settings* tab, you can set the *Direction* for the calculation.

Finally, in the *Shortest Path* panel, select a Start and a Stop point in the road network layer and click on [Calculate].

# 20.19 Spatial Query Plugin

The Popular Plugin allows you to make a spatial query (i.e., select features) in a target layer with reference to another layer. The functionality is based on the GEOS library and depends on the selected source feature layer.

Possible operators are:

- Contains
- Equals
- Overlap
- Crosses
- Intersects
- Is disjoint

396 Poзділ 20. Plugins

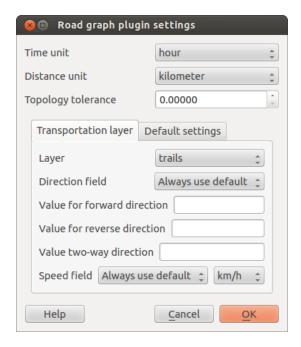


Рис. 20.37: Road graph plugin settings

- Touches
- Within

## 20.19.1 Using the plugin

As an example, we want to find regions in the Alaska dataset that contain airports. The following steps are necessary:

- 1. Start QGIS and load the vector layers regions.shp and airports.shp.
- 2. Load the Spatial Query plugin in the Plugin Manager (see *The Plugins Dialog*) and click on the Spatial Query icon, which appears in the QGIS toolbar menu. The plugin dialog appears.
- 3. Select the layer regions as the source layer and airports as the reference feature layer.
- 4. Select 'Contains' as the operator and click [Apply].

Now you get a list of feature IDs from the query and you have several options, as shown in figure\_spatial\_query\_1.

- Click on Create layer with list of items.
- Select an ID from the list and click on Create layer with selected.
- You can 

  Zoom to item or display 

  Log messages.
- Additionally in *Result Feature ID's* with the options 'Invalid source' and 'Invalid reference' you can have a look at features with geometry errors. These features aren't used for the query.

# 20.20 Topology Checker Plugin

Topology describes the relationships between points, lines and polygons that represent the features of a geographic region. With the Topology Checker plugin, you can look over your vector files and check

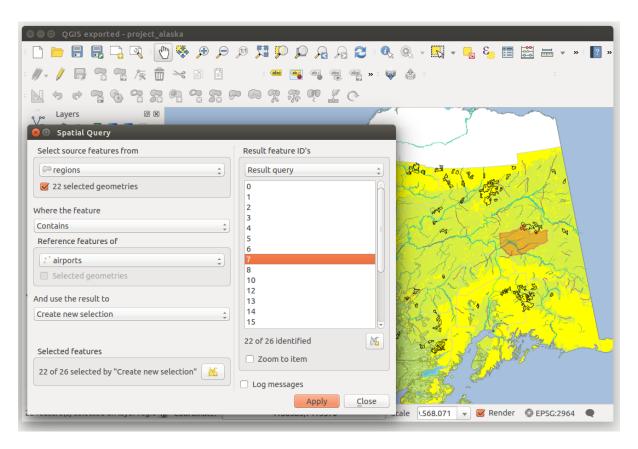


Рис. 20.38: Spatial Query analysis - regions contain airports

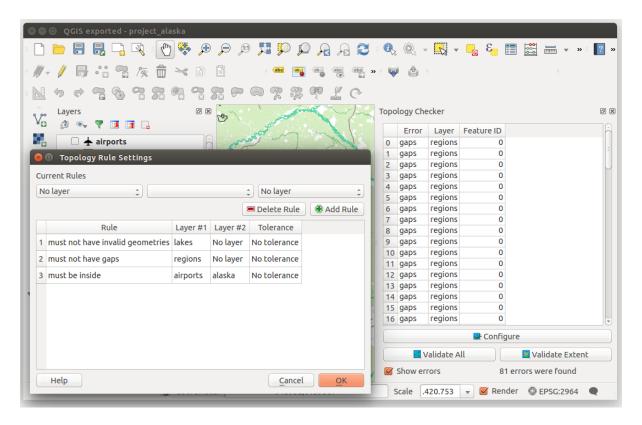


Рис. 20.39: The Topology Checker Plugin

398 Розділ 20. Plugins

the topology with several topology rules. These rules check with spatial relations whether your features 'Equal', 'Contain', 'Cover', are 'CoveredBy', 'Cross', are 'Disjoint', 'Intersect', 'Overlap', 'Touch' or are 'Within' each other. It depends on your individual questions which topology rules you apply to your vector data (e.g., normally you won't accept overshoots in line layers, but if they depict dead-end streets you won't remove them from your vector layer).

QGIS has a built-in topological editing feature, which is great for creating new features without errors. But existing data errors and user-induced errors are hard to find. This plugin helps you find such errors through a list of rules.

It is very simple to create topology rules with the Topology Checker plugin.

On **point layers** the following rules are available:

- Must be covered by: Here you can choose a vector layer from your project. Points that aren't covered by the given vector layer occur in the 'Error' field.
- Must be covered by endpoints of: Here you can choose a line layer from your project.
- Must be inside: Here you can choose a polygon layer from your project. The points must be inside a polygon. Otherwise, QGIS writes an 'Error' for the point.
- Must not have duplicates: Whenever a point is represented twice or more, it will occur in the 'Error' field.
- Must not have invalid geometries: Checks whether the geometries are valid.
- Must not have multi-part-geometries: All multi-part points are written into the 'Error' field.

On **line layers**, the following rules are available:

- End points must be covered by: Here you can select a point layer from your project.
- Must not have dangles: This will show the overshoots in the line layer.
- Must not have duplicates: Whenever a line feature is represented twice or more, it will occur in the 'Error' field.
- Must not have invalid geometries: Checks whether the geometries are valid.
- Must not have multi-part geometries: Sometimes, a geometry is actually a collection of simple (single-part) geometries. Such a geometry is called multi-part geometry. If it contains just one type of simple geometry, we call it multi-point, multi-linestring or multi-polygon. All multi-part lines are written into the 'Error' field.
- Must not have pseudos: A line geometry's endpoint should be connected to the endpoints of two other geometries. If the endpoint is connected to only one other geometry's endpoint, the endpoint is called a pseudo node.

On **polygon layers**, the following rules are available:

- Must contain: Polygon layer must contain at least one point geometry from the second layer.
- Must not have duplicates: Polygons from the same layer must not have identical geometries. Whenever a polygon feature is represented twice or more it will occur in the 'Error' field.
- Must not have gaps: Adjacent polygons should not form gaps between them. Administrative boundaries could be mentioned as an example (US state polygons do not have any gaps between them...).
- Must not have invalid geometries: Checks whether the geometries are valid. Some of the rules that define a valid geometry are:
  - Polygon rings must close.
  - Rings that define holes should be inside rings that define exterior boundaries.
  - Rings may not self-intersect (they may neither touch nor cross one another).
  - Rings may not touch other rings, except at a point.

- Must not have multi-part geometries: Sometimes, a geometry is actually a collection of simple (single-part) geometries. Such a geometry is called multi-part geometry. If it contains just one type of simple geometry, we call it multi-point, multi-linestring or multi-polygon. For example, a country consisting of multiple islands can be represented as a multi-polygon.
- Must not overlap: Adjacent polygons should not share common area.
- Must not overlap with: Adjacent polygons from one layer should not share common area with polygons from another layer.

## 20.21 Zonal Statistics Plugin

With the Zonal statistics plugin, you can analyze the results of a thematic classification. It allows you to calculate several values of the pixels of a raster layer with the help of a polygonal vector layer (see figure\_zonal\_statistics). Choosing a color band, the plugin generates output columns in the vector layer with an user-defined prefix and calculates for each polygon, statistics on pixels that are within. The available statistics are:

- Count: to count the number of pixels
- Sum: to sum the pixel values
- Mean: to get the mean of pixel values
- Median: to get the median of pixel values
- StDev: to get the standard deviation of pixel values
- Min: to get the minimum of pixel values
- Max: to get the maximum of pixel values
- Range: to get the range (max min) of pixel values
- Minority: to get the less represented pixel value
- Majority: to get the most represented pixel value
- Variety: to count the number of distinct pixel values

400 Розділ 20. Plugins

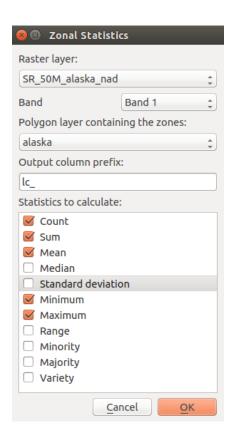


Рис. 20.40: Zonal statistics dialog

402 Розділ 20. Plugins

## Help and Support

## 21.1 Mailing lists

QGIS is under active development and as such it won't always work like you expect it to. The preferred way to get help is by joining the qgis-users mailing list. Your questions will reach a broader audience and answers will benefit others.

### 21.1.1 qgis-users

This mailing list is used for discussion of QGIS in general, as well as specific questions regarding its installation and use. You can subscribe to the qgis-users mailing list by visiting the following URL: http://lists.osgeo.org/mailman/listinfo/qgis-user

## 21.1.2 fossgis-talk-liste

For the German-speaking audience, the German FOSSGIS e.V. provides the fossgis-talk-liste mailing list. This mailing list is used for discussion of open-source GIS in general, including QGIS. You can subscribe to the fossgis-talk-liste mailing list by visiting the following URL: https://lists.fossgis.de/mailman/listinfo/fossgis-talk-liste

## 21.1.3 qgis-developer

If you are a developer facing problems of a more technical nature, you may want to join the qgis-developer mailing list here: http://lists.osgeo.org/mailman/listinfo/qgis-developer

### 21.1.4 qgis-ux

A dedicated mailing list where people can chime in and collect and discuss QGIS related UX (User Experience) / usability issues.

http://lists.osgeo.org/mailman/listinfo/qgis-ux

### 21.1.5 qgis-commit

Each time a commit is made to the QGIS code repository, an email is posted to this list. If you want to be up-to-date with every change to the current code base, you can subscribe to this list at: http://lists.osgeo.org/mailman/listinfo/qgis-commit

### 21.1.6 qgis-trac

This list provides email notification related to project management, including bug reports, tasks, and feature requests. You can subscribe to this list at: http://lists.osgeo.org/mailman/listinfo/qgis-trac

### 21.1.7 qgis-community-team

This list deals with topics like documentation, context help, user guide, web sites, blog, mailing lists, forums, and translation efforts. If you would like to work on the user guide as well, this list is a good starting point to ask your questions. You can subscribe to this list at: http://lists.osgeo.org/mailman/listinfo/qgis-community-team

### 21.1.8 qgis-release-team

This list deals with topics like the release process, packaging binaries for various OSs and announcing new releases to the world at large. You can subscribe to this list at: http://lists.osgeo.org/mailman/listinfo/qgis-release-team

### 21.1.9 ggis-tr

This list deals with the translation efforts. If you like to work on the translation of the website, manuals or the graphical user interface (GUI), this list is a good starting point to ask your questions. You can subscribe to this list at: http://lists.osgeo.org/mailman/listinfo/qgis-tr

## 21.1.10 qgis-edu

This list deals with QGIS education efforts. If you would like to work on QGIS education materials, this list is a good starting point to ask your questions. You can subscribe to this list at: http://lists.osgeo.org/mailman/listinfo/qgis-edu

## 21.1.11 qgis-psc

This list is used to discuss Steering Committee issues related to overall management and direction of QGIS. You can subscribe to this list at: http://lists.osgeo.org/mailman/listinfo/qgis-psc

You are welcome to subscribe to any of the lists. Please remember to contribute to the list by answering questions and sharing your experiences. Note that the qgis-commit and qgis-trac lists are designed for notification only and are not meant for user postings.

## 21.2 IRC

We also maintain a presence on IRC - visit us by joining the #qgis channel on irc.freenode.net. Please wait for a response to your question, as many folks on the channel are doing other things and it may take a while for them to notice your question. If you missed a discussion on IRC, not a problem! We log all discussion, so you can easily catch up. Just go to http://qgis.org/irclogs and read the IRC-logs.

Commercial support for QGIS is also available. Check the website http://qgis.org/en/commercial-support.html for more information.

## 21.3 BugTracker

While the qgis-users mailing list is useful for general 'How do I do XYZ in QGIS?'-type questions, you may wish to notify us about bugs in QGIS. You can submit bug reports using the QGIS bug tracker at <a href="http://hub.qgis.org/projects/quantum-gis/issues">http://hub.qgis.org/projects/quantum-gis/issues</a>. When creating a new ticket for a bug, please provide an email address where we can contact you for additional information.

Please bear in mind that your bug may not always enjoy the priority you might hope for (depending on its severity). Some bugs may require significant developer effort to remedy, and the manpower is not always available for this.

Feature requests can be submitted as well using the same ticket system as for bugs. Please make sure to select the type Feature.

If you have found a bug and fixed it yourself, you can submit either a Pull Request on the Github QGIS Project (prefered) or a patch also. The lovely redmine ticketsystem at <a href="http://hub.qgis.org/projects/quantum-gis/issues">http://hub.qgis.org/projects/quantum-gis/issues</a> has this type as well. Check the Patch supplied checkbox and attach your patch before submitting your bug. One of the developers will review it and apply it to QGIS. Please don't be alarmed if your patch is not applied straight away — developers may be tied up with other commitments.

Note that if you supply a Pull Request, your change would be more likely be merged into the source code!

## 21.4 Blog

The QGIS community also runs a weblog at http://planet.qgis.org/planet/, which has some interesting articles for users and developers as well provided by other blogs in the community. You are invited to contribute your own QGIS blog!

# 21.5 Plugins

The website http://plugins.qgis.org provides the official QGIS plugins web portal. Here, you find a list of all stable and experimental QGIS plugins available via the 'Official QGIS Plugin Repository'.

### 21.6 Wiki

Lastly, we maintain a WIKI web site at <a href="http://hub.qgis.org/projects/quantum-gis/wiki">http://hub.qgis.org/projects/quantum-gis/wiki</a> where you can find a variety of useful information relating to QGIS development, release plans, links to download sites, message-translation hints and more. Check it out, there are some goodies inside!

21.3. BugTracker 405

## **Appendix**

## 22.1 GNU General Public License

Version 2, June 1991

Copyright (C) 1989, 1991 Free Software Foundation, Inc. 59 Temple Place - Suite 330, Boston, MA 02111-1307, USA

Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

#### Preamble

The licenses for most software are designed to take away your freedom to share and change it. By contrast, the GNU General Public License is intended to guarantee your freedom to share and change free software—to make sure the software is free for all its users. This General Public License applies to most of the Free Software Foundation's software and to any other program whose authors commit to using it. (Some other Free Software Foundation software is covered by the GNU Library General Public License instead.) You can apply it to your programs, too.

When we speak of free software, we are referring to freedom, not price. Our General Public Licenses are designed to make sure that you have the freedom to distribute copies of free software (and charge for this service if you wish), that you receive source code or can get it if you want it, that you can change the software or use pieces of it in new free programs; and that you know you can do these things.

To protect your rights, we need to make restrictions that forbid anyone to deny you these rights or to ask you to surrender the rights. These restrictions translate to certain responsibilities for you if you distribute copies of the software, or if you modify it.

For example, if you distribute copies of such a program, whether gratis or for a fee, you must give the recipients all the rights that you have. You must make sure that they, too, receive or can get the source code. And you must show them these terms so they know their rights.

We protect your rights with two steps: (1) copyright the software, and (2) offer you this license which gives you legal permission to copy, distribute and/or modify the software.

Also, for each author's protection and ours, we want to make certain that everyone understands that there is no warranty for this free software. If the software is modified by someone else and passed on, we want its recipients to know that what they have is not the original, so that any problems introduced by others will not reflect on the original authors' reputations.

Finally, any free program is threatened constantly by software patents. We wish to avoid the danger that redistributors of a free program will individually obtain patent licenses, in effect making the program proprietary. To prevent this, we have made it clear that any patent must be licensed for everyone's free use or not licensed at all.

The precise terms and conditions for copying, distribution and modification follow. TERMS AND CONDITIONS FOR COPYING, DISTRIBUTION AND MODIFICATION

0. This License applies to any program or other work which contains a notice placed by the copyright holder saying it may be distributed under the terms of this General Public License. The "Program", below, refers to any such program or work, and a "work based on the Program" means either the Program or any derivative work under copyright law: that is to say, a work containing the Program or a portion of it, either verbatim or with modifications and/or translated into another language. (Hereinafter, translation is included without limitation in the term "modification".) Each licensee is addressed as "you".

Activities other than copying, distribution and modification are not covered by this License; they are outside its scope. The act of running the Program is not restricted, and the output from the Program is covered only if its contents constitute a work based on the Program (independent of having been made by running the Program). Whether that is true depends on what the Program does

1. You may copy and distribute verbatim copies of the Program's source code as you receive it, in any medium, provided that you conspicuously and appropriately publish on each copy an appropriate copyright notice and disclaimer of warranty; keep intact all the notices that refer to this License and to the absence of any warranty; and give any other recipients of the Program a copy of this License along with the Program.

You may charge a fee for the physical act of transferring a copy, and you may at your option offer warranty protection in exchange for a fee.

- 2. You may modify your copy or copies of the Program or any portion of it, thus forming a work based on the Program, and copy and distribute such modifications or work under the terms of Section 1 above, provided that you also meet all of these conditions:
  - (a) You must cause the modified files to carry prominent notices stating that you changed the files and the date of any change.
  - (b) You must cause any work that you distribute or publish, that in whole or in part contains or is derived from the Program or any part thereof, to be licensed as a whole at no charge to all third parties under the terms of this License.
  - (c) If the modified program normally reads commands interactively when run, you must cause it, when started running for such interactive use in the most ordinary way, to print or display an announcement including an appropriate copyright notice and a notice that there is no warranty (or else, saying that you provide a warranty) and that users may redistribute the program under these conditions, and telling the user how to view a copy of this License. (Exception: if the Program itself is interactive but does not normally print such an announcement, your work based on the Program is not required to print an announcement.)

These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Program, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Program, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Program.

In addition, mere aggregation of another work not based on the Program with the Program (or with a work based on the Program) on a volume of a storage or distribution medium does not bring the other work under the scope of this License.

- 3. You may copy and distribute the Program (or a work based on it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you also do one of the following:
  - (a) Accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for

software interchange; or,

- (b) Accompany it with a written offer, valid for at least three years, to give any third party, for a charge no more than your cost of physically performing source distribution, a complete machine-readable copy of the corresponding source code, to be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange; or,
- (c) Accompany it with the information you received as to the offer to distribute corresponding source code. (This alternative is allowed only for noncommercial distribution and only if you received the program in object code or executable form with such an offer, in accord with Subsection b above.)

The source code for a work means the preferred form of the work for making modifications to it. For an executable work, complete source code means all the source code for all modules it contains, plus any associated interface definition files, plus the scripts used to control compilation and installation of the executable. However, as a special exception, the source code distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

If distribution of executable or object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place counts as distribution of the source code, even though third parties are not compelled to copy the source along with the object code.

- 4. You may not copy, modify, sublicense, or distribute the Program except as expressly provided under this License. Any attempt otherwise to copy, modify, sublicense or distribute the Program is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.
- 5. You are not required to accept this License, since you have not signed it. However, nothing else grants you permission to modify or distribute the Program or its derivative works. These actions are prohibited by law if you do not accept this License. Therefore, by modifying or distributing the Program (or any work based on the Program), you indicate your acceptance of this License to do so, and all its terms and conditions for copying, distributing or modifying the Program or works based on it.
- 6. Each time you redistribute the Program (or any work based on the Program), the recipient automatically receives a license from the original licensor to copy, distribute or modify the Program subject to these terms and conditions. You may not impose any further restrictions on the recipients' exercise of the rights granted herein. You are not responsible for enforcing compliance by third parties to this License.
- 7. If, as a consequence of a court judgment or allegation of patent infringement or for any other reason (not limited to patent issues), conditions are imposed on you (whether by court order, agreement or otherwise) that contradict the conditions of this License, they do not excuse you from the conditions of this License. If you cannot distribute so as to satisfy simultaneously your obligations under this License and any other pertinent obligations, then as a consequence you may not distribute the Program at all. For example, if a patent license would not permit royalty-free redistribution of the Program by all those who receive copies directly or indirectly through you, then the only way you could satisfy both it and this License would be to refrain entirely from distribution of the Program.

If any portion of this section is held invalid or unenforceable under any particular circumstance, the balance of the section is intended to apply and the section as a whole is intended to apply in other circumstances.

It is not the purpose of this section to induce you to infringe any patents or other property right claims or to contest validity of any such claims; this section has the sole purpose of protecting the integrity of the free software distribution system, which is implemented by public license practices. Many people have made generous contributions to the wide range of software distributed through that system in reliance on consistent application of that system; it is up to the author/donor to

decide if he or she is willing to distribute software through any other system and a licensee cannot impose that choice.

This section is intended to make thoroughly clear what is believed to be a consequence of the rest of this License.

- 8. If the distribution and/or use of the Program is restricted in certain countries either by patents or by copyrighted interfaces, the original copyright holder who places the Program under this License may add an explicit geographical distribution limitation excluding those countries, so that distribution is permitted only in or among countries not thus excluded. In such case, this License incorporates the limitation as if written in the body of this License.
- 9. The Free Software Foundation may publish revised and/or new versions of the General Public License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns.
  - Each version is given a distinguishing version number. If the Program specifies a version number of this License which applies to it and "any later version", you have the option of following the terms and conditions either of that version or of any later version published by the Free Software Foundation. If the Program does not specify a version number of this License, you may choose any version ever published by the Free Software Foundation.
- 10. If you wish to incorporate parts of the Program into other free programs whose distribution conditions are different, write to the author to ask for permission. For software which is copyrighted by the Free Software Foundation, write to the Free Software Foundation; we sometimes make exceptions for this. Our decision will be guided by the two goals of preserving the free status of all derivatives of our free software and of promoting the sharing and reuse of software generally.

### NO WARRANTY

- 11. BECAUSE THE PROGRAM IS LICENSED FREE OF CHARGE, THERE IS NO WARRANTY FOR THE PROGRAM, TO THE EXTENT PERMITTED BY APPLICABLE LAW. EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR OTHER PARTIES PROVIDE THE PROGRAM "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE PROGRAM IS WITH YOU. SHOULD THE PROGRAM PROVE DEFECTIVE, YOU ASSUME THE COST OF ALL NECESSARY SERVICING, REPAIR OR CORRECTION.
- 12. IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN WRITING WILL ANY COPYRIGHT HOLDER, OR ANY OTHER PARTY WHO MAY MODIFY AND/OR REDISTRIBUTE THE PROGRAM AS PERMITTED ABOVE, BE LIABLE TO YOU FOR DAMAGES, INCLUDING ANY GENERAL, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE PROGRAM (INCLUDING BUT NOT LIMITED TO LOSS OF DATA OR DATA BEING RENDERED INACCURATE OR LOSSES SUSTAINED BY YOU OR THIRD PARTIES OR A FAILURE OF THE PROGRAM TO OPERATE WITH ANY OTHER PROGRAMS), EVEN IF SUCH HOLDER OR OTHER PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

### QGIS Qt exception for GPL

In addition, as a special exception, the QGIS Development Team gives permission to link the code of this program with the Qt library, including but not limited to the following versions (both free and commercial): Qt/Non-commercial Windows, Qt/Windows, Qt/X11, Qt/Mac, and Qt/Embedded (or with modified versions of Qt that use the same license as Qt), and distribute linked combinations including the two. You must obey the GNU General Public License in all respects for all of the code used other than Qt. If you modify this file, you may extend this exception to your version of the file, but you are not obligated to do so. If you do not wish to do so, delete this exception statement from your version.

## 22.2 GNU Free Documentation License

Version 1.3, 3 November 2008

Copyright 2000, 2001, 2002, 2007, 2008 Free Software Foundation, Inc.

http://fsf.org/

Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

#### Preamble

The purpose of this License is to make a manual, textbook, or other functional and useful document "free" in the sense of freedom: to assure everyone the effective freedom to copy and redistribute it, with or without modifying it, either commercially or noncommercially. Secondarily, this License preserves for the author and publisher a way to get credit for their work, while not being considered responsible for modifications made by others.

This License is a kind of "copyleft", which means that derivative works of the document must themselves be free in the same sense. It complements the GNU General Public License, which is a copyleft license designed for free software.

We have designed this License in order to use it for manuals for free software, because free software needs free documentation: a free program should come with manuals providing the same freedoms that the software does. But this License is not limited to software manuals; it can be used for any textual work, regardless of subject matter or whether it is published as a printed book. We recommend this License principally for works whose purpose is instruction or reference.

#### 1. APPLICABILITY AND DEFINITIONS

This License applies to any manual or other work, in any medium, that contains a notice placed by the copyright holder saying it can be distributed under the terms of this License. Such a notice grants a world-wide, royalty-free license, unlimited in duration, to use that work under the conditions stated herein. The **Document**, below, refers to any such manual or work. Any member of the public is a licensee, and is addressed as "you". You accept the license if you copy, modify or distribute the work in a way requiring permission under copyright law.

A "Modified Version" of the Document means any work containing the Document or a portion of it, either copied verbatim, or with modifications and/or translated into another language.

A "Secondary Section" is a named appendix or a front-matter section of the Document that deals exclusively with the relationship of the publishers or authors of the Document to the Document's overall subject (or to related matters) and contains nothing that could fall directly within that overall subject. (Thus, if the Document is in part a textbook of mathematics, a Secondary Section may not explain any mathematics.) The relationship could be a matter of historical connection with the subject or with related matters, or of legal, commercial, philosophical, ethical or political position regarding them.

The "Invariant Sections" are certain Secondary Sections whose titles are designated, as being those of Invariant Sections, in the notice that says that the Document is released under this License. If a section does not fit the above definition of Secondary then it is not allowed to be designated as Invariant. The Document may contain zero Invariant Sections. If the Document does not identify any Invariant Sections then there are none.

The "Cover Texts" are certain short passages of text that are listed, as Front-Cover Texts or Back-Cover Texts, in the notice that says that the Document is released under this License. A Front-Cover Text may be at most 5 words, and a Back-Cover Text may be at most 25 words.

A "Transparent" copy of the Document means a machine-readable copy, represented in a format whose specification is available to the general public, that is suitable for revising the document straightforwardly with generic text editors or (for images composed of pixels) generic paint programs or (for drawings) some widely available drawing editor, and that is suitable for input to text formatters or for automatic translation to a variety of formats suitable for input to text formatters. A copy made in an otherwise Transparent file format whose markup, or absence of markup, has been arranged to thwart or discourage

subsequent modification by readers is not Transparent. An image format is not Transparent if used for any substantial amount of text. A copy that is not "Transparent" is called **Opaque**.

Examples of suitable formats for Transparent copies include plain ASCII without markup, Texinfo input format, LaTeX input format, SGML or XML using a publicly available DTD, and standard-conforming simple HTML, PostScript or PDF designed for human modification. Examples of transparent image formats include PNG, XCF and JPG. Opaque formats include proprietary formats that can be read and edited only by proprietary word processors, SGML or XML for which the DTD and/or processing tools are not generally available, and the machine-generated HTML, PostScript or PDF produced by some word processors for output purposes only.

The "**Title Page**" means, for a printed book, the title page itself, plus such following pages as are needed to hold, legibly, the material this License requires to appear in the title page. For works in formats which do not have any title page as such, "Title Page" means the text near the most prominent appearance of the work's title, preceding the beginning of the body of the text.

The "publisher" means any person or entity that distributes copies of the Document to the public.

A section "Entitled XYZ" means a named subunit of the Document whose title either is precisely XYZ or contains XYZ in parentheses following text that translates XYZ in another language. (Here XYZ stands for a specific section name mentioned below, such as "Acknowledgements", "Dedications", "Endorsements", or "History".) To "Preserve the Title" of such a section when you modify the Document means that it remains a section "Entitled XYZ" according to this definition.

The Document may include Warranty Disclaimers next to the notice which states that this License applies to the Document. These Warranty Disclaimers are considered to be included by reference in this License, but only as regards disclaiming warranties: any other implication that these Warranty Disclaimers may have is void and has no effect on the meaning of this License.

### 2. VERBATIM COPYING

You may copy and distribute the Document in any medium, either commercially or noncommercially, provided that this License, the copyright notices, and the license notice saying this License applies to the Document are reproduced in all copies, and that you add no other conditions whatsoever to those of this License. You may not use technical measures to obstruct or control the reading or further copying of the copies you make or distribute. However, you may accept compensation in exchange for copies. If you distribute a large enough number of copies you must also follow the conditions in section 3.

You may also lend copies, under the same conditions stated above, and you may publicly display copies.

### 3. COPYING IN QUANTITY

If you publish printed copies (or copies in media that commonly have printed covers) of the Document, numbering more than 100, and the Document's license notice requires Cover Texts, you must enclose the copies in covers that carry, clearly and legibly, all these Cover Texts: Front-Cover Texts on the front cover, and Back-Cover Texts on the back cover. Both covers must also clearly and legibly identify you as the publisher of these copies. The front cover must present the full title with all words of the title equally prominent and visible. You may add other material on the covers in addition. Copying with changes limited to the covers, as long as they preserve the title of the Document and satisfy these conditions, can be treated as verbatim copying in other respects.

If the required texts for either cover are too voluminous to fit legibly, you should put the first ones listed (as many as fit reasonably) on the actual cover, and continue the rest onto adjacent pages.

If you publish or distribute Opaque copies of the Document numbering more than 100, you must either include a machine-readable Transparent copy along with each Opaque copy, or state in or with each Opaque copy a computer-network location from which the general network-using public has access to download using public-standard network protocols a complete Transparent copy of the Document, free of added material. If you use the latter option, you must take reasonably prudent steps, when you begin distribution of Opaque copies in quantity, to ensure that this Transparent copy will remain thus accessible at the stated location until at least one year after the last time you distribute an Opaque copy (directly or through your agents or retailers) of that edition to the public.

It is requested, but not required, that you contact the authors of the Document well before redistributing any large number of copies, to give them a chance to provide you with an updated version of the

Document.

### 4. MODIFICATIONS

You may copy and distribute a Modified Version of the Document under the conditions of sections 2 and 3 above, provided that you release the Modified Version under precisely this License, with the Modified Version filling the role of the Document, thus licensing distribution and modification of the Modified Version to whoever possesses a copy of it. In addition, you must do these things in the Modified Version:

- 1. Use in the Title Page (and on the covers, if any) a title distinct from that of the Document, and from those of previous versions (which should, if there were any, be listed in the History section of the Document). You may use the same title as a previous version if the original publisher of that version gives permission.
- 2. List on the Title Page, as authors, one or more persons or entities responsible for authorship of the modifications in the Modified Version, together with at least five of the principal authors of the Document (all of its principal authors, if it has fewer than five), unless they release you from this requirement.
- 3. State on the Title page the name of the publisher of the Modified Version, as the publisher.
- 4. Preserve all the copyright notices of the Document.
- 5. Add an appropriate copyright notice for your modifications adjacent to the other copyright notices.
- 6. Include, immediately after the copyright notices, a license notice giving the public permission to use the Modified Version under the terms of this License, in the form shown in the Addendum below.
- 7. Preserve in that license notice the full lists of Invariant Sections and required Cover Texts given in the Document's license notice.
- 8. Include an unaltered copy of this License.
- 9. Preserve the section Entitled "History", Preserve its Title, and add to it an item stating at least the title, year, new authors, and publisher of the Modified Version as given on the Title Page. If there is no section Entitled "History" in the Document, create one stating the title, year, authors, and publisher of the Document as given on its Title Page, then add an item describing the Modified Version as stated in the previous sentence.
- 10. Preserve the network location, if any, given in the Document for public access to a Transparent copy of the Document, and likewise the network locations given in the Document for previous versions it was based on. These may be placed in the "History" section. You may omit a network location for a work that was published at least four years before the Document itself, or if the original publisher of the version it refers to gives permission.
- 11. For any section Entitled "Acknowledgements" or "Dedications", Preserve the Title of the section, and preserve in the section all the substance and tone of each of the contributor acknowledgements and/or dedications given therein.
- 12. Preserve all the Invariant Sections of the Document, unaltered in their text and in their titles. Section numbers or the equivalent are not considered part of the section titles.
- 13. Delete any section Entitled "Endorsements". Such a section may not be included in the Modified Version.
- 14. Do not retitle any existing section to be Entitled "Endorsements" or to conflict in title with any Invariant Section.
- 15. Preserve any Warranty Disclaimers.

If the Modified Version includes new front-matter sections or appendices that qualify as Secondary Sections and contain no material copied from the Document, you may at your option designate some or all of these sections as invariant. To do this, add their titles to the list of Invariant Sections in the Modified Version's license notice. These titles must be distinct from any other section titles.

You may add a section Entitled "Endorsements", provided it contains nothing but endorsements of your Modified Version by various parties—for example, statements of peer review or that the text has been approved by an organization as the authoritative definition of a standard.

You may add a passage of up to five words as a Front-Cover Text, and a passage of up to 25 words as a Back-Cover Text, to the end of the list of Cover Texts in the Modified Version. Only one passage of Front-Cover Text and one of Back-Cover Text may be added by (or through arrangements made by) any one entity. If the Document already includes a cover text for the same cover, previously added by you or by arrangement made by the same entity you are acting on behalf of, you may not add another; but you may replace the old one, on explicit permission from the previous publisher that added the old one.

The author(s) and publisher(s) of the Document do not by this License give permission to use their names for publicity for or to assert or imply endorsement of any Modified Version.

#### 5. COMBINING DOCUMENTS

You may combine the Document with other documents released under this License, under the terms defined in section 4 above for modified versions, provided that you include in the combination all of the Invariant Sections of all of the original documents, unmodified, and list them all as Invariant Sections of your combined work in its license notice, and that you preserve all their Warranty Disclaimers.

The combined work need only contain one copy of this License, and multiple identical Invariant Sections may be replaced with a single copy. If there are multiple Invariant Sections with the same name but different contents, make the title of each such section unique by adding at the end of it, in parentheses, the name of the original author or publisher of that section if known, or else a unique number. Make the same adjustment to the section titles in the list of Invariant Sections in the license notice of the combined work.

In the combination, you must combine any sections Entitled "History" in the various original documents, forming one section Entitled "History"; likewise combine any sections Entitled "Acknowledgements", and any sections Entitled "Dedications". You must delete all sections Entitled "Endorsements".

## 6. COLLECTIONS OF DOCUMENTS

You may make a collection consisting of the Document and other documents released under this License, and replace the individual copies of this License in the various documents with a single copy that is included in the collection, provided that you follow the rules of this License for verbatim copying of each of the documents in all other respects.

You may extract a single document from such a collection, and distribute it individually under this License, provided you insert a copy of this License into the extracted document, and follow this License in all other respects regarding verbatim copying of that document.

#### 7. AGGREGATION WITH INDEPENDENT WORKS

A compilation of the Document or its derivatives with other separate and independent documents or works, in or on a volume of a storage or distribution medium, is called an "aggregate" if the copyright resulting from the compilation is not used to limit the legal rights of the compilation's users beyond what the individual works permit. When the Document is included in an aggregate, this License does not apply to the other works in the aggregate which are not themselves derivative works of the Document.

If the Cover Text requirement of section 3 is applicable to these copies of the Document, then if the Document is less than one half of the entire aggregate, the Document's Cover Texts may be placed on covers that bracket the Document within the aggregate, or the electronic equivalent of covers if the Document is in electronic form. Otherwise they must appear on printed covers that bracket the whole aggregate.

### 8. TRANSLATION

Translation is considered a kind of modification, so you may distribute translations of the Document under the terms of section 4. Replacing Invariant Sections with translations requires special permission from their copyright holders, but you may include translations of some or all Invariant Sections in addition to the original versions of these Invariant Sections. You may include a translation of this License, and all the license notices in the Document, and any Warranty Disclaimers, provided that you also include the original English version of this License and the original versions of those notices and disclaimers. In

case of a disagreement between the translation and the original version of this License or a notice or disclaimer, the original version will prevail.

If a section in the Document is Entitled "Acknowledgements", "Dedications", or "History", the requirement (section 4) to Preserve its Title (section 1) will typically require changing the actual title.

#### 9. TERMINATION

You may not copy, modify, sublicense, or distribute the Document except as expressly provided under this License. Any attempt otherwise to copy, modify, sublicense, or distribute it is void, and will automatically terminate your rights under this License.

However, if you cease all violation of this License, then your license from a particular copyright holder is reinstated (a) provisionally, unless and until the copyright holder explicitly and finally terminates your license, and (b) permanently, if the copyright holder fails to notify you of the violation by some reasonable means prior to 60 days after the cessation.

Moreover, your license from a particular copyright holder is reinstated permanently if the copyright holder notifies you of the violation by some reasonable means, this is the first time you have received notice of violation of this License (for any work) from that copyright holder, and you cure the violation prior to 30 days after your receipt of the notice.

Termination of your rights under this section does not terminate the licenses of parties who have received copies or rights from you under this License. If your rights have been terminated and not permanently reinstated, receipt of a copy of some or all of the same material does not give you any rights to use it.

### 10. FUTURE REVISIONS OF THIS LICENSE

The Free Software Foundation may publish new, revised versions of the GNU Free Documentation License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns. See <a href="http://www.gnu.org/copyleft/">http://www.gnu.org/copyleft/</a>.

Each version of the License is given a distinguishing version number. If the Document specifies that a particular numbered version of this License "or any later version" applies to it, you have the option of following the terms and conditions either of that specified version or of any later version that has been published (not as a draft) by the Free Software Foundation. If the Document does not specify a version number of this License, you may choose any version ever published (not as a draft) by the Free Software Foundation. If the Document specifies that a proxy can decide which future versions of this License can be used, that proxy's public statement of acceptance of a version permanently authorizes you to choose that version for the Document.

### 11. RELICENSING

"Massive Multiauthor Collaboration Site" (or "MMC Site") means any World Wide Web server that publishes copyrightable works and also provides prominent facilities for anybody to edit those works. A public wiki that anybody can edit is an example of such a server. A "Massive Multiauthor Collaboration" (or "MMC") contained in the site means any set of copyrightable works thus published on the MMC site.

"CC-BY-SA" means the Creative Commons Attribution-Share Alike 3.0 license published by Creative Commons Corporation, a not-for-profit corporation with a principal place of business in San Francisco, California, as well as future copyleft versions of that license published by that same organization.

"Incorporate" means to publish or republish a Document, in whole or in part, as part of another Document.

An MMC is "eligible for relicensing" if it is licensed under this License, and if all works that were first published under this License somewhere other than this MMC, and subsequently incorporated in whole or in part into the MMC, (1) had no cover texts or invariant sections, and (2) were thus incorporated prior to November 1, 2008.

The operator of an MMC Site may republish an MMC contained in the site under CC-BY-SA on the same site at any time before August 1, 2009, provided the MMC is eligible for relicensing.

### ADDENDUM: How to use this License for your documents

To use this License in a document you have written, include a copy of the License in the document and put the following copyright and license notices just after the title page:

Copyright @ YEAR YOUR NAME.

Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.3 or any later version published by the Free Software Foundation; with no Invariant Sections, no Front-Cover Texts, and no Back-Cover Texts. A copy of the license is included in the section entitled "GNU Free Documentation License".

If you have Invariant Sections, Front-Cover Texts and Back-Cover Texts, replace the "with ... Texts." line with this:

with the Invariant Sections being LIST THEIR TITLES, with the Front-Cover Texts being LIST, and with the Back-Cover Texts being LIST.

If you have Invariant Sections without Cover Texts, or some other combination of the three, merge those two alternatives to suit the situation.

If your document contains nontrivial examples of program code, we recommend releasing these examples in parallel under your choice of free software license, such as the GNU General Public License, to permit their use in free software.

## Literature and Web References

GDAL-SOFTWARE-SUITE. Geospatial data abstraction library. http://www.gdal.org, 2013.

 $GRASS-PROJECT.\ Geographic\ ressource\ analysis\ support\ system.\ http://grass.osgeo.org\ ,\ 2013.$ 

NETELER, M., AND MITASOVA, H. Open source gis: A grass gis approach, 2008.

 $OGR-SOFTWARE-SUITE.\ Geospatial\ data\ abstraction\ library.\ http://www.gdal.org/ogr\ ,\ 2013.$ 

OPEN-GEOSPATIAL-CONSORTIUM. Web map service (1.1.1) implementation specification. http://portal.opengeospatial.org, 2002.

OPEN-GEOSPATIAL-CONSORTIUM. Web map service (1.3.0) implementation specification. http://portal.opengeospatial.org, 2004.

POSTGIS-PROJECT. Spatial support for postgresql. http://postgis.refractions.net/, 2013.

%%, 134	conditional formatting, 156
2.5 D, 108	conditional_formatting, 156
2.5 D Rendering, 106	Context help, $35$
	Contrast enhancement, 182
Actions, 43, 133	Coordinate Reference System, 67, 195
Add Part, 168	create a rule, 105
Analysis tools, 368	create features, 163
annotation, 44	Create Maps, 305, 314
apache, 201	Create New Layers, 171
apache2, 201	crossing the 180 degrees longitude line, 88
$Arc/Info\_ASCII\_Grid, 177$	CRS, 67, 195
Arc/Info_Binary_Grid, 177	CSV, 80, 165
ArcInfo Binary Coverage, 79	Current_Edits, 166
Atlas_Generation, 345	Custom color Ramp, 93
Attribute Actions, 133	Custom_CRS, 70
attribute table, 151	customization, 64
Attribute_Table, 330	,
Attribute_Table_Selection, 152	data-defined override, 42, 123
Avoid Intersections, 161	Datum_transformation, 71
	DB_Manager, 89
Blending modes, 39	Debian_Squeeze, 201
bookmarks, 46	$default\_CRS, 67$
Browse_Maps, 74	define an action, 134
built-in forms, 127	delete parts, 168
	Derived Fields, 154
calculation bar, 155	diagram, 129
Calculator Field, 154	Digitizing, 162, 373
CAT, 191	Add Part, 168
Categorized, 102	Add Ring, 168
Categorized Renderer, 102	Advanced panel, 171
CGI, 200	Automatic tracing, 171
classes, 102	Delete Part, 168
color, 37	Delete Ring, 169
Color_interpolation, 182	Fill Ring, 169
color_Ramp, 93	Merge Attributes, 170
colorBrewer, 93	Merge Selected Features, 170
Colormap, 182	Offset Curves, 169
Comma Separated Values, 80	Redo, $167$
command line options, 14	Reshape Feature, 169
Common_Gateway_Interface, 200	Rotate Feature, 168
Compose_Maps, 305, 314	Rotate Point Symbols, 170
Composer_Items, 314	Simplify Feature, 168
Composer_Manager, 306	Snapping, 160
composer_map, 316	Split Features, 169
Composer_Template, 305	Split Parts, 170

Undo, 167	Grids
digitizing tools, 162	Map_Grid, 319
Discrete, 182	heatmap, 106
displacement circle, 106	Heatmap Renderer, 106
Displacement plugin, 106	Histogram, 103, 186
documentation, 5	HTML_Frame, 337
editing, 159, 162	Identify factures 42
environment	Identify features, 43 IGNF, 67
QGIS Server, 209	Import Maps, 74
EPSG, 67	Institut Geographique National de France, 67
Equal Interval, 103	InteProxy, 198
Erdas Imagine, 177	Inverted Polygon Renderer, 106
Errors, 373	Items Alignment, 316
ESRI, 80	Titeliis_Titigliilielie, 910
European_Petroleom_Search_Group, 67	join, 127
example actions, 134	join layer, 127
Export_as_image, 342	•
Export_as_PDF, 342	Keyboard shortcuts, 35
Export_as_SVG, 342	keyword lists, 138
Expression based labeling, 121	1111
Expressions, 141	label placement, 118
expressions, 51	labeling, 115
FastCGI, 200	layer rendering, 109
Field Calculator, 154	layer visibility, 29
field calculator, 155	layout toolbars, 28
Field Calculator Functions, 142	Layout_Maps, 305, 314
riora_omediator_runotions, 112	legend, 29
GDAL, 177	legend_composer
generalisation, 138	Map_Legend, 324
Geometry, 377	license document, 407
Geometry Checker, 373	load a shapefile, 77
Geometry snapper plugin, 377	loading_raster, 177
Geometry validity, 373	Log messages, 32
geometryless feature, 164, 168	logging OCIS Sanyan, 200
Georeferencer tools, 378	QGIS Server, 209
GeoTIFF, 177	main window, 21
GeoTiff, 177	Map overview, 32
GiST (Generalized Search Tree) index, 87	Map Tips, 137
GML, 191	Map Navigation, 40
GNU General Public License, 407	Map Template, 305
Gradient_color_Ramp, 93	MapInfo, 77
Graduated Renderer, 103	measure, 40
GRASS, $245$ , $\partial us$ . Creating new	angles, 41
vectors; editing; creating a new layer	areas, 41
attribute linkage, 250	line length, 41
attribute storage, 250	menus, 22
digitizing tools, 251	Metadata, 138, 186
display results, 255, 257	MSSQL Spatial, 89
region, 253	Multi_Band_Raster, 179
region display, 253	multiline, 168
region editing, 253	multipoint, 168
style, 252	multipolygon, 168
toolbox, 257	Multivariate analysis, 104
GRASS toolbox, 253	N
customize, 261	Natural Breaks (Jenks), 103
GRASS vector data model, 250	nesting projects, 47
$\operatorname{Grid}$	New_GPX_Layer, 171, 174

420

New Shapefile Layer, 171	Relations, 156
New SpatiaLite Layer, 171	Rendering, 36
New Spatialite Layer, 172	rendering effects, 39
New_Temporary_Scratch_Layer, 174	Rendering halting, 37
Node Tool, 163	rendering quality, 37
Nodes, 164	Rendering scale dependent, 36
Non Spatial Attribute Tables, 156	Rendering Mode, 315
<b>-</b> •	Research tools, 368
OGC, 191	Revert Layout Actions, 313
OGR, 80	ring polygons, 169
OGR Simple Feature Library, 80	Rotated North Arrow, 336
ogr2ogr, 86	Rubber $\overline{b}$ and, $1\overline{63}$
Open_Geospatial_Consortium, 191	rule-based, 105
OpenStreetMap, 82	Rule-based labeling, 123
Oracle Spatial, 89	Rule-based Rendering, 105
OSM, 82	rules of ordering, 109
output save as image, 18	G,
	Save properties, 139
Paint effects, 110	Save style, 139
Pan, 40	Scale, 36
pan arrow keys, 34	scale calculate, 34
pgsql2shp, 86	$\operatorname{Scalebar}$
Picture_database, 336	Map Scalebar, 326
Plugin, 377	Search Radius, 161
plugins, 349	Search radius, 161
Point Displacement Renderer, 106	Secured_OGC_Authentication, 19
polygon_to_line	SFS, 191
$line\_to\_polygon, 165$	Shapefile, 77, 80
PostGIS, 83	Shared Polygon Boundaries, 161
PostGIS spatial index, 87	m shp2pgsql,~86
PostgreSQL, 83	Single Symbol Renderer, 101
Pretty Breaks, 103	Single_Band_Raster, 179
print composer quick print, 18	Size assistant, 104
print_composer	SLD, 200
tools, $308$	SLD/SE, 200
Printing	Snapping, 160, 377
Export_Map, 342	Snapping On Intersections, 162
Proj.4, 70	Snapping Tolerance, 160
Proj4, 69	Snapping tolerance, 160
Proj4_text, 69	spatial bookmarks
Projections, 67	see bookmarks, 46
Proportional symbol, 104	Spatialite, 88
Proxy, 193	Spatialite_Manager, 89
proxy-server, 193	$\mathbf{SQLite},~88$
Pyramids, 185	SRS, 195
0.615.6	ST Shift Longitude, 87
QGIS Server	$\overline{\text{Statistic}}, \overline{32}$
environment, 209	Style, 31, 91, 100
logging, 209	Symbology, 100, 179
QGIS_mapserver, 199	Symbols levels, 110
QGIS_Server, 200	
QML, 139	Three_Band_Color_Raster, 179
QSpatiaLite, 89	Tiger Format, 79
Quantile, 103	toolbar, 28
Query Builder, 98	Topological Editing, 161
D1 177	Topology, 373, 377
Raster, 177	Transparency, 184
Raster_Calculator, 187	
Redo, 33	UK National Transfer Format, 79

**Індекс** 421

```
Undo, 33
US Census Bureau, 79
variable, 51
variables, 51
vector file, 77
Vertex, 164
Vertices, 164
virtual field, 154
Virtual Fields, 154
Virtual Layers, 174
WCS, 191, 199
Web Coverage Service, 199
WFS, 191, 199
WFS-T, 199
WFS Transactional, 199
WKT, 67, 165
WMS, 191
WMS-C, 196
WMS_1.3.0, 199
WMS_client, 191
WMS_identify, 196
WMS_layer_transparency, 195
WMS metadata, 197
WMS\_properties, 197
WMS\_tiles,\,196
WMT\overline{S}, 196
WMTS\_client,\,191
Work with Attribute Table, 151
z-order, 109
zoom mouse wheel, 33
Zoom In Zoom Out, 40
```

422