
QGIS User Guide

Release 1.8

QGIS Project

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Preamble

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This document has been typeset with reStructuredText. It is available as reST source code via [github](#) and online as HTML and PDF via <http://documentation.qgis.org>. 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://www.qgis.org/wiki/>.

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.

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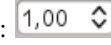
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Conventions

This section describes a collection of uniform styles throughout the manual. The conventions used in this manual are as follows:

GUI Conventions

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

- Menu Options: *Layer* → *Add a Raster Layer* or *Settings* → *Toolbars* → *Digitizing*
- Tool:  Add a Raster Layer
- Button : **[Save as Default]**
- Dialog Box Title: *Layer Properties*
- Tab: *General*
- Checkbox:  *Render*
- Radio Button:  Postgis SRID  EPSG ID
- Select a Number: 
- Select a String: 
- Browse for a File: 
- Select a Color: 
- Slider: 
- Input Text: 

A shadow indicates a clickable GUI component.

Text or Keyboard Conventions

The manual also includes styles related to text, keyboard commands and coding to indicate different entities, such as classes, or methods. They don't correspond to any actual appearance.

- 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`
- Method: `classFactory`
- 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",
```

Platform-specific instructions

GUI sequences and small amounts of text can be formatted inline: Click *File* *QGIS* → *Quit to close QGIS*.

This indicates that on Linux, Unix and Windows platforms, click the File menu option first, then Quit from the dropdown menu, while on Macintosh OSX platforms, click the QGIS menu option first, then Quit from the dropdown menu. Larger amounts of text may be formatted as a list:

- do this;
- do that;
- do something else.

or as paragraphs.

Do this and this and this. Then do this and this.

Do that. Then do 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)!

Quantum 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 (<http://qt.digia.com>) and C++. This means that QGIS feels snappy to use and has a pleasing, easy-to-use graphical user interface (GUI).

QGIS aims to be an easy-to-use GIS, providing common functions and features. The initial goal 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*.

Tip: Up-to-date Documentation

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

3.1 Introduction To GIS

A Geographical Information System (GIS) (Mitchell 2005 *Literature and Web References*) is a collection of software that allows you to create, visualize, query and analyze geospatial data. Geospatial data refers to information about the geographic location of an entity. This often involves the use of a geographic coordinate, like a latitude or longitude value. Spatial data is another commonly used term, as are: geographic data, GIS data, map data, location data, coordinate data and spatial geometry data.

Applications using geospatial data perform a variety of functions. Map production is the most easily understood function of geospatial applications. Mapping programs take geospatial data and render it in a form that is viewable, usually on a computer screen or printed page. Applications can present static maps (a simple image) or dynamic maps that are customised by the person viewing the map through a desktop program or a web page.

Many people mistakenly assume that geospatial applications just produce maps, but geospatial data analysis is another primary function of geospatial applications. Some typical types of analysis include computing:

1. distances between geographic locations
2. the amount of area (e.g., square meters) within a certain geographic region
3. what geographic features overlap other features

4. the amount of overlap between features
5. the number of locations within a certain distance of another
6. and so on...

These may seem simplistic, but can be applied in all sorts of ways across many disciplines. The results of analysis may be shown on a map, but are often tabulated into a report to support management decisions.

The recent phenomena of location-based services promises to introduce all sorts of other features, but many will be based on a combination of maps and analysis. For example, you have a cell phone that tracks your geographic location. If you have the right software, your phone can tell you what kind of restaurants are within walking distance. While this is a novel application of geospatial technology, it is essentially doing geospatial data analysis and listing the results for you.

3.1.1 Why is all this so new?

Well, it's not. There are many new hardware devices that are enabling mobile geospatial services. Many open source geospatial applications are also available, but the existence of geospatially focused hardware and software is nothing new. Global positioning system (GPS) receivers are becoming commonplace, but have been used in various industries for more than a decade. Likewise, desktop mapping and analysis tools have also been a major commercial market, primarily focused on industries such as natural resource management.

What is new is how the latest hardware and software is being applied and who is applying it. Traditional users of mapping and analysis tools were highly trained GIS Analysts or digital mapping technicians trained to use CAD-like tools. Now, the processing capabilities of home PCs and open source software (OSS) packages have enabled an army of hobbyists, professionals, web developers, etc. to interact with geospatial data. The learning curve has come down. The costs have come down. The amount of geospatial technology saturation has increased.

How is geospatial data stored? In a nutshell, there are two types of geospatial data in widespread use today. This is in addition to traditional tabular data that is also widely used by geospatial applications.

3.1.2 Raster Data

One type of geospatial data is called raster data or simply “a raster”. The most easily recognised form of raster data is digital satellite imagery or air photos. Elevation shading or digital elevation models are also typically represented as raster data. Any type of map feature can be represented as raster data, but there are limitations.

A raster is a regular grid made up of cells, or in the case of imagery, pixels. They have a fixed number of rows and columns. Each cell has a numeric value and has a certain geographic size (e.g. 30x30 meters in size).

Multiple overlapping rasters are used to represent images using more than one colour value (i.e. one raster for each set of red, green and blue values is combined to create a colour image). Satellite imagery also represents data in multiple “bands”. Each band is essentially a separate, spatially overlapping raster, where each band holds values of certain wavelengths of light. As you can imagine, a large raster takes up more file space.

A raster with smaller cells can provide more detail, but takes up more file space. The trick is finding the right balance between cell size for storage purposes and cell size for analytical or mapping purposes.

3.1.3 Vector Data

Vector data is also used in geospatial applications. If you stayed awake during trigonometry and coordinate geometry classes, you will already be familiar with some of the qualities of vector data. In its simplest sense, vectors are a way of describing a location by using a set of coordinates. Each coordinate refers to a geographic location using a system of x and y values.

This can be thought of in reference to a Cartesian plane - you know, the diagrams from school that showed an x and y-axis. You might have used them to chart declining retirement savings or increasing compound mortgage interest, but the concepts are essential to geospatial data analysis and mapping.

There are various ways of representing these geographic coordinates depending on your purpose. This is a whole area of study for another day - map projections.

Vector data takes on three forms, each progressively more complex and building on the former.

1. Points - A single coordinate (x y) represents a discrete geographic location
2. Lines - Multiple coordinates ($x_1 y_1, x_2 y_2, x_3 y_3, \dots x_n y_n$) strung together in a certain order, like drawing a line from Point ($x_1 y_1$) to Point ($x_2 y_2$) and so on. These parts between each point are considered line segments. They have a length and the line can be said to have a direction based on the order of the points. Technically, a line is a single pair of coordinates connected together, whereas a line string is multiple lines connected together.
3. Polygons - When lines are strung together by more than two points, with the last point being at the same location as the first, we call this a polygon. A triangle, circle, rectangle, etc. are all polygons. The key feature of polygons is that there is a fixed area within them.

Features

QGIS offers many common GIS functionalities provided by core features and plugins. As a short summary they are presented in six categories to gain a first insight.

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 MSSQL 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-compliant Web Map Service (WMS) or Web Feature Service (WFS), see section [Working with OGC Data](#).
- OpenStreetMap data, see section [OpenStreetMap](#).

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 projection
- Map composer
- Overview panel
- Spatial bookmarks
- Identify/select features
- Edit/view/search attributes
- Feature labeling
- Change vector and raster symbology
- Add a graticule layer - now via fTools plugin and as decoration

- Decorate your map with a north arrow scale bar and copyright label
- Save and restore projects

4.3 Create, edit, manage and export data

You can create, edit, manage and export vector maps in several formats. Raster data have to be imported into GRASS to be able to edit and export them into other formats. QGIS offers the following:

- Digitizing tools for OGR supported formats and GRASS vector layer
- Create and edit shapefiles and GRASS vector layers
- Geocode images with the Georeferencer plugin
- 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)
- Visualize and edit OpenStreetMap data
- Create PostGIS layers from shapefiles with the SPIT plugin
- Improved handling of PostGIS tables
- Manage vector attribute tables with the new attribute table (see section *Working with the Attribute Table*) or Table Manager plugin
- Save screenshots as georeferenced images

4.4 Analyse data

You can perform spatial data analysis on PostgreSQL/PostGIS and other OGR supported formats using the fTools Python plugin. 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 work with SEXTANTE, which provides powerful a geospatial analysis framework to call native and third party algorithms from QGIS, such as GDAL, SAGA, GRASS, fTools and more (see section *SEXTANTE*).

4.5 Publish maps on the Internet

QGIS can be used to export data to a mapfile and to publish them on the Internet using a webserver with UMN MapServer installed. QGIS can also be used as a WMS, WMS-C or WFS and WFS-T client, and as WMS or WFS server (see section *Working with OGC Data*).

4.6 Extend QGIS functionality through plugins

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

4.6.1 Core Plugins

1. Add Delimited Text Layer (Loads and displays delimited text files containing x,y coordinates)
2. Coordinate Capture (Capture mouse coordinates in different CRS)
3. DB Manager (Exchange, edit and view layers and tables; execute SQL queries)

4. Diagram Overlay (Placing diagrams on vector layer)
5. Dxf2Shp Converter (Convert DXF to Shape)
6. GPS Tools (Loading and importing GPS data)
7. GRASS (GRASS GIS integration)
8. GDALTools (Integrate GDAL Tools into QGIS)
9. Georeferencer GDAL (Adding projection information to raster using GDAL)
10. Heatmap tool (Generating raster heatmaps from point data)
11. Interpolation plugin (interpolate based on vertices of a vector layer)
12. Mapserver Export (Export QGIS project file to a MapServer map file)
13. Offline Editing (Allow offline editing and synchronizing with database)
14. OpenStreetMap plugin (Viewer and editor for openstreetmap data)
15. Oracle Spatial GeoRaster support
16. Plugin Installer (Download and install QGIS python plugins)
17. Raster terrain analysis (Raster based terrain analysis)
18. Road graph plugin (Shortest Path network analysis)
19. SPIT (Import Shapefile to PostgreSQL/PostGIS)
20. SQL Anywhere Plugin (Store vector layers within a SQL Anywhere database)
21. Zonal statictics plugin (Calculate count, sum, mean of raster for each polygon of a vector layer)
22. Spatial Query plugin (Makes spatial queries on vector layers)
23. eVIS (Event Visualization Tool)
24. fTools (Tools for vector data analysis and management)

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 [Loading an external QGIS Plugin](#)).

4.7 What's new in the version 1.8

Please note that this is a release in our ‘cutting edge’ release series. As such it contains new features and extends the programmatic interface over QGIS 1.0.x and QGIS 1.7.0. We recommend that you use this version over previous releases.

This release includes hundreds of bug fixes and many new features and enhancements that will be described in this manual.

QGIS Browser

A stand alone app and a new panel in QGIS. The browser lets you easily navigate your file system and connection based (PostGIS, WFS etc.) datasets, preview them and drag and drop items into the canvas.

DB Manager

The DB manager is now officially part of QGIS core. You can drag layers from the QGIS Browser into DB Manager and it will import your layer into your spatial database. Drag and drop tables between spatial databases and they will get imported. You can 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. You can also create, edit, delete, and empty tables, and move them to another schema.

Terrain Analysis Plugin

A new core plugin was added for doing terrain analysis (slope, aspect, hillshade, relief and ruggedness index).

New symbol layer types

- Line Pattern Fill
- Point Pattern Fill
- Ellipse renderer (render ellipse and also rectangles, triangles, crosses)

New plugin repository

Note that the old repository is now no longer supported by default; plugin authors are kindly requested to move their plugins to the new repository. Get the QGIS Plugins list at <http://plugins.qgis.org/plugins/>.

More new features

- Support for nesting projects within other projects to embed content from other project files
- Group Selected: Option to group layers to a group
- Message log: Lets you keep an eye on the messages QGIS generates during loading and operation
- GUI Customization: Allows setting up simplified QGIS interface by hiding various components of main window and widgets in dialogs
- Action Tool is now accessible from the map tools toolbar and allows you to click on a vector feature and execute an action
- New scale selector: select from a list of predefined scales
- Pan To Selected tool: Pans the map to selected feature(s); does not change the zoom level
- Copy and paste styles between layers
- Updated CRS selector dialog
- Define Legend-independent drawing order
- MSSQL Spatial Support - you can now connect to your Microsoft SQL Server spatial databases using QGIS
- Print Composers allows to have multiple lines on legend items using a specified character
- Expression based labeling
- Heatmap Plugin - a new core plugin has been added for generating raster heatmaps from point data
- The GPS live tracking user interface was overhauled and many fixes and improvements were added to it
- The menu was re-organised a little - we now have separate menus for Vector, Raster, Web and many plugins were updated to place their menus in the new Vector, Raster and Web top level menus
- Offset Curves - a new digitising tool for creating offset curves was added
- New tools in the Vector menu to Densify geometries and Build spatial index
- Export/add geometry column tool can export info using layer CRS, project CRS or ellipsoidal measurements
- Model/view based tree for rules in rule-based renderer
- Improvements in Spatial Bookmarks
- New Plugin metadata in metadata.txt
- Refactored postgres data provider: support for arbitrary key (including non-numeric and multi column), support for requesting a certain geometry type and/or srid in QgsDataSourceURI
- Added gdal_fillnodata to GDALTools plugin
- Support for PostGIS TopoGeometry datatype

- Python bindings for vector field symbol layer and general updates to the Python bindings
- Added a Benchmark program
- Added Row cache for attribute table
- UUID generation widget for attribute table
- Added support of editable views in SpatiaLite databases
- added expression based widget in field calculator
- Creation of event layers in analysis lib using linear referencing
- Load/save layer styles in the new symbology renderer from/to SLD document
- QGIS Server can act as WFS Server
- WFS Client support is now a core feature in QGIS
- Option to skip WKT geometry when copying from attribute table
- Support loading of zipped and gzipped layers
- The QGIS test suite now passes all tests on major platforms and nightly tests
- You can set tile size for WMS layers

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.

5.1 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 to add to your installation manager are provided. Get the latest information on binary packages at the QGIS website at <http://download.qgis.org>.

5.1.1 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 it online at <https://github.com/qgis/Quantum-GIS/blob/master/INSTALL>

5.1.2 Installation on external media

QGIS allows to define a `--configpath` option that overrides the default path (e.g. `~/.qgis` under Linux) for user configuration and forces QSettings to use this directory, too. This allows users to e.g. carry a QGIS installation on a flash drive together with all plugins and settings.

5.2 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 can either

- use GIS data that you already have;
- download the sample data from the qgis website at <http://download.qgis.org>; or
- uninstall QGIS and reinstall with the data download option checked, only if the above solutions are unsuccessful.

 For GNU/Linux and Mac OSX 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 ZIP or TAR archive from <http://download.osgeo.org/qgis/data/> and unzip or untar the archive on your system. The Alaska dataset includes

all GIS data that are used as examples and screenshots in the user guide, and also includes a small GRASS database. The projection for the qgis sample dataset is Alaska Albers Equal Area with unit 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 graphical frontend 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/data.php>.

5.3 Sample Session

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 `qgis_sample_data/raster/landcover.img` and the lakes vector layer `qgis_sample_data/gml/lakes.gml`.

5.3.1 Start QGIS

- Start QGIS by typing: “QGIS” at a command prompt, or if using precompiled binary, using the Applications menu.
- Start QGIS using the Start menu or desktop shortcut, or double click on a QGIS project file.
- Double click the icon in your Applications folder.

5.3.2 Load raster and vector layers from the sample dataset

1. Click on the Load Raster icon.
2. Browse to the folder `qgis_sample_data/raster/`, select the ERDAS Img file `landcover.img` and click [**Open**].
3. If the file is not listed, check if the Filetype combobox at the bottom of the dialog is set on the right type, in this case “Erdas Imagine Images (*.img, *.IMG)”.
4. Now click on the Load Vector icon.
5. *File* should be selected as Source Type in the new *Add Vector Layer* dialog. Now click [**Browse**] to select the vector layer.

6. Browse to the folder `qgis_sample_data/gml/`, select “GML” from the filetype combobox, then select the GML file `lakes.gml` and click **[Open]**, then in Add Vector dialog click **[OK]**.
7. Zoom in a bit to your favorite area with some lakes.
8. Double click the `lakes` layer in the map legend to open the *Properties* dialog.
9. Click on the *Style* tab and select a blue as fill color.
10. Click on the *Labels* tab and check the *Display labels* checkbox to enable labeling. Choose NAMES field as field containing label.
11. To improve readability of labels, you can add a white buffer around them, by clicking “Buffer” in the list on the left, checking *Buffer labels?* and choosing 3 as buffer size.
12. 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.

5.4 Starting and Stopping QGIS

In Section [Sample Session](#) you already learned how to start QGIS. We will repeat this here and you will see that QGIS also provides further command line options.

-  Assuming that QGIS is installed in the PATH, you can start QGIS by typing: `qgis` at a command prompt or by double clicking on the QGIS application link (or shortcut) on the desktop or in the application menu.
-  Start QGIS using the Start menu or desktop shortcut, or double click on a QGIS project file.
-  Double click the icon in your Applications folder. If you need to start QGIS in a shell, run `/path-to-installation-executable/Contents/MacOS/Qgis`.

To stop QGIS, click the menu options    *File*  *QGIS* → *Quit*, or use the shortcut `Ctrl+Q`.

5.5 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 --help
Quantum GIS - 1.8.0-Lisboa 'Lisboa' (exported)
Quantum GIS (QGIS) is a viewer for spatial data sets, including
raster and vector data.
Usage: qgis [options] [FILES]
      options:
        [--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
        [--nopugins]                  don't restore plugins on startup
        [--nocustomization]           don't apply GUI customization
        [--optionspath path]           use the given QSettings path
        [--configpath path]            use the given path for all user configuration
        [--help]                       this text

      FILES:
```

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

Tip: 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 adapted 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: `--lang=it` starts QGIS in italian localization. A list of currently supported languages with language code and status is provided at http://hub.qgis.org/wiki/quantum-gis/GUI_Translation_Progress

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 loaded described in the given file.

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 --nopugins

If you have trouble at startup with plugins, you can avoid loading them at startup. They will still be available in Plugins Manager after-wards.

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 using this option. See [Options](#) to check where does the operating system save the settings files. Presently there is no way to specify in which file where to write the settings, therefore you can create a copy of the original settings file and rename it.

Command line option --configpath

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

5.6 Projects

The state of your QGIS session is considered a Project. QGIS works on one project at a time. Settings are either considered as being 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 *File* →  *Save Project* or *File* →  *Save Project As*.

Load saved projects into a QGIS session using *File* →  *Open Project* or *File* → *Open Recent Project*.

If you wish to clear your session and start fresh, choose *File* →  *New Project*. 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
- Layer properties, including symbolization
- Projection for the map view
- Last viewed extent

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 was updated several times compared to earlier QGIS versions. Project files from older QGIS versions may not work properly anymore. To be made aware of this, in the *General* tab under *Settings* → *Options* you can select:

- Prompt to save project changes when required*
- Warn when opening a project file saved with an older version of QGIS*

5.7 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 *File* →  *Save as Image* opens a file dialog where you select the name, path and type of image (PNG or JPG format). A world file with extension PNGW or JPGW saved in the same folder georeferences the image.
- Menu option *File* →  *New Print Composer* opens a dialog where you can layout and print the current map canvas (see Section [Print Composer](#)).

QGIS GUI

When QGIS starts, you are presented with the GUI as shown below (the numbers 1 through 5 in yellow ovals refer to the six major areas of the interface as discussed below):

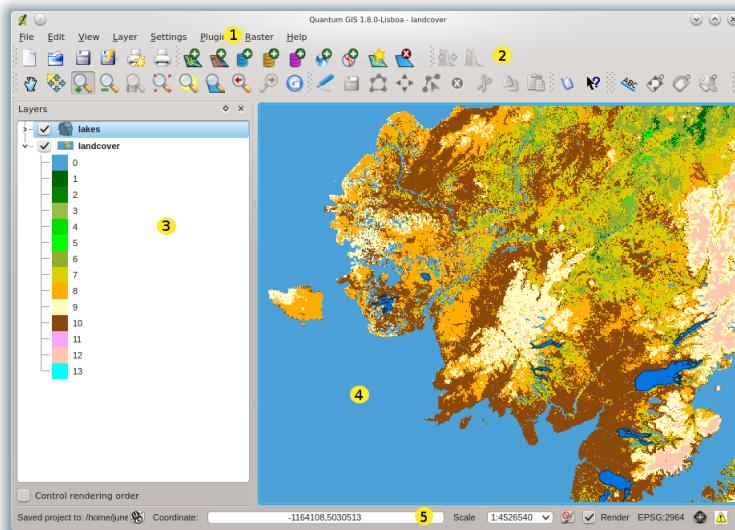


Figure 6.1: QGIS GUI with Alaska sample data 

Note: 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. Tool Bar
3. Map Legend
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.

6.1 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 icons of the corresponding tools as they appear on the toolbar, as well as keyboard shortcuts. Keyboard shortcuts can also be configured manually (shortcuts presented in this section are the defaults), using the [Configure Shortcuts] tool under *Settings*.

Although most menu options have a corresponding tool and vice-versa, the menus are not organized quite 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 [Toolbar](#).

6.1.1 File

Menu Option	Shortcut	Reference	Toolbar
 <i>New Project</i>	Ctrl+N	see <i>Projects</i>	<i>File</i>
 <i>Open Project</i>	Ctrl+O	see <i>Projects</i>	<i>File</i>
<i>Open Recent Projects</i> →		see <i>Projects</i>	
 <i>Save Project</i>	Ctrl+S	see <i>Projects</i>	<i>File</i>
 <i>Save Project As</i>	Ctrl+Shift+S	see <i>Projects</i>	<i>File</i>
 <i>Save as Image</i>		see <i>Output</i>	
 <i>New Print Composer</i>	Ctrl+P	see <i>Print Composer</i>	<i>File</i>
 <i>Composer manager</i>		see <i>Print Composer</i>	
<i>Print Composers</i> →		see <i>Print Composer</i>	
 <i>Exit</i>	Ctrl+Q		

6.1.2 Edit

Menu Option	Shortcut	Reference	Toolbar
Undo	Ctrl+Z	see Advanced digitizing	Advanced Digitizing
Redo	Ctrl+Shift+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	Ctrl+V	see Digitizing an existing layer	Digitizing
Add Feature	Ctrl+.	see Digitizing an existing layer	Digitizing
Move Feature(s)		see Digitizing an existing layer	Digitizing
Delete Selected		see Digitizing an existing layer	Digitizing
Simplify Feature		see Advanced digitizing	Advanced Digitizing
Add Ring		see Advanced digitizing	Advanced Digitizing
Add Part		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 Curves		see Advanced digitizing	Advanced Digitizing
Split Features		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

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

6.1.3 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

6.1.4 View

Menu Option	Shortcut	Reference	Toolbar
Pan Map			Map Navigation
Pan Map to Selection			Map Navigation
Zoom In	Ctrl++		Map Navigation
Zoom Out	Ctrl+-		Map Navigation
Select →		see <i>Select and deselect features</i>	Attributes
Identify Features	Ctrl+Shift+I		Attributes
Measure →		see <i>Measuring</i>	Attributes
Zoom Full	Ctrl+Shift+F		Map Navigation
Zoom To Layer			Map Navigation
Zoom To Selection	Ctrl+J		Map Navigation
Zoom Last			Map Navigation
Zoom Next			Map Navigation
Zoom Actual Size			Map Navigation
Decorations →		see <i>Decorations</i>	
Map Tips			Attributes
New Bookmark	Ctrl+B	see <i>Spatial Bookmarks</i>	Attributes
Show Bookmarks	Ctrl+Shift+B	see <i>Spatial Bookmarks</i>	Attributes
Refresh	Ctrl+R	see <i>Tilesets</i>	Map Navigation Tile scale
Tile scale slider			

6.1.5 Layer

Menu Option	Shortcut	Reference	Toolbar
New →			Manage Layers
Embed Layers and Groups ...		see <i>Creating a new Vector layer</i> see <i>Nesting Projects</i>	
Add Vector Layer	Ctrl+Shift+V	see <i>Working with Vector Data</i>	Manage Layers
Add Raster Layer	Ctrl+Shift+R	see <i>Loading raster data in QGIS</i>	Manage Layers
Add PostGIS Layer	Ctrl+Shift+D	see <i>PostGIS Layers</i>	Manage Layers
Add SpatiaLite Layer	Ctrl+Shift+L	see <i>SpatiaLite Layers</i>	Manage Layers
Add MSSQL Spatial Layer	Ctrl+Shift+M	see <i>MSSQL Spatial Layers</i>	Manage Layers
Add WMS Layer	Ctrl+Shift+W	see <i>WMS Client</i>	Manage Layers
Add Delimited Text Layer		see <i>Delimited Text Plugin</i>	Manage Layers
Create new GPX layer		see <i>GPS Plugin</i>	Manage Layers
Add Oracle GeoRaster layer		see <i>Oracle GeoRaster Plugin</i>	Manage Layers
Add SQL Anywhere Layer		see <i>SQL Anywhere Plugin</i>	Manage Layers
Add WFS Layer			Manage Layers
Copy style		see <i>Style Tab</i>	

Continued on next page

Table 6.1 – continued from previous page

Menu Option	Shortcut	Reference	Toolbar
Paste style Open Attribute Table Save edits Toggle editing Save as... Save selection as vector file... Remove Layer Set CRS of Layer(s) Set project CRS from Layer Properties Query... Labeling Add to Overview Add All To Overview Remove All From Overview Show All Layers Hide All Layers	Ctrl+D Ctrl+Shift+C Ctrl+Shift+O Ctrl+Shift+U Ctrl+Shift+H	see Style Tab See Working with the Attribute Table	<i>Attributes</i> <i>Digitizing</i> <i>Digitizing</i> <i>Manage Layers</i> <i>Manage Layers</i> <i>Manage Layers</i>

6.1.6 Settings

Menu Option	Shortcut	Reference	Toolbar
Panels → Toolbars → Toggle Full Screen Mode Project Properties ... Custom CRS ... Style Manager... Configure shortcuts ... Customization ... Options ... Snapping Options ...	Ctrl+F Ctrl+Shift+P	see Panels and Toolbars see Panels and Toolbars see Projects see Custom Coordinate Reference System see Style Manager see Customization see Options	

6.1.7 Plugins

Menu Option	Shortcut	Reference	Toolbar
Fetch Python Plugins Manage Plugins Python Console GRASS →		see QGIS Plugins see Managing Plugins see GRASS GIS Integration	GRASS

6.1.8 Vector

Menu Option	Shortcut	Reference	Toolbar
<i>Analysis Tools</i> →		see fTools Plugin	
<i>Coordinate Capture</i> →		see Coordinate Capture Plugin	
<i>Data Management Tools</i> →		see fTools Plugin	
<i>Dxf2Shp</i> →		see Dxf2Shp Converter Plugin	<i>Vector</i>
<i>Geometry Tools</i> →		see fTools Plugin	
<i>Geoprocessing Tools</i> →		see fTools Plugin	
<i>GPS</i> →		see GPS Plugin	<i>Vector</i>
<i>Research Tools</i> →		see fTools Plugin	
<i>Road Graph</i> →		see Road Graph Plugin	
<i>Spatial Query</i> →		see Spatial Query Plugin	<i>Vector</i>

6.1.9 Raster

Menu Option	Shortcut	Reference	Toolbar
<i>Raster calculator</i>		see Raster Calculator	
<i>Georeferencer</i> →		see Georeferencer Plugin	
<i>Heatmap</i> →		see Heatmap Plugin	
<i>Interpolation</i> →		see Interpolation Plugin	
 <i>Terrain Analysis</i>		see Raster Terrain Analysis Plugin	<i>Raster</i>
<i>Zonal Statistics</i> →		see Zonal Statistics Plugin	
<i>Projections</i> →		see GDAL Tools Plugin	
<i>Conversion</i> →		see GDAL Tools Plugin	
<i>Extraction</i> →		see GDAL Tools Plugin	
<i>Analysis</i> →		see GDAL Tools Plugin	
<i>Miscellaneous</i> →		see GDAL Tools Plugin	
<i>GdalTools settings</i>		see GDAL Tools Plugin	

6.1.10 Database

Menu Option	Shortcut	Reference	Toolbar
<i>DB manager</i> →		see DB Manager Plugin	<i>Database</i>
<i>eVis</i> →		see eVis Plugin	<i>Database</i>
<i>Offline Editing</i> →		see Offline Editing Plugin	<i>Database</i>
<i>Split</i> →		see SPIT Plugin	<i>Database</i>

6.1.11 Web

Menu Option	Shortcut	Reference	Toolbar
<i>MapServer Export ...</i> →		see MapServer Export Plugin	<i>Web</i>
<i>OpenStreetMap</i> →		see OpenStreetMap	<i>OpenStreetMap</i>

6.1.12 Help

Menu Option	Shortcut	Reference	Toolbar
 <i>Help Contents</i>	F1		<i>Help</i>
 <i>What's This?</i>	Shift+F1		<i>Help</i>
<i>API Documentation</i>			
 <i>QGIS Home Page</i>	Ctrl+H		
 <i>Check QGIS Version</i>			
 <i>About</i>			
 <i>QGIS Sponsors</i>			

Please note that for Linux  the Menu Bar items listed above are the default ones in KDE window manager. In GNOME, Settings menu is missing and its items are to be found here:

 <i>Project Properties</i>	<i>File</i>
 <i>Options</i>	<i>Edit</i>
 <i>Configure Shortcuts</i>	<i>Edit</i>
<i>Style Manager</i>	<i>Edit</i>
 <i>Custom CRS</i>	<i>Edit</i>
<i>Panels →</i>	<i>View</i>
<i>Toolbars →</i>	<i>View</i>
<i>Toggle Full Screen Mode</i>	<i>View</i>
<i>Tile scale slider</i>	<i>View</i>
<i>Live GPS tracking</i>	<i>View</i>

6.2 Toolbar

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 popup help available. Hold your mouse over the item and a short description of the tool's purpose will be displayed.

Every menubar can be moved around according to your needs. Additionally every menubar can be switched off using your right mouse button context menu holding the mouse over the toolbars (read also [Panels and Toolbars](#)).

Tip: Restoring toolbars

If you have accidentally hidden all your toolbars, you can get them back by choosing menu option *Settings → Toolbars →*. If a toolbar disappears under Windows, which seems to be a problem in QGIS from time to time, you have to remove `\HKEY_CURRENT_USER\Software\QuantumGIS\qgis\UI\state` in the registry. When you restart QGIS, the key is written again with the default state, and all toolbars are visible again.

6.3 Map Legend

The map legend area lists all the layers in the project. The checkbox in each legend entry can be used to show or hide the layer.

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.

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

1. Right click in the legend window and choose *Add 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 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.

Right mouse button menu for raster layers

- *Zoom to layer extent*
- *Zoom to best scale (100 %)*
- *Show in overview*
- *Remove*
- *Set Layer CRS*
- *Set Project CRS from Layer*
- *Properties*
- *Rename*
- *Copy Style*
- *Add New Group*
- *Expand all*
- *Collapse all*
- *Update Drawing Order*

Additionally, according to layer position and selection

- *Make to toplevel item*
- *Group Selected*

Right mouse button menu for vector layers

- *Zoom to layer extent*
- *Show in overview*
- *Remove*
- *Set Layer CRS*
- *Set Project CRS from Layer*
- *Open attribute table*
- *Toggle editing* (not available for GRASS layers)
- *Save as*
- *Save selection as*
- *Query*
- *Show Feature Count*
- *Properties*

- *Rename*
- *Copy Style*
- *Add New Group*
- *Expand all*
- *Collapse all*
- *Update Drawing Order*

Additionally, according to layer position and selection

- *Make to toplevel item*
- *Group Selected*

Right mouse button menu for layer groups

- *Zoom to group*
- *Remove*
- *Set group CRS*
- *Rename*
- *Add New Group*
- *Expand all*
- *Collapse all*
- *Update Drawing Order*

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 are also able to delete more than one Layer or Group at once by selecting several Layers with the `Ctrl` key and pressing `Ctrl+D` afterwards. This way all selected Layers or groups will be removed from the layerlist.

6.3.1 Working with the Legend independent layer order

Since QGIS 1.8 there is a widget that allows to define a legend independent drawing order. You can activate it in the menu *Settings → Panels*. Determine the drawing order of the layers in the map view here. Doing so makes it possible to order your layers in order of importance, for example, but to 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.

6.4 Map View

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 zoomed in and out. Various other operations can be performed on the map as described in the toolbar 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.

Tip: 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 mouse cursor position is the center where the zoom occurs. You can customize the behavior of the mouse wheel zoom using the *Map tools* tab under the *Settings → Options* menu.

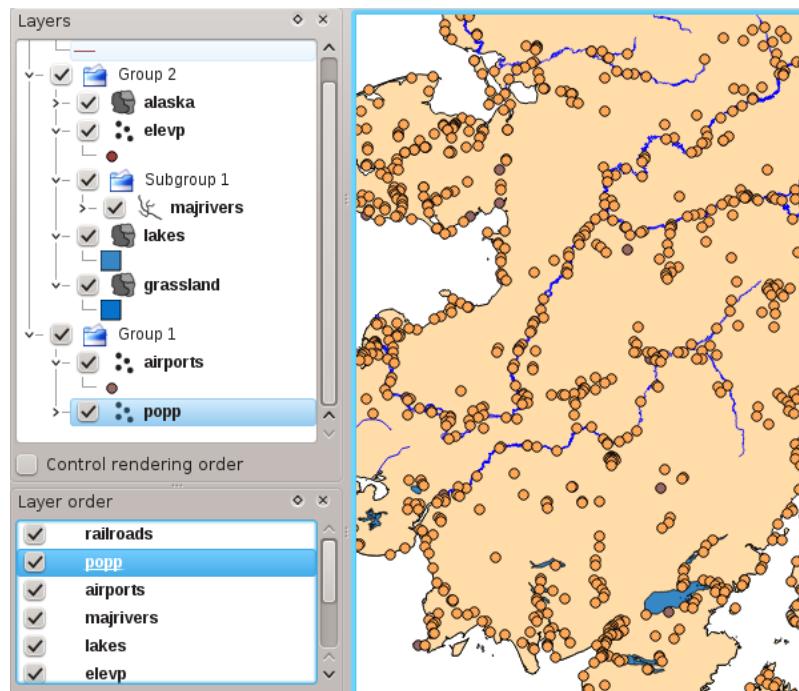


Figure 6.2: Define a legend independent layer order 

Tip: Panning the Map with the Arrow Keys and Space Bar

You can use the arrow keys to pan in 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: just move the mouse while holding down space bar.

6.5 Status Bar

The status bar shows you your current position in map coordinates (e.g. meters or decimal degrees) as the mouse pointer is moved across the map view. To the left of the coordinate display in the status bar is a small button that will toggle between showing coordinate position or the view extents of the map view as you pan and zoom in and out.

Next to the coordinate display you find the scale display. It shows the scale of the map view. If you zoom in or out QGIS shows you the current scale. Since QGIS 1.8 there is a scale selector which allows you to choose between predefined scales from 1:500 until 1:1000000.

A progress bar in the status bar shows progress of rendering as each layer is drawn to the map view. In some cases, such as the gathering of statistics in raster layers, the progress bar will be used to show the status of lengthy operations.

If a new plugin or a plugin update is available, you will see a message at the far right of the status bar. On the right side of the status bar is a small checkbox which can be used to temporarily prevent layers being rendered to the map view (see Section [Rendering](#) below). The icon  immediately stops the current map rendering process.

To the right of the render functions you find the EPSG code of the current project CRS and a projector icon. Clicking on this opens the projection properties for the current project.

Tip: Calculating the correct Scale of your Map Canvas

When you start QGIS, degrees is the default unit, and it tells QGIS that any coordinate in your layer is in degrees.

To get correct scale values, you can either change this to meter manually in the *General* tab under *Settings* → *Project Properties* or you can select a project Coordinate Reference System (CRS) clicking on the  CRS status icon in the lower right-hand corner of the statusbar. In the last case, the units are set to what the project projection specifies, e.g. '+units=m'.

General Tools

7.1 Keyboard shortcuts

QGIS provides default keyboard shortcuts for many features. You find them in Section [Menu Bar](#). Additionally the menu option *Settings → Configure Shortcuts* allows to change the default keyboard shortcuts and to add new keyboard shortcuts to QGIS features.

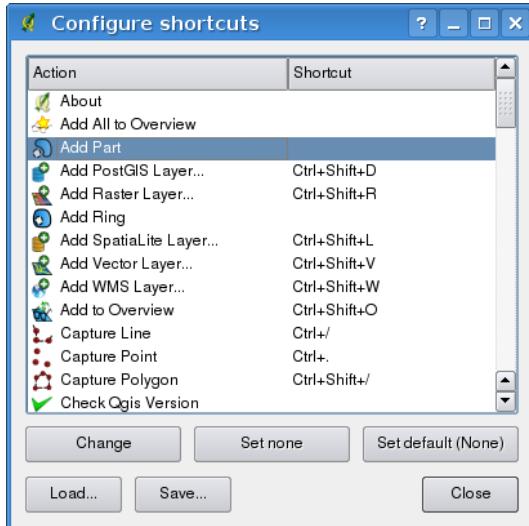


Figure 7.1: Define shortcut options

Configuration is very simple. Just select a feature from the list and click on [**Change**], [**Set none**] or [**Set default**]. Once you have found your configuration, you can save it as XML file and load it to another QGIS installation.

7.2 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.

7.3 Rendering

By default, QGIS renders all visible layers whenever the map canvas must be 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.

7.3.1 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 dependency rendering, open the *Properties* dialog by double-clicking on the layer in the legend. On the *General* tab, set the minimum and maximum scale values and then click on the *Use scale dependent rendering* checkbox.

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.

7.3.2 Controlling Map Rendering

Map rendering can be controlled in the following ways:

Suspending Rendering

To suspend rendering, click the *Render* checkbox in the lower right corner of the statusbar. 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:

- Add many layers and symbolize them prior to drawing
- Add one or more large layers and set scale dependency before drawing
- Add one or more large layers and zoom 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* → *Options* → and click on the *Rendering* tab. Uncheck the *By default new layers added to the map should be displayed* checkbox. Any layer 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.

Note: It is currently not possible to stop rendering - this was disabled in qt4 port because of User Interface (UI) problems and crashes.

Updating the Map Display During Rendering

You can set an option to update the map display as features are drawn. By default, QGIS does not display any features for a layer until the entire layer has been rendered. To update the display as features are read from the datastore, choose menu option *Settings → Options* click on the *Rendering* tab. Set the feature count to an appropriate value to update the display during rendering. Setting a value of 0 disables update during drawing (this is the default). Setting a value too low will result in poor performance as the map canvas is continually updated during the reading of the features. A suggested value to start with is 500.

Influence Rendering Quality

To influence the rendering quality of the map you have 2 options. Choose menu option *Settings → Options* click on the *Rendering* tab and select or deselect following checkboxes.

- *Make lines appear less jagged at the expense of some drawing performance*
- *Fix problems with incorrectly filled polygons*

7.4 Measuring

Measuring works within projected coordinate systems (e.g., UTM) and unprojected data. If the loaded map is defined with a geographic coordinate system (latitude/longitude), the results from line or area measurements will be incorrect. To fix this you need to set an appropriate map coordinate system (See Section [Working with Projections](#)). All measuring modules also 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 measure tool click on  and select the tool you want to use.

7.4.1 Measure length, areas and angles

 QGIS is able to measure real distances between given points according to a defined ellipsoid. To configure this, choose menu option *Settings → Options*, click on the *Map tools* tab and choose the appropriate ellipsoid. There you can also define a rubberband color and your preferred measurement units (meters or feet) and angle units (degrees, radians and gon). The tools 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.

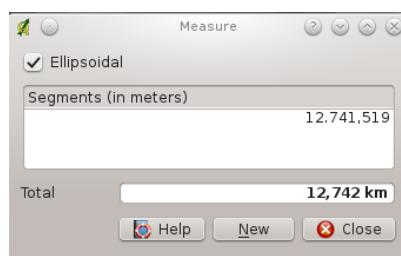


Figure 7.2: Measure Distance 

 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.



Figure 7.3: Measure Area  (KDE)

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



Figure 7.4: Measure Angle  (KDE)

7.4.2 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 single feature
-  Select features 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.

7.5 Decorations

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

Note: Before QGIS 1.8 the same functionality was provided by the Decoration Plugin.

7.5.1 Copyright Label

 *Copyright label* adds a Copyright label using the text you prefer to the map.

1. Select from menu *View → Decorations → Copyright Label*. The dialog starts (see [figure_decorations_1](#)).
2. Enter the text you want to place on the map. You can use HTML as shown in the example
3. Choose the placement of the label from the *Placement* ‘Bottom Right’ drop-down box



Figure 7.5: The copyright Dialog 

4. Make sure the *Enable Copyright Label* checkbox is checked
5. Click [OK]

In the example above (default) QGIS places a copyright symbol followed by the date in the lower right hand corner of the map canvas.

7.5.2 North Arrow

 *North Arrow* places a simple north arrow on the map canvas. At present 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.

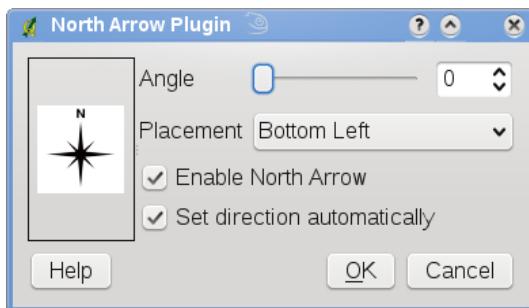


Figure 7.6: The North Arrow Dialog 

7.5.3 Scale Bar

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

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* → *Decorations* → *Scale Bar* The dialog starts (see [figure_decorations_3](#))

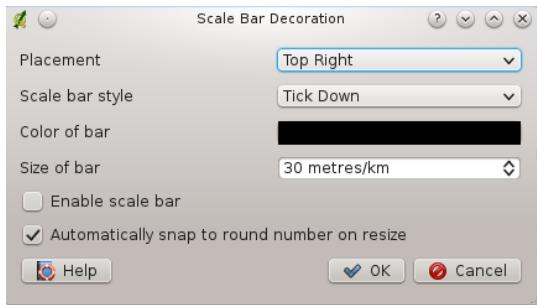


Figure 7.7: The Scale Bar Dialog 

2. Choose the placement from the *Placement* ‘Bottom Left’ drop-down list
3. Choose the style from the *Scale bar style* ‘Tick Down’ list
4. Select the color for the bar *Color of bar* ‘black’ or use the default black color
5. Set the size of the bar and its label *Size of bar* ‘30 degrees’
6. Make sure the *Enable scale bar* checkbox is checked
7. Optionally choose to automatically snap to a round number when the canvas is resized *Automatically snap to round number on resize*
8. Click [OK]

Tip: Settings of Decorations

When you save a .qgs project, any changes you have made to NorthArrow, ScaleBar and Copyright will be saved in the project and restored the next time you load the project.

7.6 Annotation Tools

The  *Text Annotation* tools 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.

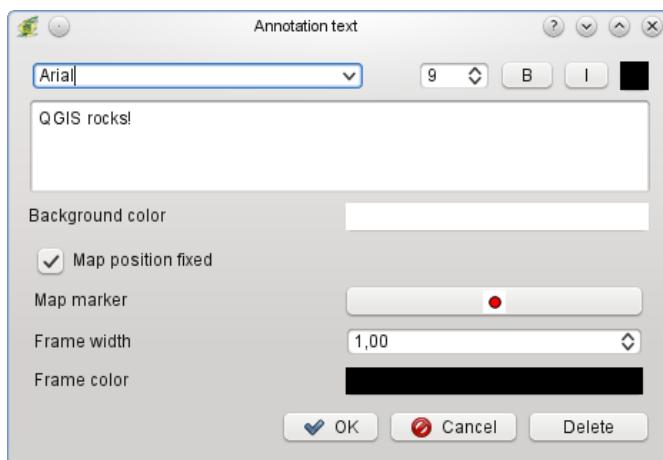


Figure 7.8: Annotation text dialog 

Double click on the item opens a dialog with various options. There is the text editor to enter the formatted text and other item settings. E.g. 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 (drag the map marker) or by moving only the balloon. The icons are part of GIS theme, and are used by default in the other themes too.

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

7.6.1 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](#)). It is similar to the designer forms for the *Identify features* tool, but displayed in an annotation item. Also see QGIS blog <http://blog.qgis.org/node/143> for more information.

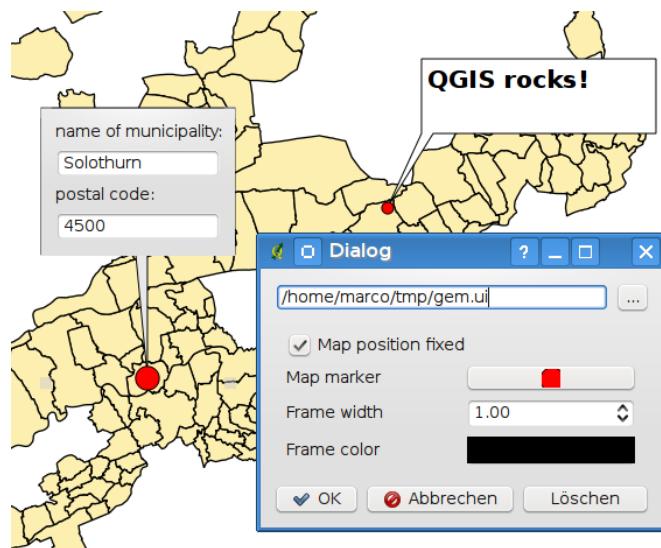


Figure 7.9: Customized qt designer annotation form 

Note: 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.

7.7 Spatial Bookmarks

Spatial Bookmarks allow you to “bookmark” a geographic location and return to it later.

7.7.1 Creating a Bookmark

To create a bookmark:

1. Zoom or pan to the area of interest.
2. Select the menu option *View → New Bookmark* or press **Ctrl+B**.
3. Enter a descriptive name for the bookmark (up to 255 characters).
4. Press **Enter** to add the bookmark or **[Delete]** to remove the bookmark.

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

7.7.2 Working with Bookmarks

To use or manage bookmarks, select the menu option *View → Show Bookmarks*. The *Geospatial Bookmarks* dialog allows you to zoom to or delete a bookmark. You can not edit the bookmark name or coordinates.

7.7.3 Zooming to a Bookmark

From the *Geospatial Bookmarks* dialog, select the desired bookmark by clicking on it, then click [**Zoom To**]. You can also zoom to a bookmark by double-clicking on it.

7.7.4 Deleting a Bookmark

To delete a bookmark from the *Geospatial Bookmarks* dialog, click on it then click [**Delete**]. Confirm your choice by clicking [**Yes**] or cancel the delete by clicking [**No**].

7.8 Nesting Projects

If you want to embed content from other project files into your project you can choose *Layer → Embed Layers and Groups*.

7.8.1 Embedding layers

The following dialog allows you to embed layers from other projects:

1. Press  to look for another project from the Alaska dataset.
2. Select the project file `grassland`. You can see the content of the project (see [figure_embed_dialog](#)).
3. Press `Ctrl` and klick on the layers `regions` and `grassland`. The layers are embedded in the map legend and the map view now.

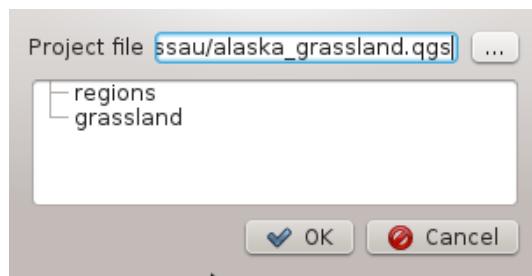


Figure 7.10: Select layers and groups to embed 

While the embedded layers are editable you can't change its properties like Style and Labeling.

Removing embedded layers

Right-click on the embedded layer and choose  `Remove`.

QGIS Configuration

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

8.1 Panels and Toolbars

In the *Panels*→ menu you can switch on and off QGIS widgets. The *Toolbars*→ menu provides the possibility to switch on and off icon groups in the QGIS toolbar (see figure_panels_toolbars).

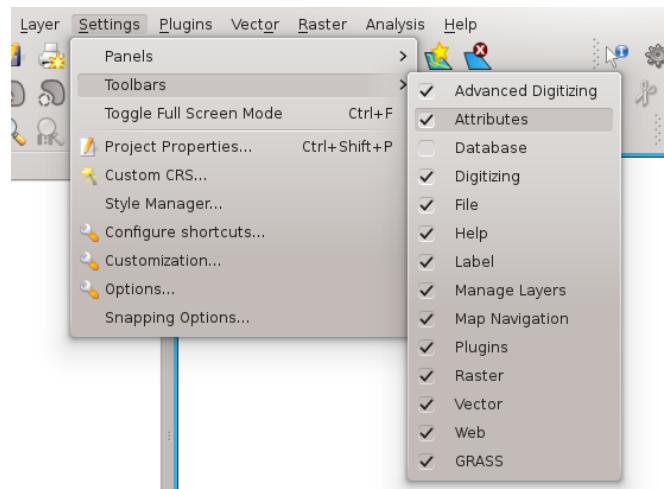


Figure 8.1: The Panels and Toolbars menu 🐧

Tip: Activating the QGIS Overview

In QGIS you can use an overview panel that provides a full extent view of layers added to it. It can be selected under the menu *Settings* → *Panels*. 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 labeling. If you click and drag the red rectangle in the overview that shows your current extent, the main map view will update accordingly.

Tip: Show Log Messages

Since QGIS 1.8 it's possible to track the QGIS messages. You can activate *Log Messages* in the menu *Settings* → *Panels* and follow the messages in the *General* and *Plugin* tab during loading and operation.

8.2 Project Properties

In the properties window for the project under *Settings* → *Project Properties* or *Settings* → *Project Properties* you set project specific options. These include:

- In the *General* tab the project title, selection and background color, layer units, precision, and the option to save relative paths to layers can be defined. You can define the layer units (only used when CRS transformation is disabled) and the precision of decimal places to use.
- The *CRS Coordinate Reference System* tab enables you to choose the CRS 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 third *Identifiable layers* tab you set (or disable) which layers will respond to the identify tool. (See the Map tools paragraph from the *Options* section to enable identifying of multiple layers.)
- The tab *OWS Server* allows to define information about the QGIS mapserver Service Capabilities, the Extent and the CRS Restrictions as well as the WFS Capabilities. Activating the *Add WKT geometry to feature info response* will allow to query the WMS layers.

8.3 Options

Some basic options for QGIS can be selected using the *Options* dialog. Select the menu option *Settings* → *Options*. The tabs where you can optimize your options are:

8.3.1 General Tab

- *Prompt to save project changes when required*
- *Warn when opening a project file saved with an older version of QGIS*
- Change Selection and Background color
- Change the QGIS Style
- Change the icon theme (choose between ‘default’, ‘classic’ and ‘gis’)
- Change icon size between 16, 24 and 32 pixel.
- Change the menu size
- Define double click action in legend (choose between ‘open layer properties’ and ‘open ’) attribute table.
- *Capitalize layer names in legend*
- *Display classification attribute names in legend*
- *Create raster icons in legend*
- *Hide splash screen at startup*
- *Show tips at startup*
- *Open identify results in a dock window (QGIS restart required)*
- *Open snapping options in a dock window (QGIS restart required)*
- *Open attribute table in a dock window*
- *Add PostGIS layers with double click and select in extended mode*
- *Add new layers to selected or current group*

- *Copy geometry in WKT representation from attribute table*
- *Attribute table behavior* (choose between ‘Show all features’ (default), ‘Show selected features’, ‘Show features in current canvas’)
- *Attribute table row cache*
- Define *Representation for NULL values*
- *Prompt for raster sublayers*  . 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 is 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
- *Scan for valid items in the browser dock*  . The ‘Check extension’ option was designed to speed up the loading of a directory, which can be time-consuming when ‘Check file contents’ is activated and there are many files (tens or hundreds).
- *Scan for contents of compressed files (.zip) in browser dock*  This option was also designed to speed up the loading of a directory. You have the following choices:
 - ‘Basic Scan’: checks that the extension is supported by one of the drivers
 - ‘Full Scan’: opens every file to check it is valid
 - ‘Passthru’: don’t use this option it will be removed in the next QGIS version

8.3.2 GDAL tab

GDAL is a data exchange library for raster files. In this tab you can define which GDAL driver to be used for a raster format as in some cases more than one GDAL driver is available.

8.3.3 Plugins tab

- Add *Path(s)* to search for additional C++ plugin libraries.

8.3.4 Rendering Tab

- *By default new layers added to the map should be displayed*
- Define *Number of features to draw before updating the display*.
- *Use render caching where possible to speed up redraws*
- *Make lines appear less jagged at the expense of some drawing performance*
- *Fix problems with incorrectly filled polygons*
- *Use new generation symbology for rendering*
- Define the default Raster settings for visualisation: ‘RGB band selection’, *Use standard deviation* and ‘Contrast Enhancement’

- Add/remove *Path(s) to search for Scalable Vector Graphics (SVG) symbols*

Additionally you can define whether to save the path for svg textures absolute or relative in the *General* tab of the *Settings → Project Properties* menu.

8.3.5 Map tools Tab

- The *Mode* setting determines which layers will be shown by the Identify tool. By switching to ‘Top down’ or ‘Top down, stop at first’ instead of ‘Current layer’ attributes for all identifiable layers (see the Project properties section under: *Projects* to set which layers are identifiable) will be shown with the Identify tool.
 - *Open feature form, if a single feature is identified*
- Define *Search radius for identifying and displaying map tips as a percentage of the map width*
- Define *Ellipsoid for distance calculations*
- Define *Rubberband color* for measure tools
- Define *Decimal places*
- *Keep base unit*
- *Define preferred measurement units ('meters' or 'feet')*
- *Define preferred angle units ('Degrees', 'Radians' or 'Gon')*
- Define *Mouse wheel action*  (‘Zoom’, ‘Zoom and recenter’, ‘Zoom to mouse cursor’, ‘Nothing’)
- Define *Zoom factor* for wheel mouse

8.3.6 Overlays Tab

- Define *Placement algorithm*  for labels, symboly and diagrams (choose between ‘Central point’ (standard), ‘Chain’, ‘Popmusic tabu chain’, ‘Popmusic tabu’ and ‘Popmusic chain’)

8.3.7 Digitizing Tab

- Define Rubberband *Line color* and *Line width*
- Define *Default snap mode*  (‘To vertex’, ‘To segment’, ‘To vertex and segment’)
- Define *Default snapping tolerance* in map units or pixel
- Define search radius for vertex edits in ‘map units’ or ‘pixel’
- *Show markers only for selected features*
- Define vertex *Marker style*  (‘Cross’ (default), ‘Semi transparent circle’ or ‘None’) and vertex *Marker size*.
- *Suppress attributes pop-up windows after each created feature*
- *Reuse last entered attribute values*
- *Validate geometries* Editing complex lines/polygons with many nodes can end up with very slow rendering. This is because the default validation procedures in QGIS can use 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.

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 from GEOS 3.3 .

- *Join style for curve offset*
- *Quadrantsegments for curve offset*
- *Miter limit for curve offset*

8.3.8 CRS Tab

The CRS tab is divided in two areas. The first area allows to define the default CRS for new projects.

- Select a CRS and *Always start new projects with this CRS*.
- *Enable on the fly re-projection by default*

The second area allows to define the action, when a new layer is created, or when a layer without CRS is loaded.

- *Prompt for Coordinate Reference System (CRS)*
- *Use project Coordinate Reference System (CRS)*
- *Use default Coordinate Reference System (CRS) displayed below*

8.3.9 Locale Tab

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

8.3.10 Network Tab

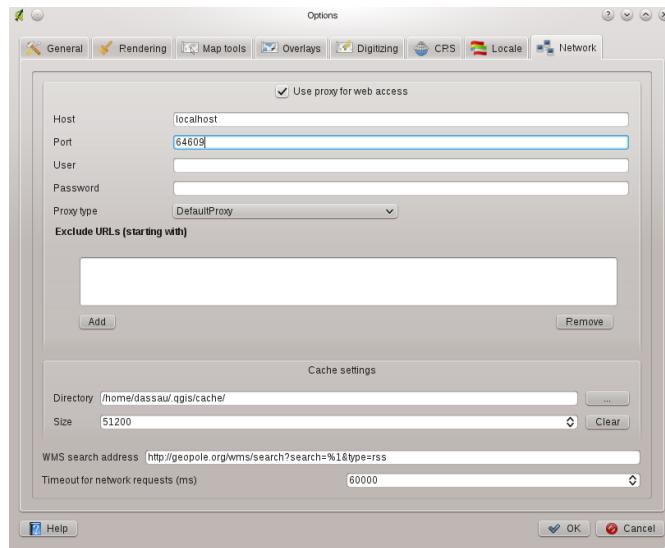


Figure 8.2: Proxy-settings in QGIS

- *Use 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
- *FtpCachingProxy*: Implemented using an FTP proxy, it is useful only in the context of FTP requests
- Define *Cache settings* (path and size)
- Define *WMS search address*, default is `http://geopole.org/wms/search?search=%1&type=rss`
- Define *Timeout for network requests (ms)* - default is 60000

Excluding some URLs can be added to the text box below the proxy-settings (see [Figure_Network_Tab](#)) by pressing the **[Add]** button. After that double-click into the just created URL-field and enter the URL you would like to exclude from using the proxy. Obviously the button **[Remove]** removes the selected entry.

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>.

Tip: Using Proxies

Using proxies can sometimes be tricky. It is useful to ‘trial and error’ the above proxy types and check 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.

- settings are saved in a texfile: `$HOME/.config/QuantumGIS/qgis.conf`
- you can find your settings in: `$HOME/Library/Preferences/org.qgis.qgis.plist`
- settings are stored in the registry under:

`\HKEY_CURRENT_USER\Software\QuantumGIS\qgis`

8.4 Customization

The customization tool is a new development in QGIS 1.8.. It lets you (de)activate almost every element in the QGIS user interface. This can get very useful if you have a lot of plug-ins installed that you never use and that are filling your screen.

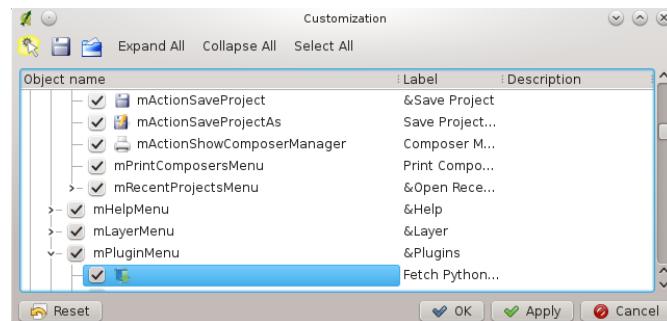


Figure 8.3: The Customization dialog

QGIS Customization is divided into five groups. In **Docks** you find the dock windows. Dock windows are applications that can be started and used as a floating, top-level window or embedded to the QGIS main window

as a docked widget (see also [Panels and Toolbars](#)). In [Menus](#) you can hide entries in the Menu bar. In the [Status Bar](#) features like the coordinate information can be deactivated. In [Toolbars](#) you can (de)activate the toolbar icons of QGIS and in [Widgets](#) you can (de)activate dialogs as well as their buttons.

With [Switch to catching widgets in main application](#) you can click on elements in QGIS you want to be hidden and find the corresponding entry in Customization (see [figure_customization](#)). You can also save your various different setups for different use cases as well. Before your changes are applied, you need to restart QGIS.

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 these features allow the user to display layers with different CRS and have them overlay properly.

9.1 Overview of Projection Support

QGIS has support for approximately 2,700 known CRS. Definitions for each of these 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 CRS are stored in a user database. See Section [Custom Coordinate Reference System](#) for information on managing your custom coordinate reference systems.

The CRS 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, your data must contain information about its coordinate reference system or you have 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 used layer units will automatically be changed in the *General* tab of the  *Project Properties* dialog under the *Edit* (Gnome, OSX) or *Settings* (KDE, Windows) menu.

9.2 Specifying a Projection

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 comes predefined in QGIS. This default can be changed using the **[Select...]** button in the first section, used to defining the Default Coordinate Reference System to use when starting 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 *Edit* →  *Options* (Gnome, OSX) or *Settings* →  *Options* (KDE, Windows).

The options shown in [figure_projection_1](#) are:

-  *Prompt for CRS*

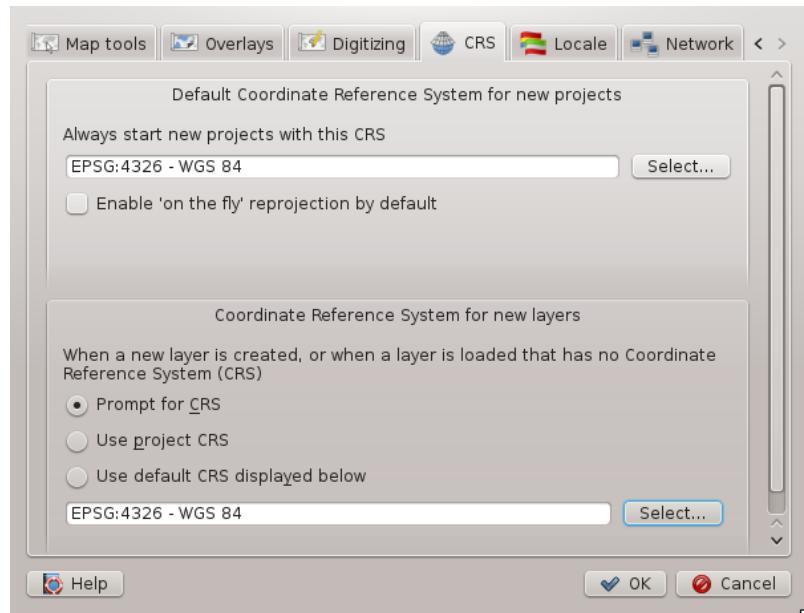


Figure 9.1: CRS tab in the QGIS Options Dialog 

- *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 (see [General Tab](#)) and vector (see [General Tab](#)) properties dialog. If your layer already has a CRS defined, it will be displayed as shown in [Vector Layer Properties Dialog](#).

Tip: CRS in the Map Legend

Right-clicking on a layer in the Map Legend (Section [Map Legend](#)) provides two CRS short cuts. *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

9.3 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 achieve this end:

1. Select  *Project Properties* from the *Edit* (Gnome, OSX) or *Settings* (KDE, Windows) menu.
2. Click on the  *CRS status* icon in the lower right-hand corner of the statusbar.
3. Turn OTF on by default, by selecting the *CRS* tab of the *Options* dialog and selecting *Enable 'on the fly' reprojection by default*.

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

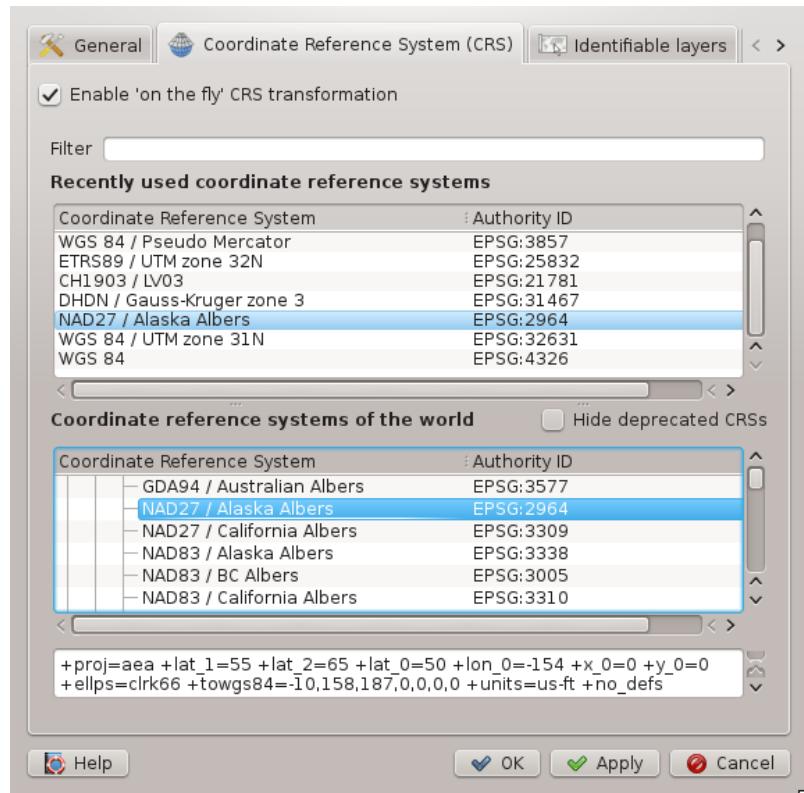


Figure 9.2: Projection Dialog

The *Coordinate Reference System* 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. **Coordinate Reference System** - this is a list of all CRS 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.
3. **Proj4 text** - this is the CRS string used by the Proj4 projection engine. This text is read-only and provided for informational purposes.
4. **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.
5. **Recently used CRS** - if you have certain CRS that you frequently use in your everyday GIS work, these will be displayed in the table at the bottom of the Projection Dialog. Click on one of these buttons to select the associated CRS.

Tip: Project Properties Dialog

If you open the *Project Properties* dialog from the *Edit* (Gnome, OSX) or *Settings* (KDE, Windows) menu, you must click on the *Coordinate Reference System* tab to view the CRS settings.

Opening the dialog from the *CRS status* icon will automatically bring the *Coordinate Reference System* tab to the front.

9.4 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 *Edit* (Gnome, OSX) or *Settings* (KDE, Windows) menu. Custom CRS are stored in your QGIS user database. In addition to your custom CRS, this database also contains your spatial bookmarks and other custom data.

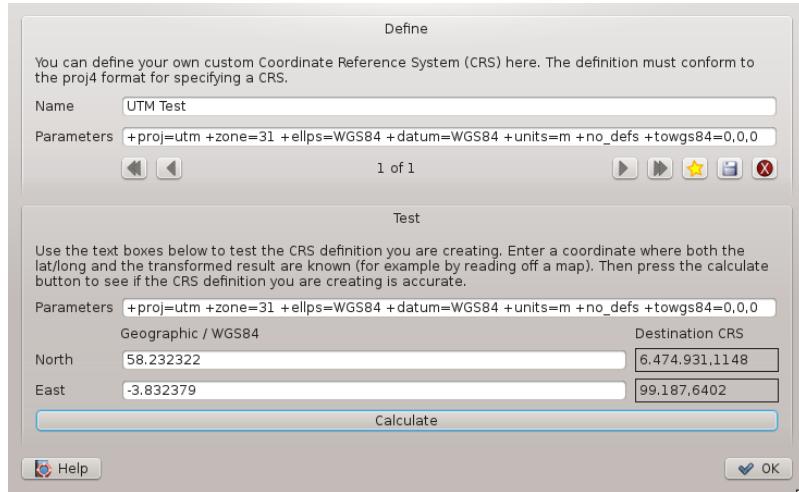


Figure 9.3: Custom CRS Dialog

Defining a custom CRS in QGIS requires a good understanding of the Proj.4 projection library. To begin, refer to the *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 and
2. the cartographic parameters in PROJ.4 format.

To create a new CRS, click the *New* button and enter a descriptive name and the CRS parameters. After that you can save your CRS by clicking the *Save* button.

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 by clicking on the **[Calculate]** button inside the *Test* block and pasting your CRS parameters into the *Parameters* field. Then 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.

QGIS Browser

The QGIS Browser is a new panel in QGIS that lets you easily navigate in your database. You can have access to common vector files (e.g. ESRI shapefile or MapInfo files), databases (e.g. PostGIS or MSSQL Spatial) and WMS/WFS connections. You can also view your GRASS data (to get the data into QGIS see [GRASS GIS Integration](#)).

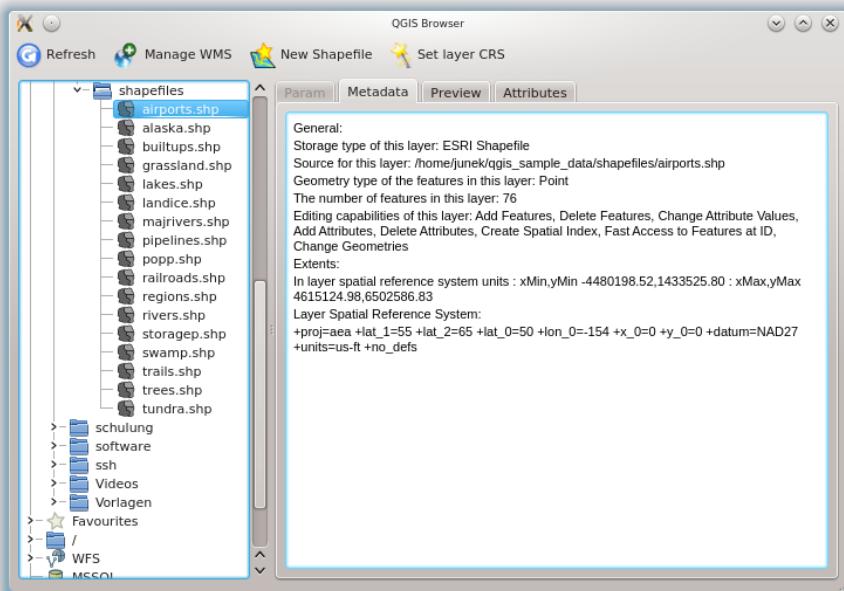


Figure 10.1: Qgis browser as a standalone application to view metadata, preview and attributes 

Use QGIS Browser to preview your data. The drag and drop function makes it easy to get your data into the Map view and the Map legend.

1. Activate QGIS Browser: Right-click on the tool bar and click *Browser*.
2. Drag the panel into the legend window.
3. Klick on the *Browser* tab.
4. Browse in your database and choose the shapefile folder from qgis_sample_data.
5. Press the Shift key and klick on airports.shp and alaska.shp .
6. Press the left mouse button then drag and drop the files into the map canvas.
7. Right-click on a layer and choose *Set project CRS from layer*. For more information see [Working with Projections](#).

8. Click on  *Zoom Full* to make the layers visible.

It's also possible to run QGIS Browser as a standalone application.

Start qgis browser

-  Type in “qbrowser” at a command prompt.
-  Start QGIS browser using the Start menu or desktop shortcut, or double click on a QGIS project file.
-  QGIS browser is not available yet from your Applications folder. However it can easily be made available. In Finder use *Go* → *Go to map...* and use it to find the folder /Applications/QGIS.app/Contents/MacOS/bin. Use the key combination option – command and drag **qbrowser.app** while holding down the left mouse button to the Applications folder. This will create a link that you can use to start QGIS browser.

In [figure_browser_standalone_metadata](#) you can see the enhanced functionality of 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 Tab](#)). 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.

Working with Vector Data

11.1 Supported Data Formats

QGIS uses the OGR library to read and write vector data formats (GRASS vector and PostgreSQL support is supplied by native QGIS data provider plugins), including ESRI Shapefiles, MapInfo and Microstation file formats; PostGIS, SpatiaLite, Oracle Spatial databases and many more. The vector data can also be loaded in read mode from zip and gzip archives into QGIS. At the date of this document, 69 vector formats are supported by the OGR library (see OGR-SOFTWARE-SUITE *Literature and Web References*). The complete list is available at http://www.gdal.org/ogr/ogr_formats.html.

Note: 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 was not build 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 and SpatiaLite layers. Many of the features available in QGIS work the same, regardless of the vector data source. This is by design and includes the identify, select, labeling and attributes functions.

11.1.1 ESRI Shapefiles

The standard vector file format used in QGIS is the ESRI Shapefile. 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>.

Loading a Shapefile

 To load a shapefile, start QGIS and click on the  Add Vector Layer toolbar button or simply type **Ctrl+Shift+V**. This will bring up a new window (see [figure_vector_1](#)).

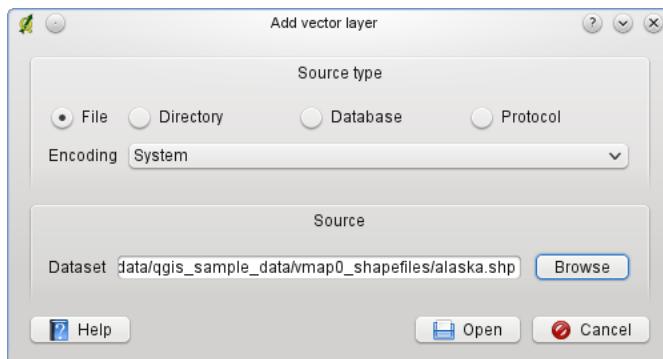


Figure 11.1: Add Vector Layer Dialog 

From the available options check **File**. Click on button [**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 type for the shapefile if desired.

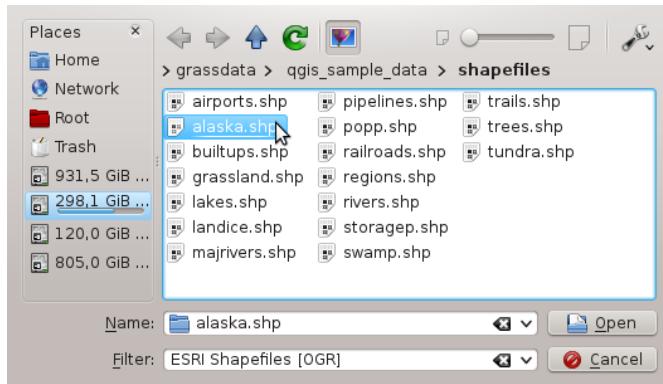


Figure 11.2: Open an OGR Supported Vector Layer Dialog 

Selecting a shapefile from the list and clicking [**Open**] loads it into QGIS. [Figure_vector_3](#) shows QGIS after loading the `alaska.shp` file.

Tip: 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 loaded, you can zoom around the shapefile 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 popup menu. See Section [Style Tab](#) for more information on setting symbology of vector layers.

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

On OS X, portable drives that are mounted besides the primary hard drive do not show up under *File → Open Project* as expected. 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 `return`. Then you can navigate to external drives and network mounts.

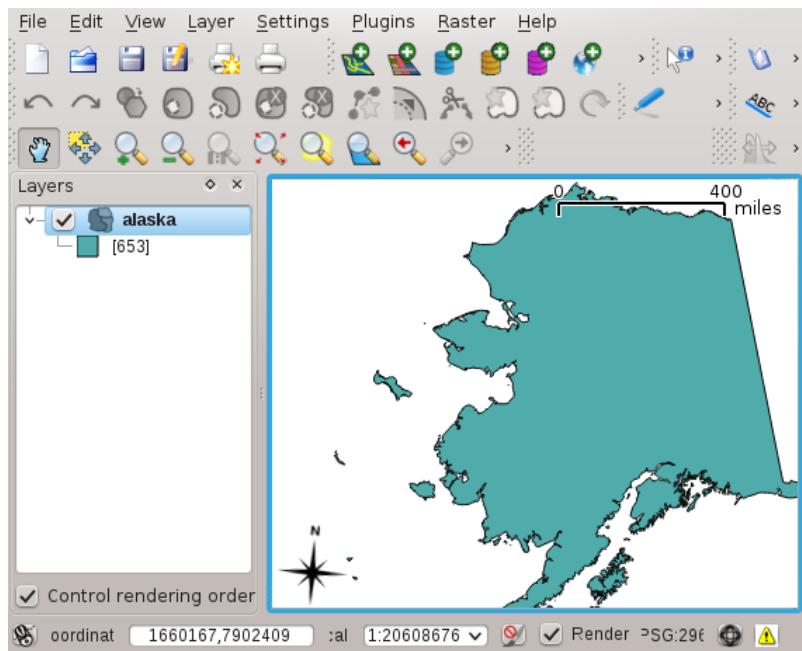


Figure 11.3: QGIS with Shapefile of Alaska loaded 

Improving Performance Shape

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.
- Open the *Layer Properties* dialog by double-clicking on the shapefile name in the legend or by right-clicking and choosing *Properties* from the popup menu.
- In the tab *General* click the **[Create Spatial Index]** button.

Problem loading a shape .prj file

If you load a shapefile with `.prj` file and QGIS is not able to read the coordinate reference system from that file, you have to define the proper projection manually within the *General* tab of the *Layer Properties* dialog of the layer. 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 that 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`.

11.1.2 Loading a MapInfo Layer

 To load a MapInfo layer, click on the  Add Vector Layer toolbar button or type `Ctrl+Shift+V`, change the file type filter *Filter*  : to 'Mapinfo File [OGR]' and select the MapInfo layer you want to load.

11.1.3 Loading an ArcInfo Binary Coverage

To load an ArcInfo binary coverage, click on the  Add Vector Layer toolbar button or press **Ctrl+Shift+V** to open the *Add Vector Layer* dialog. Select  *Directory*. Change to *Filter*  to ‘Arc/Info Binary Coverage’. Navigate to the directory that contains the coverage files and select it.

Similarly, you can load directory based vector files in the UK National Transfer Format as well as the raw TIGER Format of the US Census Bureau.

11.1.4 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 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. 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`
- **Host:** Name of the database host. This must be a resolvable host name the same 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. 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 login to the database.
- **Password:** Password used with *Username* to connect to the database.

Optional you can activate following checkboxes:

- *Save Username*
- *Save Password*
- *Only look in the geometry_columns table*
- *Only look in the ‘public’ schema*

- *Also list tables with no geometry*
- *Use estimated table metadata*

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

Tip: QGIS User Settings and Security

Depending on your computing environment, storing passwords in your QGIS settings may be a security risk. Your customized settings for QGIS are stored based on the operating system:

- , the settings are stored in your home directory in `.qgis/`.
 - , the settings are stored in the registry.
-

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, click on the  Add PostGIS 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 PostgreSQL Query Builder to further define the layer.
- Click on the [Add] button to add the layer to the map.

Tip: 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.

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 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. In this case QGIS will try to find a column in the view that is derived from a suitable table column. It does this by parsing the view definition SQL. However there are several aspects of SQL that QGIS ignores these include the use of table aliases and columns that are generated by SQL functions.

If a suitable column cannot be found, 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 int4 and either a primary key or with a unique constraint, preferably indexed).

11.1.5 Importing Data into PostgreSQL

Data can be imported into PostgreSQL/PostGIS using several tools, such as the SPIT plugin, or the command line tools `shp2pgsql` or `ogr2ogr`.

SPIT Plugin



QGIS comes with a core plugin named **SPIT** (Shapefile to PostGIS Import Tool). SPIT can be used to load multiple shapefiles at one time and includes support for schemas. See Section [SPIT Plugin](#) for more information.

shp2pgsql

PostGIS includes a 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.

Tip: 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

Beside `shp2pgsql` and **SPIT** 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 see this by typing

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

If you like to use PostgreSQL's **COPY** -command instead of the default **INSERT INTO** method you can export the following environment-variable (at least available on and):

```
export PG_USE_COPY=YES
```

ogr2ogr does not create spatial indexes like **shp2pgsql** 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.refractions.net>).

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.
```

```
Type: \copyright for distribution terms
\h for help with SQL commands
\? for help with psql commands
\g or terminate with semicolon to execute query
\q to quit
```

```
gis_data=# CREATE INDEX sidx_alaska_lakes ON alaska_lakes
gis_data-# USING GIST (the_geom GIST_GEOMETRY_OPS);
CREATE INDEX
gis_data=# VACUUM ANALYZE alaska_lakes;
VACUUM
gis_data=# \q
gsherman@madison:~/current$
```

11.1.6 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-1.4/ST_Shift_Longitude.html). As result, if we open such map in QGIS, we will see two far, distinct locations, that should show 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, right of New Zealand main islands.



Figure 11.4: Map in lat/lon crossing the 180° longitude line 🐧

A workaround 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 coordi-

nate is $< 0^\circ$ adds 360° to it. The result would be a $0^\circ - 360^\circ$ version of the data to be plotted in a 180° centric map.

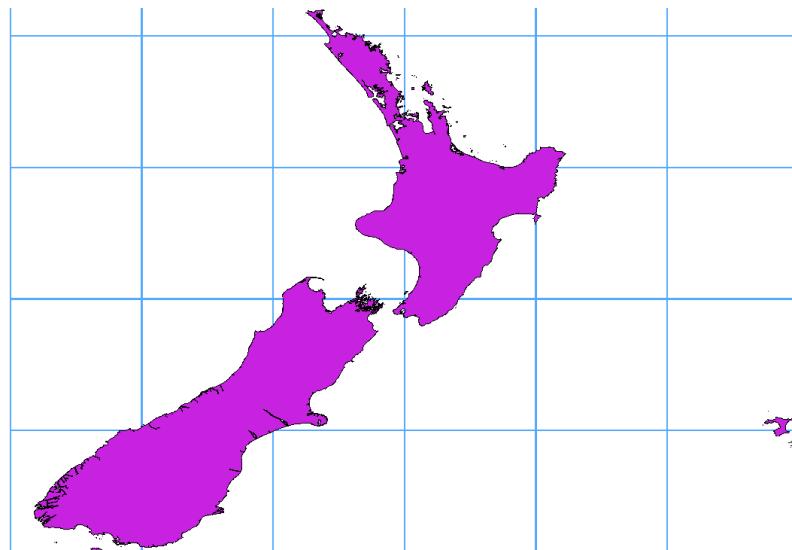


Figure 11.5: Crossing 180° longitude applying the **ST_Shift_Longitude** function 

Usage

- Import data to PostGIS (*Importing Data into PostgreSQL*) using for example the PostGIS Manager plugin or the SPIT plugin
- Use the PostGIS command line interface to issue the following command (this is an example where “TABLE” is the actual name of your PostGIS table)

```
gis_data=# update TABLE set the_geom=ST_Shift_Longitude(the_geom);
```
- If everything went right 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](#))

11.1.7 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, which will allow you to either connect to a SpatiaLite database already known to QGIS, which you can choose from the dropdown 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, 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](#).

Tip: SpatialLite data management Plugins

For SpatialLite data management you can also use several Python plugins: QSpatialLite, Spatialite Manager or DB Manager (core plugin, recommended). They can be downloaded and installed with the Plugin Installer.

11.1.8 MSSQL Spatial Layers

 QGIS also provides native MS SQL 2008 support. The  Add MSSQL Spatial Layer is part of the new toolbar button or available in the MS SQL node in the QBrowser tree, providing drag and drop import support.

11.2 The Vector Properties Dialog

The *Layer Properties* dialog for a vector layer provides information about the layer, symbology settings and labeling options. If your vector layer has been loaded from a PostgreSQL/PostGIS datastore, you can also alter the underlying SQL for the layer by invoking the *Query Builder* dialog on the *General* tab. 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 popup menu.

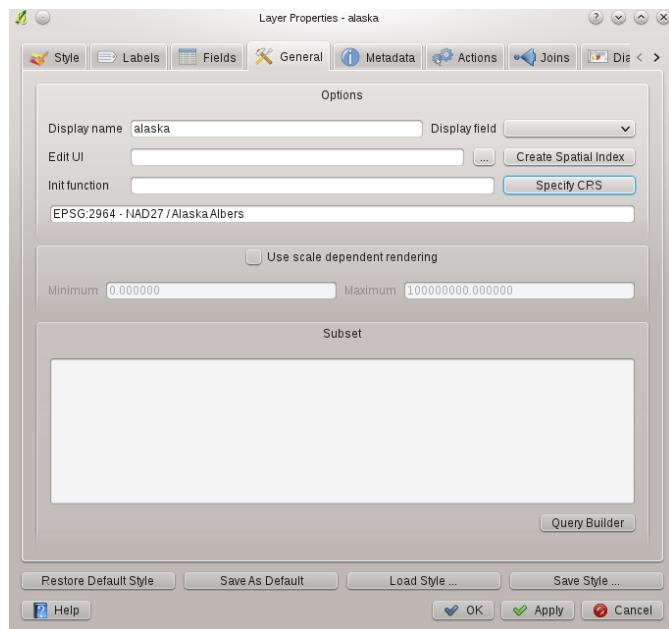


Figure 11.6: Vector Layer Properties Dialog 

11.2.1 Style Tab

 Since QGIS 1.4.0 a new symbology was integrated in parallel to improve and finally replace the old symbology. QGIS 1.8 now uses the new symbology as default, which provides a variety of improvements and new features.

A description of the old symbology is available in section [Old Symbology](#).

There are three types of symbols: marker symbols (for points), line symbols (for lines) and fill and outline symbols (for polygons). Symbols can consist of one or more symbol layers. It is possible to define the color of a symbol and this color is then defined for all symbol layers. Some layers may have the color locked - for those the color

can not be altered. This is useful when you define the color of a multilayer symbol. Similarly, it is possible to define the width for line symbols, as well as size and rotation for marker symbols.

Available symbol layer types

- Point layers
 - **Font marker:** Rendering with a font.
 - **Simple marker:** Rendering with a hardcoded marker.
 - **SVG marker:** Rendering with a SVG picture.
 - **Ellipse marker:** Rendering with ellipse shapes derived from attributes.
 - **Vector field marker:** Rendering with vector fields derived from attributes.
- Line layers
 - **Line decoration:** Add a line decoration, e.g an arrow to indicate line direction.
 - **Marker line:** A line rendered by repeating a marker symbol.
 - **Simple line:** Usual rendering of a line (with specified width color and pen style).
- Polygon layers
 - **Centroid fill:** Fill a polygon centroid with a hardcoded marker.
 - **SVG fill:** Fill a polygon with a SVG symbol.
 - **Simple fill:** Usual rendering of a polygon (with defined fill color, fill pattern and outline).
 - **Line pattern fill:** Fill a polygon with a line pattern.
 - **Point pattern fill:** Fill a polygon with a point pattern.
 - **Outline: Line decoration:** Add a line decoration, e.g an arrow to indicate line direction.
 - **Outline: Marker line:** Use a hardcoded marker as area outline.
 - **Outline: Simple line:** Define width, color and pen style as area outline.

Color ramps

Color ramps are used to define a range of colors that can be used during the creation of renderers. The symbol's color will be set from the color ramp.

There are three types of color ramps:

- **Gradient:** Linear gradient from one color to some other.
- **Random:** Randomly generated colors from a specified area of color space.
- **ColorBrewer:** Create color area from a color schema and a defined number of color classes.

Color ramps can be defined in the *Color ramp* tab of the *Style Manager* by clicking the **[Add]** button and then choosing a color ramp type (see section [vector_style_manager](#)).

Styles

A style groups a set of various symbols and color ramps. You can define your preferred or frequently used symbols, and can use it without having to recreate it everytime. Style items (symbols and color ramps) have always a name by which they can be queried from the style. There is at least one default style in QGIS (modifiable) and the user can add further styles. In the lower part of the Style tab there are four buttons for managing styles: Use **[Restore Default Style]** to get back to your default settings, **[Save As Default]** to save your style as default, **[Load Style...]** to get to your own styles and **[Save Style]** to save your own styles. Layer styles can also be transferred from one layer to another layer. Activate a layer and choose *Layer* →  *Copy style* and switch to another layer. Then choose *Layer* →  *Paste style*.

Renderers

The renderer is responsible for drawing a feature together with the correct symbol. There are four types of renderers: single symbol, categorized (called unique color in the old symbology), graduated and rule-based. There is no continuous color renderer, because it is in fact only a special case of the graduated renderer. The categorized and graduated renderer can be created by specifying a symbol and a color ramp - they will set the colors for symbols appropriately. **Working with the New Generation Symbology**

In the *Style* tab you can choose one of the five renderers: single symbol, categorized, graduated, rule-based and point displacement. For each data type (points, lines and polygons) vector symbol layer types are available (see [vector_symbol_types](#)). Depending on the chosen renderer, the symbology Depending on the chosen renderer, the *Style* tab provides different following sections. The new generation symbology dialog also provides a **[Style Manager]** button which gives access to the Style Manager (see Section [Style Manager](#)). The Style Manager allows you to edit and remove existing symbols and add new ones.

Tip: Select and change multiple symbols

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

Single Symbol Renderer

The Single Symbol Renderer is used to render all features of the layer using a single user-defined symbol. The properties, that can be adjusted in the *Style* tab, depend partially on the type of the layer, but all types share the following structure. In the top left part of the tab, there is a preview of the current symbol to be rendered. In the bottom part of the tab, there is a list of symbols already defined for the current style, prepared to be used via selecting them from the list. The current symbol can be modified using the **[Change]** button below the preview, which opens a *Symbol Properties* dialog, or the **[Change]** button right of the preview, which opens an ordinary *Color* dialog.

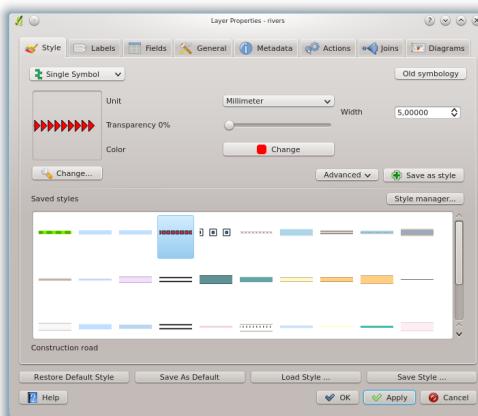


Figure 11.7: Single symbol line properties 

In the *Style* tab you can apart from a general layer transparency also define to use millimeter or map units for the size scale. In the **[Advanced]** button next to the **[Save as style]** button you can use data-defined size scale and rotation. Here the *Symbol levels* → menu allows to enable and define the order in which the symbol layers are rendered (if the symbol consists of more than one layer).

After having done any needed changes, the symbol can be added to the list of current style symbols (using the **[Save as style]** button) and then easily be used in the future. Furthermore you can use the **[Save Style]** button to save the symbol as a QGIS layer style file (.qml) or SLD file(.sl). Currently in version 1.8 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 could be very handy sometimes to have this easy way of converting styles to rule-based.

Categorized Renderer

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

- The attribute (using the Column listbox)
- The symbol (using the Symbol dialog)
- The colors (using the Color Ramp listbox)

The [Advanced] button in the lower right corner of the dialog allows to set the fields containing rotation and size scale information. For convenience, the list in the bottom part of the tab lists the values of all currently selected attributes together, including the symbols that will be rendered.

The example in [figure_symbology_2](#) shows the category rendering dialog used for the rivers layer of the QGIS sample dataset.

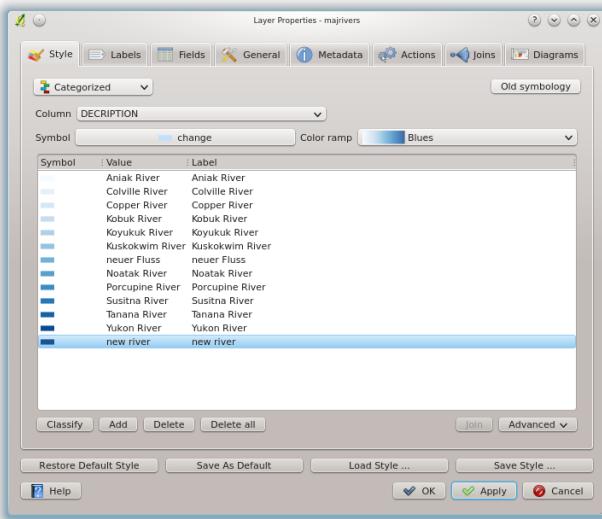


Figure 11.8: Categorized Symbolizing options 🐧

You can create a custom color ramp choosing *New color ramp...* from the Color ramp dropdown menu. A dialog will prompt for the ramp type: Gradient, Random, ColorBrewer, then each one has options for number of steps and/or multiple stops in the color ramp. See [figure_symbology_3](#) for an example of custom color ramp.

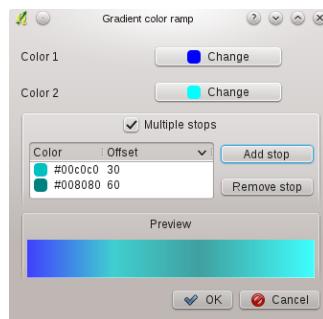


Figure 11.9: Example of custom gradient color ramp with multiple stops 🐧

Graduated Renderer

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

Like Categorized Renderer, it allows to define rotation and size scale from specified columns.

Analogue to the categorized rendered, the *Style* tab allows you to select:

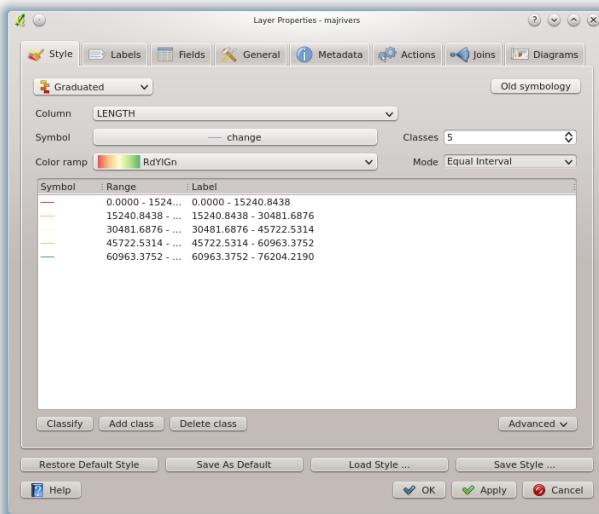


Figure 11.10: Graduated Symbolizing options 

- The attribute (using the Column listbox)
- The symbol (using the Symbol Properties button)
- The colors (using the Color Ramp list)

Additionally, you can specify the number of classes and also the mode how to classify features inside the classes (using the Mode list). The available modes are:

- Equal Interval
- Quantile
- Natural Breaks (Jenks)
- Standard Deviation
- Pretty Breaks

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

The example in [figure_symbology_4](#) shows the graduated rendering dialog for the rivers layer of the QGIS sample dataset.

Rule-based rendering

The rule-based renderer is used to render all the features from a layer, using rule based symbols, whose color reflects the classification 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 first matched rule.

The example in [figure_symbology_5](#) shows the rule-based rendering dialog for the rivers layer of the QGIS sample dataset.

To create a rule, activate an existing row by clicking on it or click on '+' and click on the new rule. Then press the **[Edit]** button. In the *Rule properties* dialog you can define a label for the rule. Press the  button to open the Expression 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 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 [Field Calculator](#)).

Point displacement

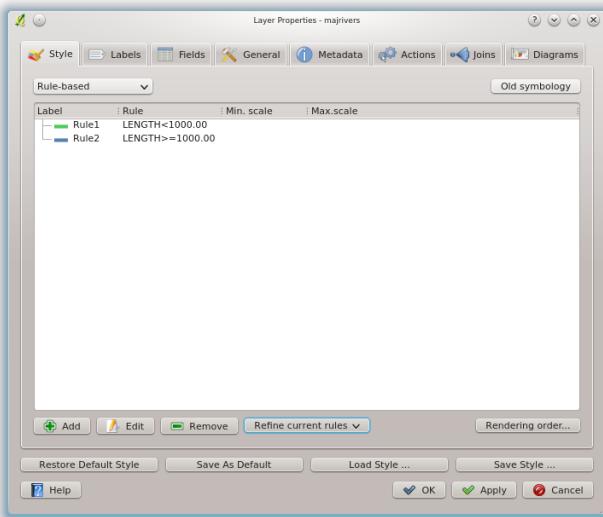


Figure 11.11: Rule-based Symbolizing options 

The point displacement renderer offers 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 a center symbol.

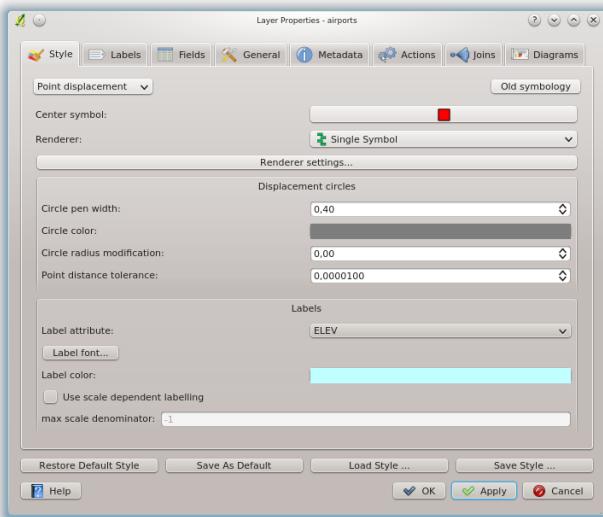


Figure 11.12: Point displacement dialog 

Symbol Properties

The symbol properties dialog allows the user to specify different properties of the symbol to be rendered. In the bottom left part of the dialog, you find a preview of the current symbol as it will be displayed in the map canvas. Above the preview is the list of symbol layers. To start the *Symbol properties* dialog, click the [ **Change...**] button in the *Style* tab of the *Layer Properties* dialog.

The buttons allow adding or removing layers, changing the position of layers, or locking layers for color changes. In the right part of the dialog, there are shown the settings applicable to the single symbol layer selected in the symbol layer list. The most important is the *Symbol Layer Type*  combobox, which allows you to choose the layer type. The available options depend on the layer type (Point, Line, Polygon). The symbol layer type options are described in section [vector_symbol_types](#). You can also change the symbol layer properties in the

right part of the dialog. For example if you have chosen an SVG marker for a point layer it is now possible to change its color using *Color* button.

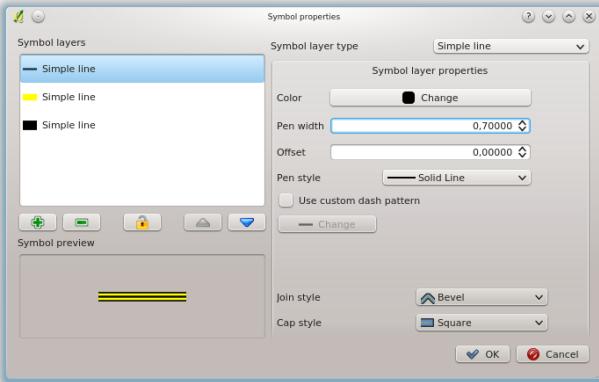


Figure 11.13: Line composed from three simple lines 

11.2.2 Style Manager

The Style Manager is a small helper application, that lists symbols and color ramps available in a style. It also allows you to add and/or remove items. To launch the Style Manager, click on *Settings → Style Manager* in the main menu. Alternatively, you can access it via the *Style* tab.

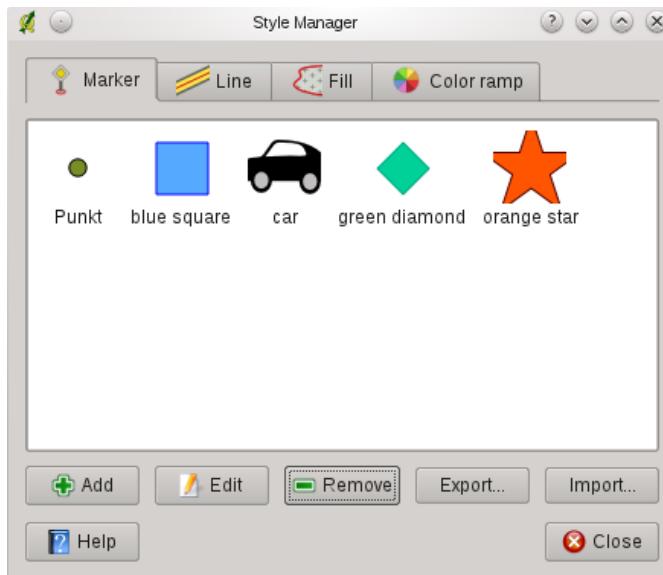


Figure 11.14: Style Manager to manage symbols and color ramps 

11.2.3 Old Symbology

Note: QGIS 1.8. still supports the usage of the old symbology, although it is recommended to switch to the new symbology, described in section [vector_new_symbology](#), because the old symbology will be removed in one of the next releases.

If you want or need to switch back to the old symbology you can click on the **[Old symbology]** button in the *Style* tab of the *Layer Properties* dialog.

You can also make the old symbology the default, deactivating  *Use new generation symbology for rendering* in the *Rendering* tab under *Settings* →  *Options*.

The old QGIS symbology supports the following renderers:

- **Single symbol** - a single style is applied to every object in the layer.
- **Graduated symbol** - objects within the layer are displayed with different symbols classified by the values of a particular field.
- **Continuous color** - objects within the layer are displayed with a spread of colours classified by the numerical values within a specified field.
- **Unique value** - objects are classified by the unique values within a specified field with each value having a different symbol.

To change the symbology for a layer, simply double click on its legend entry and the vector *Layer Properties* dialog will be shown.

Style Options

Within this dialog you can style your vector layer. Depending on the selected rendering option you have the possibility to also classify your map features.

At least the following styling options apply for nearly all renderers:

- **Fill style** - Style for filling. Beside the given brushes you can select *Fill style*:  ‘Texture’ and click the  button for selecting your own texture file. Currently the fileformats *.jpeg, *.xpm, and *.png are supported.
- **Fill color** - fill-color of your features.
- **Outline options**
 - Outline style - Pen-style for your outline of your feature. You can also set this to ‘no Pen’.
 - Outline color - color of the ouline of your feature.
 - Outline width - width of your features.

Once you have styled your layer you also could save your layer-style to a separate file (ending with *.qml). To do this, use the button [**Save Style...**]. No need to say that [**Load Style...**] loads your saved layer-style-file.

If you wish to always use a particular style whenever the layer is loaded, use the [**Save As Default**] button to make your style the default. Also, if you make changes to the style that you are not happy with, use the [**Restore Default Style**] button to revert to your default style.

Vector transparency

QGIS allows to set a transparency for every vector layer. This can be done with the slider *Transparency*  inside the *Style* tab. This is very useful for overlaying several vector layers.

11.2.4 Labels Tab

 As for the symbology QGIS 1.8 currently provides an old and a new labeling engine in parallel. The *Labels* tab still contains the old labeling. The new labeling is implemented as a core application and will replace the features of the old labels tab in one of the next versions.

We recommend to switch to the new labeling, described in section [New Labeling](#).

The old labeling in the *Labels* tab allows you to enable labeling features and control a number of options related to fonts, placement, style, alignment and buffering. We will illustrate this by labeling the lakes shapefile of the QGIS sample dataset:

1. Load the Shapefile `alaska.shp` and GML file `lakes.gml` in QGIS

2. Zoom in a bit to your favorite area with some lake
3. Make the `lakes` layer active
4. Open the *Layer Properties* dialog
5. Click on the *Labels* tab
6. Check the *Display labels* checkbox to enable labeling
7. Choose the field to label with. We will use *Field containing label*  NAMES
8. Enter a default for lakes that have no name. The default label will be used each time QGIS encounters a lake with no value in the NAMES field.
9. If you have labels extending over several lines, check *Multiline labels?*. QGIS will check for a true line return in your label field and insert the line breaks accordingly. A true line return is a **single** character \n, (not two separate characters, like a backlash \ followed by the character n). To insert line returns in an attribute field configure the edit widget to be text edit (not line edit).
10. Click **[Apply]**.

Now we have labels. How do they look? They are probably too big and poorly placed in relation to the marker symbol for the lakes.

Select the `Font` entry and use the **[Font]** and **[Color]** buttons to set the font and color. You can also change the angle and the placement of the text-label.

To change the position of the text relative to the feature:

1. Beneath the Basic label options change the placement by selecting one of the radio buttons in the *Placement* group. To fix our labels, choose the *Right* radio button.
2. the `Font size` units allows you to select between *Points* or *Map units*.
3. Click **[Apply]** to see your changes without closing the dialog.

Things are looking better, but the labels are still too close to the marker. To fix this we can use the options on the `Offset` entry which is on the bottom of the menu. Here we can add offsets for the X and Y directions. Adding an X offset of 5 will move our labels off the marker and make them more readable. Of course if your marker symbol or font is larger, more of an offset will be required.

The last adjustment we'll make is to `Buffer` the labels. This just means putting a backdrop around them to make them stand out better. To buffer the lakes labels:

1. Click the *Buffer Labels* checkbox to enable buffering.
2. Choose a size for the buffer using the spin box.
3. Choose a color by clicking on **[Color]** and choosing your favorite from the color selector. You can also set some transparency for the buffer if you prefer.
4. Click **[Apply]** to see if you like the changes.

If you aren't happy with the results, tweak the settings and then test again by clicking **[Apply]**.

A buffer of 1 points seems to give a good result. Notice you can also specify the buffer size in map units if that works out better for you.

The advanced entries inside the *Label* tab allow you control the appearance of the labels using attributes stored in the layer. The entries beginning with `Data defined` allow you to set all the parameters for the labels using fields in the layer.

Note that the *Label* tab provides a preview-box where your selected label is shown.

11.2.5 New Labeling

The new  **Labeling** core application provides smart labeling for vector point, line and polygon layers and only requires a few parameters. This new application will replace the current QGIS labeling, described in section [Labels Tab](#) and also supports on-the-fly transformed layers.

Using new labeling

1. Start QGIS and load a vector point, line or polygon layer.
2. Activate the layer in the legend and click on the  **Labeling** icon in the QGIS toolbar menu.

Labeling point layers

First step is to activate the *Label this layer* checkbox and select an attribute column to use for labeling. Click  if you want to define labels based on expressions. After that you can define the text style and the scale-based visibility in the *Label settings* tab (see [Figure_labels_1](#)). Choose the *Advanced* tab for the label placement and the labeling priority. You can define if every part of a multipart feature is to be labeled here. With the wrap label on character function you can define a character for a line break in the labels. The *Data defined settings* tab provides you with the attribute-based definition of Font properties, Buffer properties and Position.

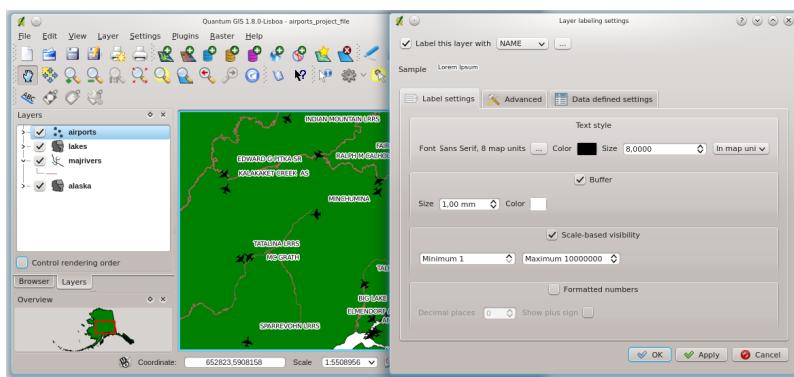


Figure 11.15: Smart labeling of vector point layers 

Labeling line layers

First step is to activate the *Label this layer* checkbox in the *Label settings* tab and select an attribute column to use for labeling. Here you can also define labels based on expressions. After that you can define the text style and the scale-based visibility. Further labeling options are available through the *Advanced* tab. You can define the label placement and label distance, a line orientation dependend position and the labeling priority here. Furthermore you can define if every part of a multipart line is to be labeled, if lines shall be merged to avoid duplicate labels and if a direction symbol is added (see [Figure_labels_2](#)). It is also possible to suppress labeling of features and wrap labels on characters. Use *Data defined settings* for attribute-based or database-connection-based settings.

Labeling polygon layers

First step is to activate the *Label this layer* checkbox and select an attribute column to use for labeling. Here you can also define labels based on expressions. In *Label settings* define the text style and the scale-based visibility (see [Figure_labels_3](#)). Use the *Advanced* tab for label placement, label distance and labeling priority. Define if every part of a multipart feature is to be labeled, suppress labeling of features and wrap labels on characters here. Use *Data defined settings* for attribute-based or database-connection-based settings.

Change engine settings

Additionally you can click the **[Engine settings]** button and select the search method, used to find the best label placement. Available is Chain, Popmusic Tabu, Popmusic Chain, Popmusic Tabu Chain and FALP.

Furthermore the number of candidates can be defined for point, line and polygon features, and you can define whether to show all labels (including colliding labels) and label candidates for debugging.

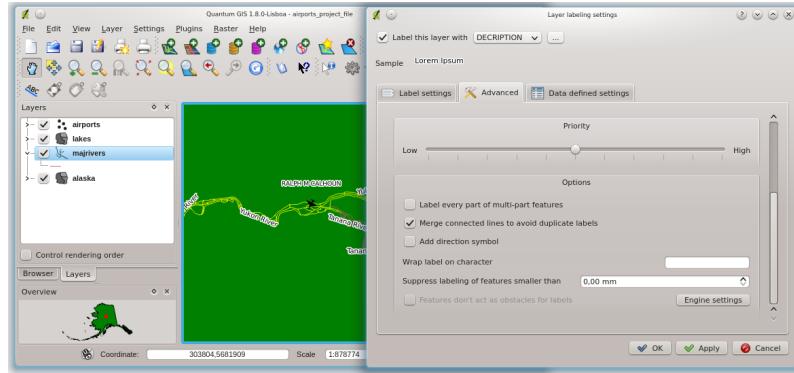


Figure 11.16: Smart labeling of vector line layers 🐧

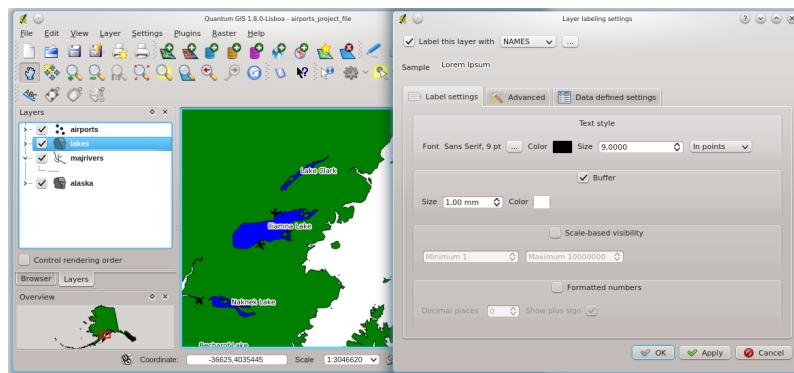


Figure 11.17: Smart labeling of vector polygon layers 🐧

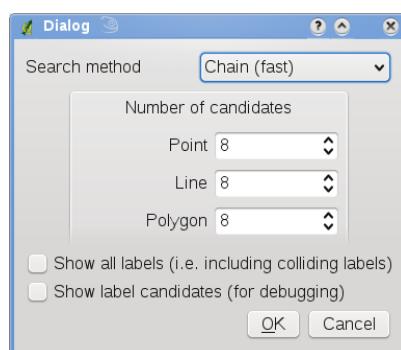


Figure 11.18: Dialog to change label engine settings 🐧

Keywords to use in attribute columns for labeling

There is a list of supported key words, that can be used for the placement of labels in defined attribute columns.

- **For horizontal alignment:** left, center, right
- **For vertical alignment:** bottom, base, half, top
- **Colors can be specified in svg notation,** e.g. #ff0000
- **for bold, underlined, strikeout and italic:** 0 = false 1 = true

A combination of key words in one column also works, e.g.: base right or bottom left.

11.2.6 Fields Tab

 Within the *Fields* tab the field attributes of the selected dataset can be manipulated. The buttons  New Column and  Delete Column can be used, when the dataset is  Editing mode.

At the moment only columns from PostGIS layers can be removed and added. The OGR library supports to add and remove columns, if you have a GDAL version >= 1.9 installed.

Edit Widget

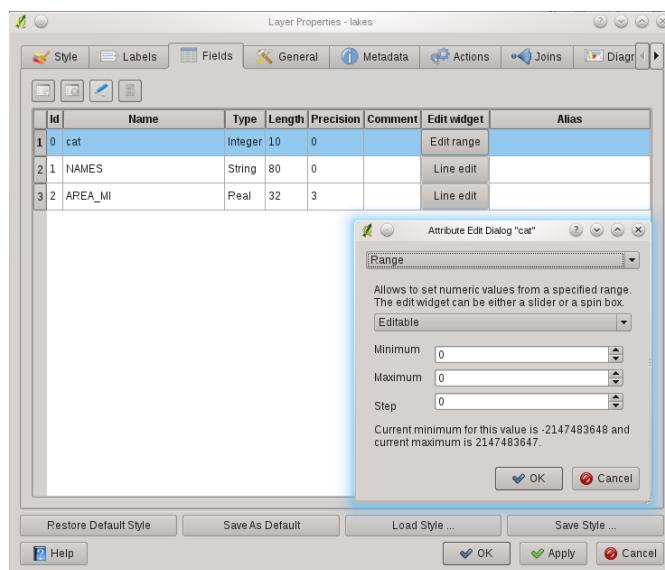


Figure 11.19: Dialog to select an edit widget for an attribute column 

Within the *Fields* tab 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:

- **Line edit:** an edit field which allows to enter simple text (or restrict to numbers for numeric attributes).
- **Classification:** Displays a combo box with the values used for classification, if you have chosen ‘unique value’ as legend type in the *Style* tab of the properties dialog.
- **Range:** Allows to set numeric values from a specific range. The edit widget can be either a slider or a spin box.
- **Unique values:** The user can select one of the values already used in the attribute table. If editable is activated, a line edit is shown with autocomplete support, otherwise a combo box is used.
- **File name:** Simplifies the selection by adding a file chooser dialog.

- **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.
- **Enumeration:** Opens a combo box with values that can be used within the columns type. This is currently only supported by the postgres provider.
- **Immutable:** The immutable attribute column is read-only. The user is not able to modify the content.
- **Hidden:** A hidden attribute column is invisible. The user is not able to see its content.
- **Checkbox:** Displays a checkbox and you can define what attribute is added to the column when the checkbox is activated or not.
- **Text edit:** This opens a text edit field that allows multiple lines to be used.
- **Calendar:** Opens a calendar widget to enter a date. Column type must be text.
- **Value Relation:** Offers values from a related table in a combobox. You can select layer, key column and value column.
- **UUID Generator:** Generates a read-only UUID (Universally Unique Identifiers) field, if empty.

11.2.7 General Tab



The *General* tab is essentially like that of the raster dialog. There are several options available:

- Change the display name of the layer
- Set a display field to be used for the *Identify Results* dialog
- Define a certain Edit User Interface for the vector layer written with the Qt Creator IDE and tools at <http://qt.digia.com/Product/Developer-Tools/>
- Create a *Spatial Index* (only for OGR supported formats)
- Add an *Init function* for the layer. They will overwrite existing QGIS widget initializations, if applied
- *Update Extents* information for a layer
- View or change the projection of the specific vector layer, clicking on *Specify CRS*

Furthermore you can activate and set *Use scale dependent rendering*, define provider specific options (e.g. encoding) and with the **[Query Builder]** button you can create a subset of the features in the layer that will be visualized (also refer to section [Selection](#)).

11.2.8 Metadata Tab



The *Metadata* tab contains general information about the layer, including specifics about the type and location, number of features, feature type, and the editing capabilities. The *Extents* section, providing layer extent information, and the *Layer Spatial Reference System* section, providing information about the CRS of the layer. This is a quick way to get information about the layer.

Additionally you can add/edit a title for the layer and some abstract information. These information will be saved in the QGIS project file for following sessions and will be used for QGIS server.

11.2.9 Actions Tab



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.

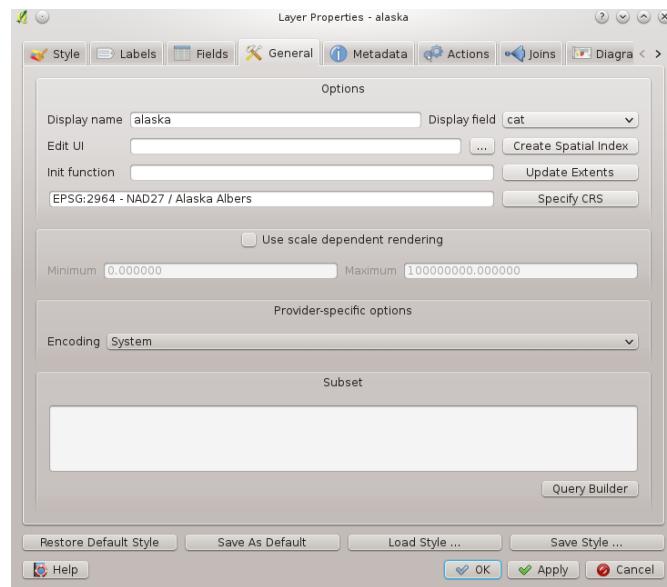


Figure 11.20: General tab in vector layers properties dialog 

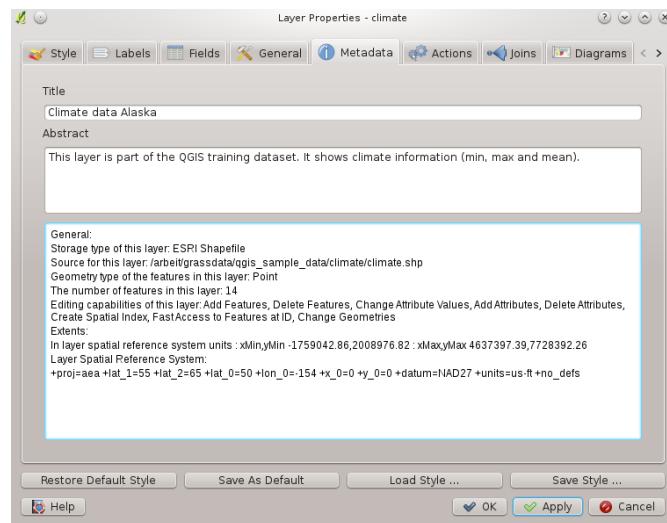


Figure 11.21: Metadata tab in vector layers properties dialog 

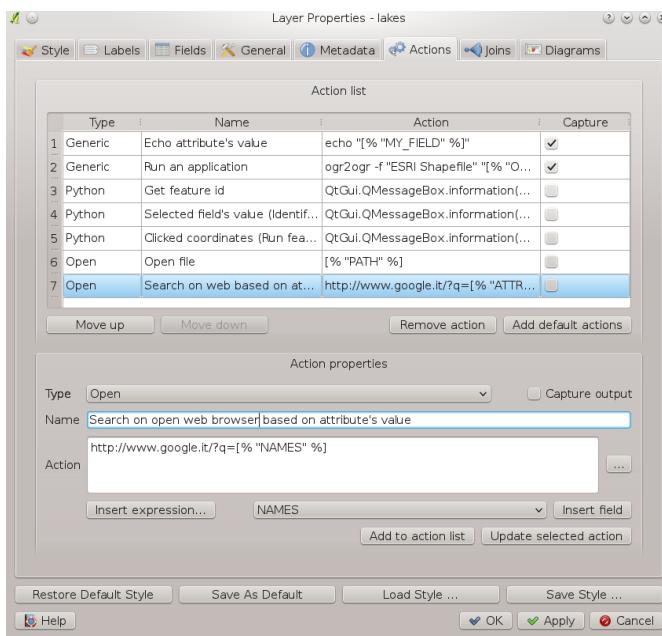


Figure 11.22: Overview action dialog with some sample actions 

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 6 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 clicking on [**Add default actions**]. An 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* tab. 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 so, by surrounding the field name (and the % character) with square brackets (e.g., [%col10]). This will prevent the %col10 field name 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 *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 using preceding the derived field name by (*Derived*) .. For example, a point layer has an X and Y field and the value of these 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 sure, 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  Identify Features or  Open Attribute Table or  Run Feature Action). To invoke an action, right click on the record and choose the action from the popup menu. Actions are listed in the popup menu by the name you assigned when defining the actions. 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 them into a file using bash and the `echo` command (so it will only work  or perhaps ). The layer in question has fields for a species name `taxon_name`, latitude `lat` and longitude `long`. I would like to be able to make a spatial selection of a 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:

```
Acacia mearnsii -34.0800000000 150.0800000000
Acacia mearnsii -34.9000000000 150.1200000000
Acacia mearnsii -35.2200000000 149.9300000000
Acacia mearnsii -32.2700000000 150.4100000000
```

As an exercise we create an action that does a Google search on the `lakes` layer. First we need to determine the URL needed 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: <http://google.com/search?q=qgis>, 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 popup menu.
3. Click on the *Actions* tab.
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 included 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 *The valid attribute names for this layer*  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 [**Insert action**] 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:

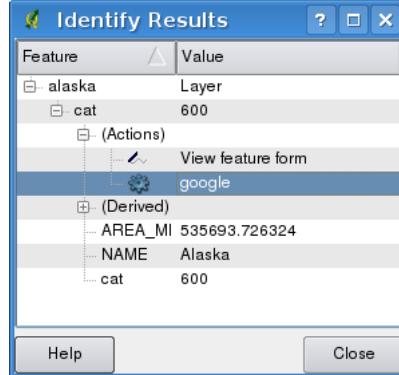


Figure 11.23: Select feature and choose action 

When we click on the action, it brings up Firefox and navigates to the URL <http://www.google.com/search?q=Tustumena>. 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 think of 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 on how to use **Python** actions.

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 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 have to just remember that the action is one of type *Python* and to change the *command* and *imagerelpath* variables to fit our needs.

But what about if the relative path need 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 actions example if 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 name of files to be added to the project and the name to be given to the layer are data driven (*filename* and *layname* are column names of the table of attributes of the vector where the action was created):

```
qgis.utils.iface.addVectorLayer('/yourpath/[% "filename" %].shp','[% "layname" %]', 'ogr')
```

To add a raster (a tif image in this example) it becomes:

```
qgis.utils.iface.addRasterLayer('/yourpath/[% "filename" %].tif','[% "layname" %']')
```

11.2.10 Joins Tab



The *Joins* tab allows you to join a loaded attribute table to a loaded vector layer. As key columns you have to define a join layer, a join field and a target field. QGIS currently supports to join non spatial table formats supported by OGR, delimited text and the PostgreSQL provider (see [figure_joins_1](#)).

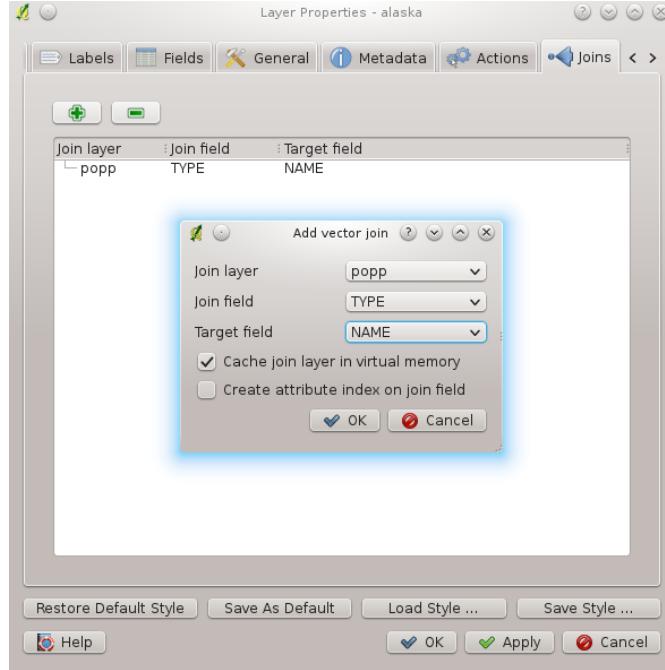


Figure 11.24: Join an attribute table to an existing vector layer

Additionally the add vector join dialog allows to:

- Cache join layer in virtual memory
- Create attribute index on the join field

11.2.11 Diagrams Tab



The *Diagrams* tab allows you to add a graphic overlay to a vector layer (see [figure_diagrams_1](#)).

The current core implementation of diagrams provides support for piecharts and text diagrams. Text values of different data columns are displayed one below the other with a circle or a box and dividers. Diagram size is based on a fixed size or on linear scaling according to a classification attribute. The placement of the diagrams interacts with the new labeling, so position conflicts between diagrams and labels are detected and solved. In addition to chart positions can be fixed by the users hand.

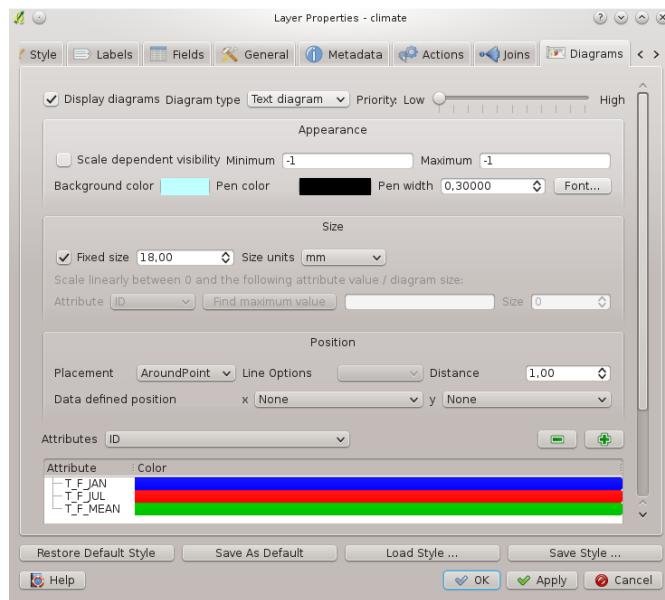


Figure 11.25: Vector properties dialog with diagram tab

We will demonstrate an example and overlay the alaska boundary layer a text diagram showing some 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* tab, activate *Display diagrams* and from *Diagram type* combobox select 'Text diagram'
4. As Background color we choose a light blue and set a fixed size to 18 mm.
5. Placement could be set to AroundPoint.
6. In the diagram we want to display the values of the three columns `T_F_JAN`, `T_F_JUL` and `T_F_MEAN`. First select `T_F_JAN` as Attributes and click the green **[+]** button, then `T_F_JUL` and finally `T_F_MEAN`.
7. Now click **[Apply]** to display the diagram in the QGIS main window.
8. You can now adapt the chart size, or change the attribute colors by double clicking on the color values in the attribute field. [Figure_diagrams_2](#) gives an impression.
9. Finally click **[Ok]**.

Additionally in the *Settings → Options* dialog, there is a *Overlay* tab where it is possible to select the placement algorithm of the diagrams. The central point method is a generic one, the others use algorithms of the PAL library.

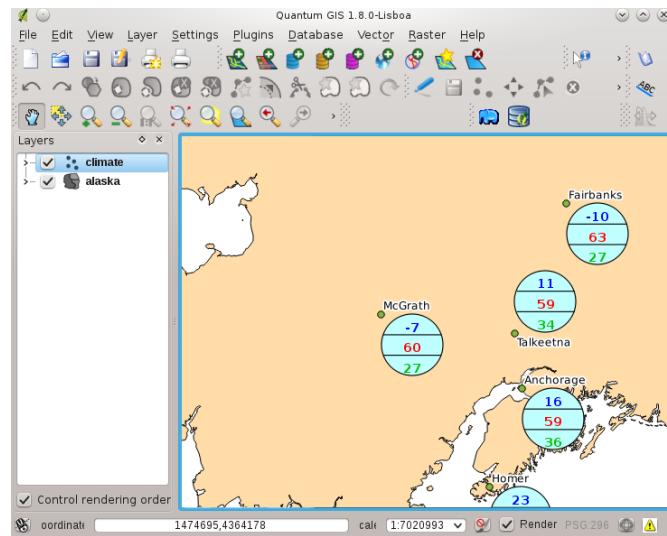


Figure 11.26: Diagram from temperature data overlayed on a map 

They also consider diagram objects and labels in different layers. Also see section [Diagram Overlay Plugin](#) for additional diagram features.

11.3 Editing

QGIS supports various capabilities for editing OGR, PostGIS and SpatiaLite vector layers.

Note: The procedure for editing GRASS layers is different - see Section [Digitizing and editing a GRASS vector layer](#) for details.

Tip: Concurrent Edits

This version of QGIS does not track if somebody else is editing a feature at the same time as you. The last person to save their edits wins.

11.3.1 Setting the Snapping Tolerance and Search Radius

Before we can edit vertices, we must set the snapping tolerance and search radius to a value that allows us an optimal editing of the vector layer geometries.

Snapping tolerance

Snapping tolerance is the distance QGIS uses to search for the closest vertex and/or segment you are trying to connect 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 which work with tolerance.

1. A general, project wide snapping tolerance can be defined choosing *Settings* →  *Options*. On Mac: go to *QGIS* →  *Preferences...*, on Linux: *Edit* →  *Options*. In the *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 300ft should be fine at a scale of 1:10 000 should be a reasonable setting.

2. A layer based snapping tolerance can be defined by choosing *Settings* → (or *File* →) *Snapping options...* to enable and adjust snapping mode and tolerance on a layer basis (see [figure_edit_1](#)).

Note that this layer based snapping overrides the global snapping option set in the Digitizing tab. So if you need to edit one layer, and snap its vertices to another layer, then enable snapping only on the `snap to` layer, then decrease the global snapping tolerance to a smaller value. Furthermore, snapping will never occur to a layer which 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.



Figure 11.27: Edit snapping options on a layer basis 

Search radius

Search radius is the distance QGIS uses to search for the closest vertex you are trying to move when you click on the map. If you aren't within the search radius, QGIS won't find and select any vertex for editing and it will pop up an annoying warning to that effect. 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* →  *Options*. The same place where you define the general, project wide snapping tolerance.

11.3.2 Zooming and Panning

Before editing a layer, you should zoom in to your area of interest. This avoids waiting while all the vertex markers are rendered across the entire layer.

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

Zooming and panning with the mouse wheel

While digitizing 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* →  *Options* menu.

Panning with the arrow keys

Panning the map during digitizing 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 spacebar to temporarily cause mouse movements to pan then map. The PgUp and PgDown keys on your keyboard will cause the map display to zoom in or out without interrupting your digitizing session.

11.3.3 Topological editing

Besides layer based snapping options you can also define some topological functionalities in the *Snapping options...* dialog in the *Settings* (or *File*) menu. Here you can define *Enable topological editing* and/or for polygon layers you can activate the column *Avoid Int.* which avoids intersection of new polygons.

Enable topological editing

The option *Enable topological editing* is for editing and maintaining common boundaries in polygon mosaics. QGIS ‘detects’ a shared boundary in a polygon mosaic and you only have to move the vertex once and QGIS will take care about updating the other boundary.

Avoid intersections of new polygons

The second topological option in the *Avoid Int.* column, called *Avoid intersections of new polygons* avoids overlaps in polygon mosaics. 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 common boundary. The advantage is that users don’t have to digitize all vertices of the common boundary.

11.3.4 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). Layer editing is most versatile when used on PostgreSQL/PostGIS data sources.

In general, editing vector layers is divided into a digitizing and an advanced digitizing toolbar, described in Section [Advanced digitizing](#). You can select and unselect both under *Settings* → *Toolbars* →. Using the basic digitizing tools you can perform the following functions:

Icon	Purpose	Icon	Purpose
	Toggle editing		Adding Features: Capture Point
	Adding Features: Capture Line		Adding Features: Capture Polygon
	Move Feature		Node Tool
	Delete Selected		Cut Features
	Copy Features		Paste Features
	Save edits and continue		

Table Editing: Vector layer basic editing toolbar

All editing sessions start by choosing the *Toggle editing* option. This can be found in the context menu after right clicking on the legend entry for that layer.

Alternately, you can use the Toggle Editing *Toggle editing* button from the digitizing toolbar to start or stop the editing mode. Once the layer is in edit mode, markers will appear at the vertices, and additional tool buttons on the editing toolbar will become available.

Tip: Save Regularly

Remember to  **Save 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 put the QGIS cursor into digitizing mode.

For each feature, 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 lines and polygons, keep on left-clicking for each additional point you wish to capture. When you have finished adding points, right-click anywhere on the map area to confirm you have finished entering the geometry of that feature.

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. In the *Digitizing* tab under the *Settings → Options* menu, you can also activate *Suppress attributes pop-up windows after each created feature* *Reuse last entered attribute values*.

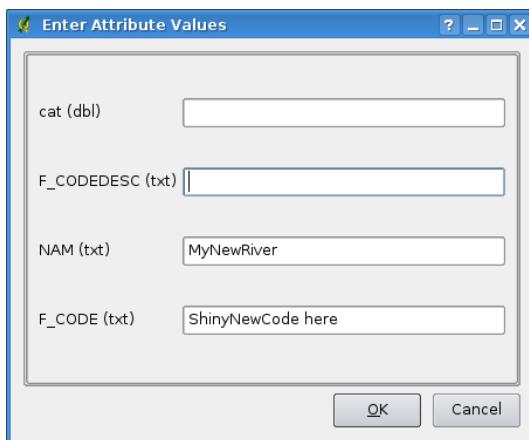


Figure 11.28: Enter Attribute Values Dialog after digitizing a new vector feature 

With the  Move Feature(s) icon on the toolbar you can move existing features.

Tip: Attribute Value Types

For editing the attribute types are validated during the entry. Because of this, it is not possible to enter a number into the text-column in the dialog *Enter Attribute Values* or vice versa. If you need to do so, you should edit the attributes in a second step within the *Attribute table* dialog.

Node Tool

For both PostgreSQL/PostGIS and shapefile-based layers, 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 Quantum GIS, persistent, so when some operation is done, selection stays active for this feature and tool. If the node tool couldn’t find any features, a warning will be displayed.

Important is to set the property *Settings* → *Options* → *Digitizing* → *Search Radius*: to a number greater than zero (i.e. 10). Otherwise QGIS will not be able to tell which vertex is being edited.

Tip: 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 and 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** or **Shift** 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 has to be moved if necessary.
- **Deleting vertices:** After selecting vertices for deletion, click the **Delete** key. Note that you cannot use the **Node Tool** to delete a complete feature; QGIS will ensure it retains the minimum number of vertices for the feature type you are working on. 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.

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.

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.

However in this version of QGIS, text features from outside QGIS cannot 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 are copying 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 Single Feature 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 - feature and its attributes - gets copied, make sure the schemas match.

Tip: 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.

Deleting Selected Features

If we want to delete an entire polygon, we can do that by first selecting the polygon using the regular  Select Single Feature tool. You can select multiple features for deletion. Once you have the selection set, use the  Delete Selected tool to delete the features.

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.

Tip: Feature Deletion Support

When editing ESRI shapefiles, the deletion of features only works if QGIS is linked to a GDAL version 1.3.2 or greater. The OS X and Windows versions of QGIS available from the download site are built using GDAL 1.3.2 or higher.

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 Edits button. When you turn editing mode off with the  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.

Tip: 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.

11.3.5 Advanced digitizing

Icon	Purpose	Icon	Purpose
↶	Undo	↷	Redo
	Simplify Feature		Add Ring
	Add Part		Delete Ring
	Delete Part		Reshape Features
	Offset Curve		Split Features
	Merge Selected Features		Rotate Point Symbols
	Merge Attributes of Selected Features		

Table Advanced Editing: Vector layer advanced editing toolbar

Undo and Redo

The ↶ Undo and ↷ Redo tools allow the user 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_3](#)). This widget is not displayed by default; it can be displayed by right clicking on the toolbar and activating the Undo/Redo check box. Undo/Redo is however active, even if the widget is not displayed.



Figure 11.29: Redo and Undo digitizing steps

When Undo is hit, 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.

Simplify Feature

The Simplify Feature tool allows to reduce the number of vertices of a feature, as long as the geometry doesn't change. You need to select a feature, it will be highlighted by a red rubber band and a slider appears. Moving the slider, the red rubber band is changing its shape to show how the feature is being simplified. Clicking [OK] the new, simplified geometry will be stored. If a feature cannot be simplified (e.g. MultiPolygons), a message shows up.

Add Ring

You can create ring polygons using the  Add Ring icon in the toolbar. This means inside an existing area it is possible to digitize further polygons, that will occur as a ‘hole’, so only the area in between the boundaries of the outer and inner polygons remain as a ring polygon.

Add Part

 You can  add part polygons to a selected multipolygon. The new part polygon has to be digitized outside the selected multipolygon.

Delete Ring

 The  Delete Ring tool allows to delete ring polygons inside an existing area. This tool only works with polygon layers. It doesn’t change anything when it is used on the outer ring of the polygon. This tool can be used on polygon and multi-polygon features. Before you select the vertices of a ring, adjust the vertex edit tolerance.

Delete Part

 The  Delete Part tool allows to delete parts from multifeatures (e.g. to delete polygons from a multipolygon feature). It won’t delete the last part of the feature, this last part will stay untouched. This tool works with all multi-part geometries point, line and polygon. Before you select the vertices of a part, adjust the vertex edit tolerance.

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 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.

Note: 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 is a new editing tool. It creates parallel shifts of lines and polygon rings. The tool can be applied to the edited layer (the geometries are modified) or also to background layers (creates copies of the lines / rings and adds it to the the edited layer). It is thus ideally suited for the creation of distance line layers. The displacement is shown at the bottom left of the taskbar.

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.

Merge selected features

The  Merge Selected Features tool allows to merge features that have common boundaries and the same attributes.

Merge attributes of selected features

The  Merge Attributes of Selected Features tool allows to merge attributes of features with common boundaries and attributes without merging their boundaries.

Rotate Point Symbols

The  Rotate Point Symbols tool is currently only supported by the old symbology engine. It allows to change the rotation of point symbols in the map canvas, if you have defined a rotation column from the attribute table of the point layer in the *Style* tab of the *Layer Properties*. Otherwise the tool is inactive.

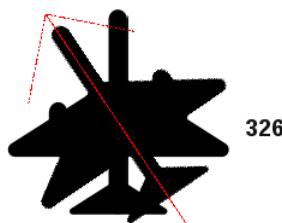


Figure 11.30: Rotate Point Symbols 

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_4](#)). When you release the left mouse button again, the value will be updated in the attribute table.

Note: If you hold the `Ctrl` key pressed, the rotation will be done in 15 degree steps.

11.3.6 Creating a new Vector layer

QGIS allows to create new Shapefile layers and new SpatiaLite 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* →  *New Shapefile Layer...* from the *Layer* menu. The *New Vector Layer* dialog will be displayed as shown in [Figure_edit_5](#). Choose the type of layer (point, line or polygon) and the CRS (Coordinate Reference System).

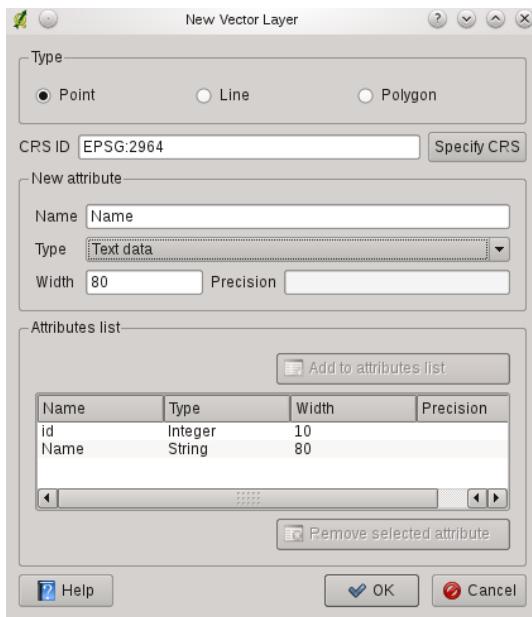


Figure 11.31: Creating a new Shapefile layer Dialog 

Note that QGIS does not yet support creation of 2.5D features (i.e. features with X,Y,Z coordinates).

To complete the creation of the new Shapefile layer, add the desired attributes by clicking on the [Add] 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* , and *Type: string*  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* →  *New SpatiaLite Layer...* from the *Layer* menu. The *New SpatiaLite Layer* dialog will be displayed as shown in [Figure_edit_6](#).

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 and define the layer type and the EPSG SRID. If desired you can select to *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 according 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](#).

11.3.7 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 menu *Layer* choose  *Open Attribute Table*. It is also possible to rightclick on the layer and

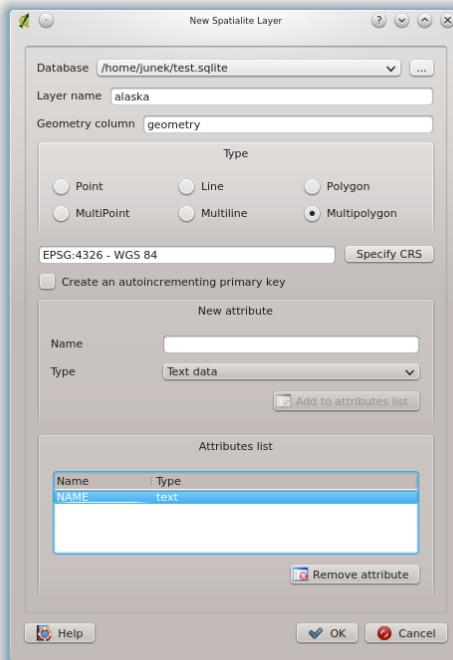


Figure 11.32: Creating a New SpatiaLite layer Dialog 

choose  *Open Attribute Table* from the dropdown menu.

This will open a new window which displays the feature attributes in the layer ([figure_attributes_1](#)). The number of features and the number of selected features are shown in the attribute table title.

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 the *Look for* field can be used. Select the field (column) from which the search should be performed from the dropdown menu and hit the [**Search**] button. The matching rows will be selected and the total number of matching rows will appear in the title bar of the attribute table, and in the status bar of the main window. For more complex searches use the Advanced search button , which will launch the Search Query Builder described in Section [Query Builder](#).

To show selected records only, use the checkbox  *Show selected only*. To search selected records only, use the checkbox  *Search selected only*. The  *Case sensitive* checkbox allows to select case sensitive. The other buttons at the bottom left of the attribute table window provide following functionality:

	cat	NAME	AREA_MI
0	1	Alaska	0.168541
1	2	Alaska	0.209257
2	3	Alaska	0.837275
3	4	Alaska	0.322511
4	5	Alaska	1.46241
5	6	Alaska	2.778535
6	7	Alaska	0.359589
7	8	Alaska	0.225724
8	9	Alaska	0.136504
9	10	Alaska	1.272344
10	11	Alaska	0.095759
11	12	Alaska	0.251123
12	13	Alaska	6.964526
13	14	Alaska	5.126354
14	15	Alaska	1.18393

Figure 11.33: Attribute Table for Alaska layer

- Unselect all also with `Ctrl+U`
- Move selected to top also with `Ctrl+T`
- Invert selection also with `Ctrl+S`
- Copy selected rows to clipboard also with `Ctrl+C`
- Zoom map to the selected rows also with `Ctrl+J`
- Pan map to the selected rows also with `Ctrl+P`
- Toggle editing mode to edit single values and to enable functionalities described below also with `Ctrl+E`
- Delete selected features also with `Ctrl+D`
- New Column for PostGIS layers and for OGR layers with GDAL version ≥ 1.6 also with `Ctrl+W`
- Delete Column for PostGIS layers and for OGR layers with GDAL version ≥ 1.9 also with `Ctrl+L`
- Open field calculator also with `Ctrl+I`

Tip: 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* → *Options* → General tab *Copy geometry in WKT representation from attribute table*.

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 selection as* → to define the name of the output file, its format and CRS (see Section [Map Legend](#)). It is also possible to specify OGR creation options within the dialog.

Working with non spatial attribute tables

QGIS allows also to load non spatial tables. This includes currently tables supported by OGR, delimited text and the PostgreSQL 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 e.g. with the  tool and is then editable like any other layer attribute table.

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 Tab* to find out more.

11.4 Query Builder

The Query Builder allows you to define a subset of a table using a SQL-like WHERE clause and display the result in the main window. The query result then can be saved as a new vector layer.

11.4.1 Query

Open the attribute table choosing  Open Attribute Table from the menu bar. Click on the [Advanced Search] button to open the *Query builder*. For example, if you have a towns layer with a population field you could select only larger towns by entering `population > 100000` in the SQL box of the Query builder. [Figure_attributes_2](#) shows an example of the Query builder populated with data from a PostGIS layer with attributes stored in PostgreSQL. The Fields, Values and Operators sections help the user to construct the SQL-like query.

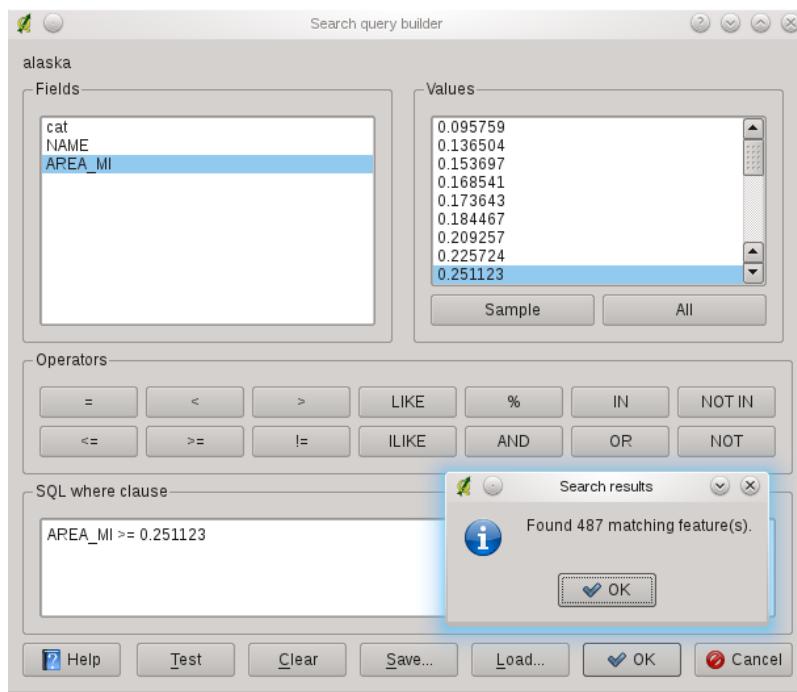


Figure 11.34: Query Builder 

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), logical operators (AND, OR, ...) are available.

The [Test] button shows a message box with the number of features satisfying the current query, which is usable in the process of query construction. The [Clear] button clears the text in the SQL where clause text field. The [Save] and [Load] button allow to save and load SQL queries. The [OK] button closes the window and selects the features satisfying the query. The [Cancel] button closes the window without changing the current selection.

Tip: Changing the Layer Definition

You can change the layer definition after it is loaded by altering the SQL query used to define the layer. To do this, open the vector *Layer Properties* dialog by double-clicking on the layer in the legend and click on the [Query Builder] button on the *General* tab. See Section [The Vector Properties Dialog](#) for more information.

11.4.2 Selection

With QGIS it is possible also to select features for visualisation using a similar query builder interface to that used in *Query Builder*. In the above section the purpose of the query builder is to highlight all selected features meeting the filter criteria in yellow. The rest of the features do not change their appearance.

Another possibility is to make a selection by right clicking on a layer in the legend and choosing *Query* If you perform a SQL query here only the selected features are displayed in the map view. Features that don't match the SQL query are not visualised in the map view. The same function is available from the *General* tab in the vector *Layer Properties* dialog. You can find a [Query builder] button right below. The selection described above can be used with all vector data providers.

11.4.3 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 selection as* → to define the name of the output file, its format and CRS (see Section [Map Legend](#)). It is also possible to specify OGR creation options within the dialog.

11.5 Field Calculator

The  **Field Calculator** button in the attribute table allows to perform calculations on basis of existing attribute values or defined functions, e.g to calculate length or area of geometry features. The results can be written to a new attribute column or it can be used to update values in an already existing column.

You have to bring the vector layer in editing mode, before you can click on the field calculator icon to open the dialog (see [figure_attributes_3](#)). In the dialog you first have to 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.

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_3](#)). For example, if you choose a field width of 10 and a field precision of 3 it means you have 6 signs before the dot, then the dot and another 3 signs for the precision.

The **Function List** contains functions as well as fields and values. View the help function in the **Selected Function Help**. In **Expression** you see the calculation expressions you create with the **Function List**. The most commonly used operators, see **Operators**.

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 its name in the *Fields and Values* list. Generally

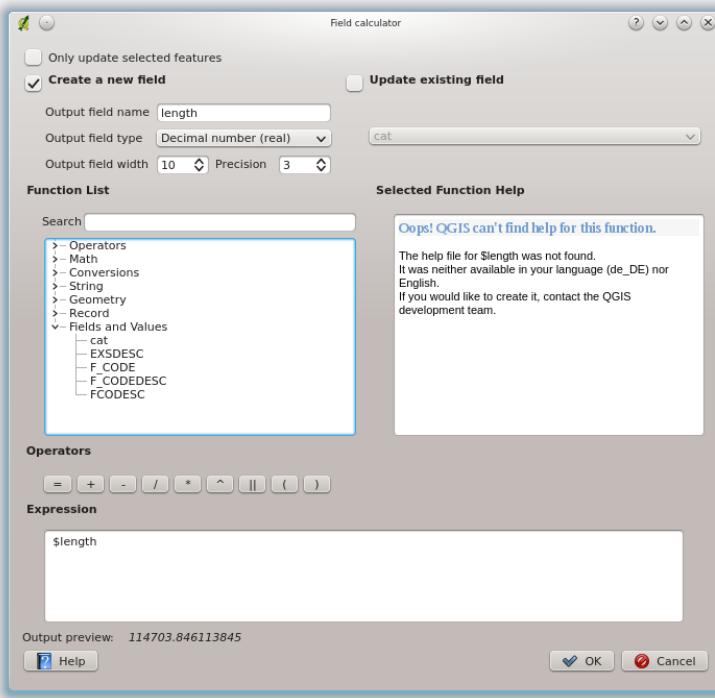


Figure 11.35: Field Calculator 

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 right click on the appropriate field. You can choose between *Load top 10 unique values* and *Load all unique values*. On the right side opens the **Field Values** list with the unique values. To add a value to the Field calculator **Expression** box, double click its name in the **Field Values** list.

The *Operators*, *Math*, *Conversions*, *String*, *Geometry* and *Record* groups provides several functions. In *Operators* you find mathematical operators. Find *Math* for mathematical functions. The *Conversions* group contains functions that convert one data type to another. The *String* group provides functions for data strings. In the *Geometry* group you find functions for geometry objects. With *Record* group functions you can add a numeration to your data set. To add a function to the Field calculator **Expression** box, click on the > and then doubleclick the function.

A short example illustrates how the field calculator works. We want to calculate the length 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, `real` as Output field type and define Output field width 10 and a Precision of 3.
5. Now click on function `length` in the *Geometry* group to add it as `$length` into the Field calculator expression box and click **[Ok]**.
6. You can now find a new column `length` in the attribute table.

The available functions are listed below.

<code>column name "column name"</code>	value of the field column name
<code>'string'</code>	a string value
<code>NULL</code>	null value

a IS NULL	a has no value
a IS NOT NULL	a has a value
a IN (value[,value])	a is below the values listed
a NOT IN (value[,value])	a is not below the values listed
a OR b	a or *b* is true
a AND b	a and *b* is true
NOT a	inverted truth value of a
sqrt(a)	square root of a
sin(a)	sinus of a
cos(a)	cosinus of b
tan(a)	tangens of a
asin(a)	arcussinus of a
acos(a)	arcuscosinus of a
atan(a)	arcustangens of a
to int(a)	convert string a to integer
to real(a)	convert string a to real
to string(a)	convert number a to string
lower(a)	convert string a to lower case
upper(a)	convert string a to upper case
length(a)	length of string a
atan2(y,x)	arcustangens of y/x using the signs of the two arguments to determine the quadrant of the result
replace(*a*, replacethis, withthat)	replace this with that in string a
regexp_replace(a,this,that)	replace the regular expression this with that
substr(*a*,from,len)	len characters of string *a* starting from from (first character index is 1)
a b	concatenate strings a and b
\$rownum	number current row
\$area	area of polygon
\$perimeter	perimeter of polygon
\$length	length of line
\$id	feature id
\$x	x coordinate of point
\$y	y coordinate of point
xat(n)	X coordinate of the point of an n-th line (indeces start at 0; negative values refer to the line end)
yat(n)	y coordinate of the point of an n-th line (indeces start at 0; negative values refer to the line end)
a = b	a and b are equal
a != b and a <> b	a and b are not equal
a >= b	a is larger than or equal to b
a <= b	a is less than or equal to b
a > b	a is larger than b
a < b	a is smaller than b
a ~ b	a matches the regular expression b
a LIKE b	a equals b
a ILIKE b	a equals b (without regard to case-sensitive)
a wedge b	a raised to the power of b
a * b	a multiplied by b
a / b	a divided by b
a + b	a plus b
a - b	a minus b
+ a	positive sign
- a	negative value of a

The field calculator **Function list** with the **Selected Function Help**, **Operators** and **Expression** menu are also available through the rule-based rendering in the Style tab of the Layer properties and the expression based labeling  in the  Labeling core application.

Working with Raster Data

12.1 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 Arc/Info Binary Grid, Arc/Info 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.

At the date of this document, more than 100 raster formats are supported by the GDAL library (see [GDAL-SOFTWARE-SUITE Literature and Web References](#)). A complete list is available at http://www.gdal.org/formats_list.html.

Note: 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 was not 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](#).

12.1.1 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 its 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.

12.1.2 Loading raster data in QGIS

Raster layers are loaded either by clicking on the  Load Raster icon or by selecting the *Layer → Add Raster Layer* menu option. More than one layer can be loaded at the same time by holding down the Control or Shift key and clicking on multiple items in the dialog *Open a GDAL Supported Raster Data Source*.

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%)*
- *Show in Overview*
- *Remove*
- *Set Layer CRS*
- *Set Project CRS from Layer*
- *Properties*
- *Rename*
- *Copy Style*
- *Add New Group*
- *Expand all*
- *Collapse all*
- *Update Drawing Order*

12.2 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 tabs on the dialog:

- *Style*
- *Transparency*
- *Colormap*
- *General*
- *Metadata*
- *Pyramids*
- *Histogram*

12.2.1 Style Tab

QGIS can render raster layers in two different ways:

1. Single band - one band of the image will be rendered as gray or in pseudocolor or a freak out.
2. Three band color - three 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.

Within both render types you can invert the color output using the *Invert color map* checkbox.

Single Band Rendering

This selection offers you two possibilites to choose. At first you can select which band you like to use for rendering (if the dataset has more than one band).

The second option offers a selection of available colortables for rendering.

The following settings are available through the dropdownbox *Color map* 

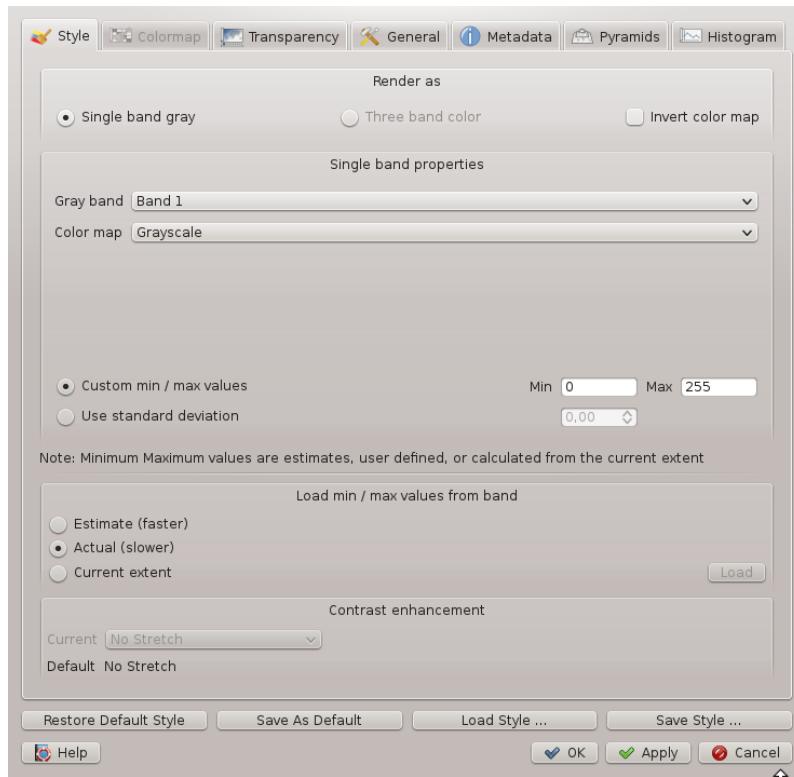


Figure 12.1: Raster Layers Properties Dialog 

- Grayscale (default)
- Pseudocolor
- Freak Out
- Colormap

When selecting the entry ‘Colormap’ from *Color map*  combobox, the tab *Colormap* becomes available. For more information see [Colormap](#).

QGIS can restrict the data displayed to only show cells whose values are within a given number of standard deviations of the mean for the layer.

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. This option is only available for pseudocolor and freak out images.

Three band color

This selection offers you a wide range of options to modify the appearance of your rasterlayer. For example you could switch color-bands from the standard RGB-order to something else.

Also scaling of colors are available.

Tip: Viewing a Single Band of a Multiband Raster

If you want to view a single band (for example Red) of a multiband image, 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 grayscale, then select Red as the band to use for Gray.

Contrast enhancement

Note: When adding GRASS rasters the option *Contrast enhancement* will be always set to automatically to *stretch to min max* regardless if the Quantum GIS general options this is set to another value.

12.2.2 Transparency Tab

QGIS has the ability to display each raster layer at varying transparency levels. Use the transparency slider to indicate to what extent the underlying layers (if any) should be visible through the current raster layer. This is very useful, if you like to overlay more than one rasterlayer, e.g. a shaded relief map overlaid by a classified rastermap. This will make the look of the map more three dimensional.

Additionally you can enter a rastervalue, which should be treated as *NODATA*. This can be done manually or with the  Add values from display icon.

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 neccessary:

1. Load the rasterfile `landcover`.
2. Open the *Properties* dialog by double-clicking on the raster name in the legend or by right-clicking and choosing *Properties* from the popup menu.
3. Select the *Transparency* tab
4. Click the  Add values manually button. A new row will appear in the pixel-list.
5. Enter the raster-value (we use 0 here) and adjust the transparency to 20 %.
6. Press the **[Apply]** button and have a look at the map.

You can repeat the steps 4 and 5 to adjust more values with custom transparency.

As you can see this 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.

12.2.3 Colormap

The *Colormap* tab is only available, when you have selected a singleband rendering within the *Style* tab (see *Style Tab*).

Three ways of color interpolation are available:

1. Discrete
2. Linear
3. Exact

The button **[Add Entry]** adds a color to the individual color table. Button **[Delete Entry]** deletes a color from the individual color table and the **[Sort]** 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 *Select 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 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.

The block *Generate new color map* allows you to create newly categorized colormaps. You only need to select the *number of entries* and press the button *Classify*. Currently only one *Classification mode*  is supported - 'Equal interval'

12.2.4 General Tab

The *General* tab displays basic information about the selected raster, including the layer source and display name in the legend (which can be modified). This tab also shows a thumbnail of the layer, its legend symbol, and the palette.

Additionally scale-dependent visibility can be set in this tab. You need to check the checkbox and set an appropriate scale where your data will be displayed in the map canvas.

Also the coordinate reference system (CRS) is printed here as a PROJ.4-string. This can be modified by hitting the [Specify] button.

12.2.5 Metadata Tab

The *Metadata* tab displays a wealth of information about the raster layer, including statistics about each band in the current raster layer. Statistics are gathered on a ‘need to know’ basis, so it may well be that a given layers statistics have not yet been collected.

This tab is mainly for information. You cannot change any values printed inside this tab.

12.2.6 Pyramids Tab

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:

- Average
- Nearest Neighbour

When checking the checkbox *Build pyramids internally if possible* QGIS tries to build pyramids internally.

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.

12.2.7 Histogram Tab

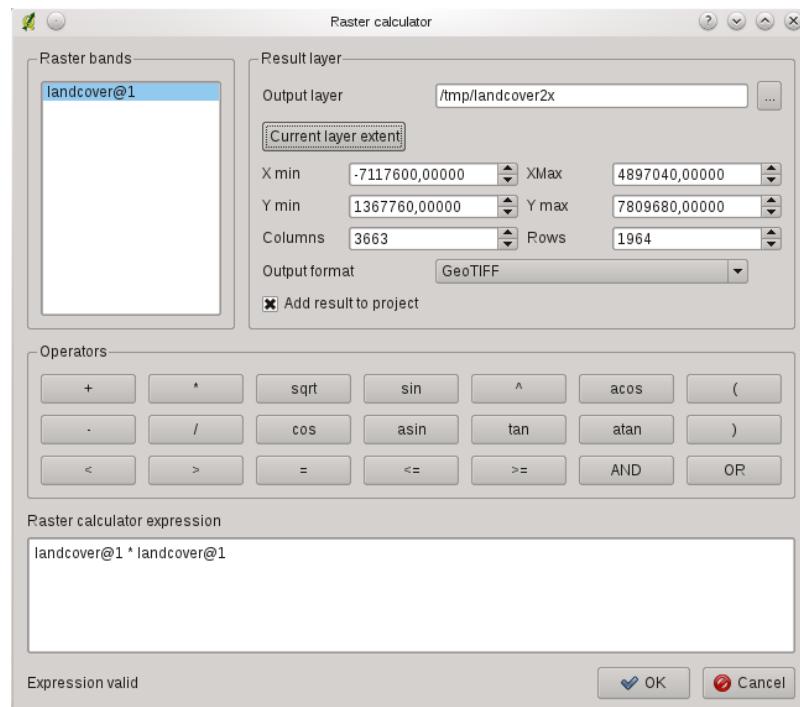
The *Histogram* tab allows you to view the distribution of the bands or colors in your raster. It is generated automatically when you open *Histogram* tab. All existing bands will be displayed together. You can save the histogram as an image with the  button.

12.3 Raster Calculator

The *Raster Calculator* in the *Raster* menu (see [figure_raster_2](#)) allows to perform calculations on basis of existing raster pixel values. 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 it into the box.

In the **Result layer** section you have 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 nearest neighbor algorithm.

Figure 12.2: Raster Calculator 

The **Operators** section contains all usable 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 added to the legend area and can be visualized.

12.3.1 Examples

Convert elevation values from meter to feet

Creating an elevation raster feet from a raster in meter, 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, because you are only interested in elevations above 0 meter, you can use following expression to create a mask and apply the result to a raster in one step.

```
(elevation@1 >= 0) * elevation@1
```

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.

Working with OGC Data

13.1 Working with OGC Data

QGIS supports WMS and WFS as data sources.

13.1.1 What is OGC Data

The Open Geospatial Consortium (OGC), is an international organization with 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 to serve specific needs for interoperable location and geospatial technology, including GIS. Further information can be found under <http://www.opengeospatial.org/>.

Important OGC specifications are:

- **WMS** — Web Map Service
- **WFS** — Web Feature Service
- **WCS** — Web Coverage Service
- **CAT** — Web Catalog Service
- **SFS** — Simple Features for SQL
- **GML** — Geography Markup Language

OGC services are increasingly being used to exchange geospatial data between different GIS implementations and data stores. QGIS can now deal with three of the above specifications, being SFS (through support of the PostgreSQL / PostGIS data provider, see Section *PostGIS Layers*), WFS and WMS as a client.

13.1.2 WMS 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. It has particularly been tested against publicly accessible servers such as DEMIS.

WMS servers act 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 would typically be JPEG or PNG.

WMS is generically a REST (Representational State Transfer) service rather than a fully-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 servers in 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.

Selecting WMS Servers

The first time you use the WMS feature, there are no servers defined.

Begin by clicking the  Add WMS layer button inside the toolbar, or through the *Layer → Add WMS Layer...* menu.

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 tab *Layers*, 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 GetMap URI	<input checked="" type="checkbox"/> <i>Ignore GetMap URI reported in capabilities</i> , use given URI from URL-field above.
Ignore GetFeatureInfo URI	<input checked="" type="checkbox"/> <i>Ignore GetFeatureInfo URI reported in capabilities</i> , use given URI from URL-field above

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 menu *Settings → Options* and click on the tab *Network & Proxy*. There you can add your proxy-settings and enable them by setting the *Use proxy for web access*. Make sure that you select the correct proxy type from the *Proxy type*  dropdown menu.

Once the new WMS Server connection has been created, it will be preserved for future QGIS sessions.

Tip: On WMS Server URLs

Be sure, when entering in the WMS server URL, that you have the base URL. For example, you shouldn't have fragments such as `request=GetCapabilities` or `version=1.0.0` in your URL.

Loading WMS Layers

Once you have successfully filled in your parameters you can select 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 left bottom of the WMS dialog.

Your screen should now look a bit like [figure_OGR_1](#), which shows the response provided by the DM Solutions Group WMS server.

Image Encoding

The *Image encoding* section now lists the formats that are supported by both the client and server. Choose one depending on your image accuracy requirements.

Tip: Image Encoding

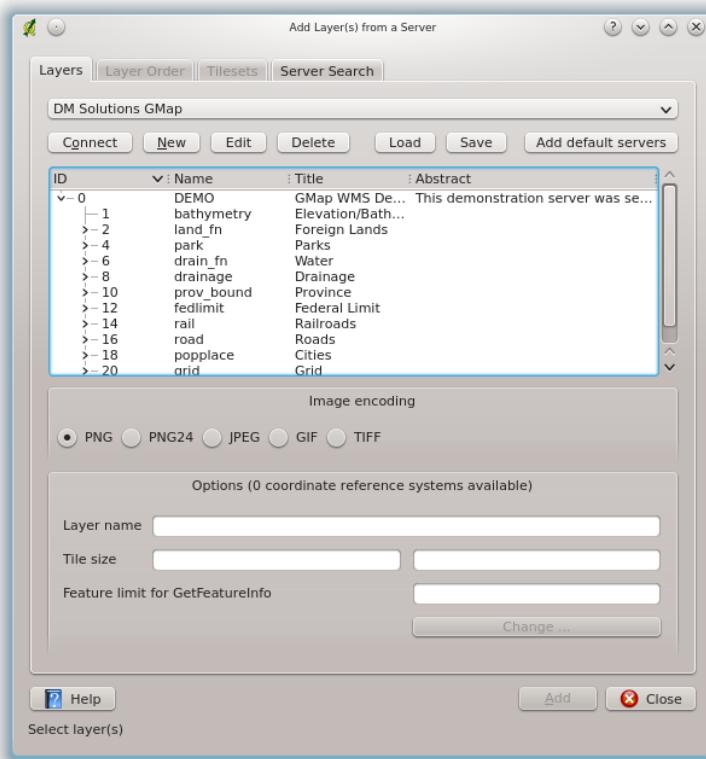


Figure 13.1: Dialog for adding a WMS server, showing its available layers 

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 5 times the data transfer requirement compared to 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 field provides a text field where you can add a *Layer name* for the WMS-layer. This name will be presented in the legend after loading the layer.

Below the layer name you can define *Tile size*, if you want to set tile sizes (eg. 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.

Layer Order

The tab *Layer Order* 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.

Tip: 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 tab *Layer Order*.

Transparency

In this version of QGIS, the *Global transparency* setting from the *Layer Properties* is hard-coded to be always on, where available.

Tip: 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 screen 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 tab *Server Search* with the *Add Layer(s) from a Server* dialog.

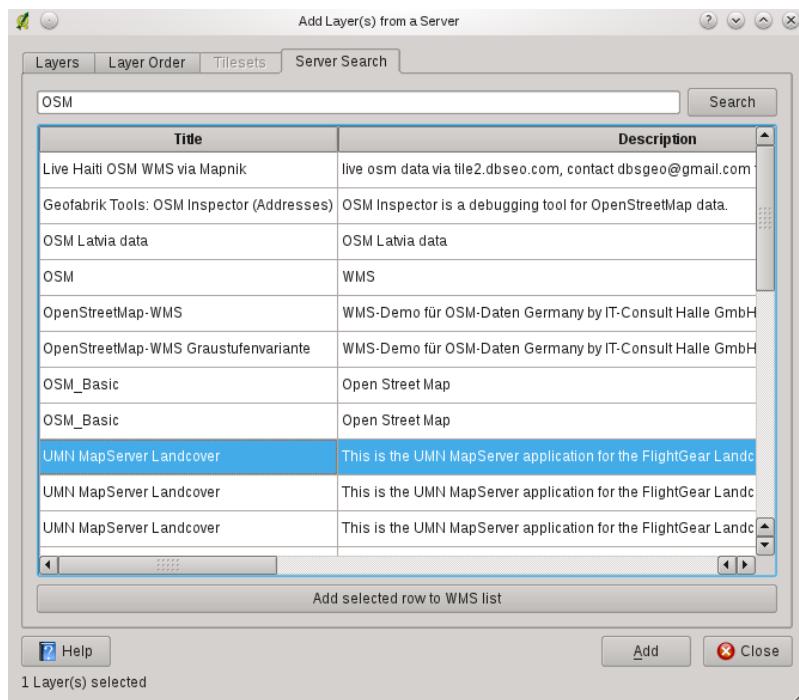


Figure 13.2: Dialog for searching WMS servers after some keywords 🐧

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 tab *Layers*. QGIS automatically has 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 frontend to the API of <http://geopole.org>.

Tilesets

When using WMS-C (Cached WMS) Services like <http://labs.metacarta.com/wms-c/Basic.py> you are able to browse through the tab *Tilesets* 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 from the *View → Tile scale slider*, which gives you the available scales from the tileserver with 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. **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 cleaned by reading the WMS standards (see OPEN-GEOSPATIAL-CONSORTIUM [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.

WMS Client Limitations

Not all possible WMS Client functionality had been included in this version of QGIS. Some of the more notable exceptions follow.

Editing WMS Layer Settings

Once you've completed the  Add WMS layer procedure, there is no ability to change the settings. A workaround is to delete the layer completely and start again.

WMS Servers Requiring Authentication

Currently public 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 Servers](#) for details.

Tip: Accessing secured OGC-layers

If you need to access secured layers with other secured methods than basic authentication, you could use InteProxy as a transparent proxy, which does support several authentication methods. More information can be found at the InteProxy manual found on the website <http://inteproxy.wald.intevation.org>.

Tip: QGIS WMS Mapserver

From Version 1.7.0 QGIS has its own implementation of a WMS 1.3.0 Mapserver. Read more about this at chapter [QGIS Server](#).

13.1.3 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 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: http://www2.dmsolutions.ca/cgi-bin/mswfs_gmap

1. Click on the  Add WFS Layer tool on the Layers toolbar, the dialog *Add WFS Layer from a Server* 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*  combobox
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 proxy-settings you have set in your preferences are also recognized.

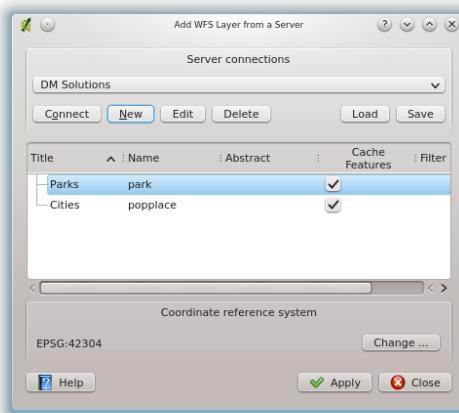


Figure 13.3: Adding a WFS layer 

You'll notice the download progress is visualized in the left bottom 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 point 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 *Mailing lists* for further information about the mailinglists.

Tip: Finding WFS Servers

You can find additional WFS servers by using Google or your favorite search engine. There are a number of lists with public URLs, some of them maintained and some not.

13.2 QGIS Server

QGIS Server is an open source WMS 1.3 and WFS 1.0.0 implementation which, 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 webserver (e.g. Apache, Lighttpd). It is funded by the EU projects Orchestra, Sany and the city of Uster in Switzerland.

It uses QGIS as backend 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.

Moreover, the QGIS Server project provides the ‘Publish to Web’ plugin, a plugin for QGIS desktop which exports the current layers and symbology as a web project for QGIS Server (containing cartographic visualization rules expressed in SLD).

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. The ‘Publish to Web’ plugin currently supports basic symbolization, with more complex cartographic visualization rules introduced manually. As the configuration is performed with the [SLD standard](#) and its documented extensions, there is only one standardised language to learn, which greatly simplifies the complexity of creating maps for the Web.

In one of the following manuals we will provide a sample configuration to set up a QGIS Server. But for now we recommend to read one of the following URLs to get more information:

- http://karlinapp.ethz.ch/qgis_wms/
- http://hub.qgis.org/projects/quantum-gis/wiki/QGIS_Server_Tutorial
- <http://linfiniti.com/2010/08/qgis-mapserver-a-wms-server-for-the-masses/>

13.2.1 Sample installation on Debian Squeeze

At this point we will give a short and simple sample installation howto for Debian Squeeze. Many other OS provide packages for QGIS Server, too. If you have to build it all from source, please refer to the URLs above.

Apart from qgis and qgis-mapserver you need a webserver, in our case apache2. You can install all packages with aptitude or apt-get install together with other necessary dependency packages. After installation you should test, if the webserver and qgis server works as expected. Make sure the apache server is running with /etc/init.d/apache2 start. Open a web browser and type URL: http://localhost. If apache is up, you should see the message 'It works!'.

Now we test the qgis server installation. The qgis_mapserv.fcgi is available at /usr/lib/cgi-bin/qgis_mapserv.fcgi and provides a standard wms that shows the state boundaries of Alaska. Add the WMS with the URL http://localhost/cgi-bin/qgis_mapserv.fcgi as described in [Selecting WMS Servers](#).

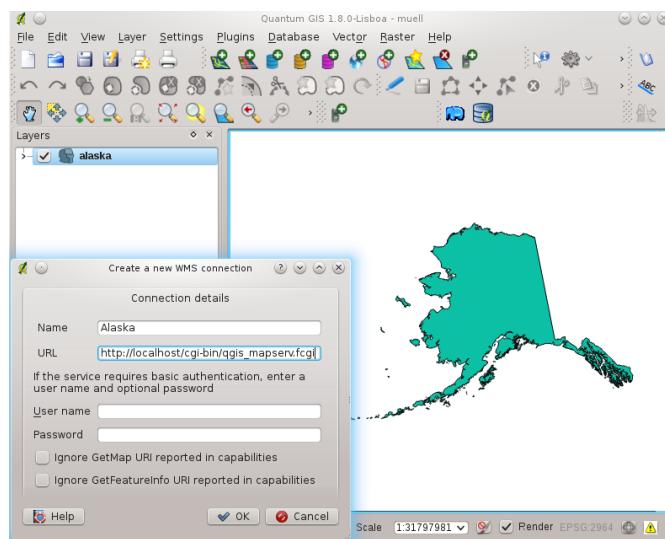


Figure 13.4: Standard WMS with USA boundaries included in the qgis server (KDE) 

13.2.2 Creating a WMS/WFS from a QGIS project

To provide a new qgis wms/wfs server 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 define the project CRS, if not already done.

Then open the OWS Server tab in the menu *Settings* → *Project Properties* and define the general fields under 'Service Capabilities'. For WMS Capabilities define 'Coordinate System Restrictions' and 'Advertised Extend'. Additionally you can enable the checkbox *Add WKT geometry to feature into response* to make the layers queryable and add a 'Maximum width' and height that can be requested. For WFS Capabilities you only need to select the layers that you want to provide as WFS. 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 and WFS, add the WMS and WFS as described in [Loading WMS Layers](#) and [WFS and WFS-T Client](#) to QGIS and load the WMS. The URL is:

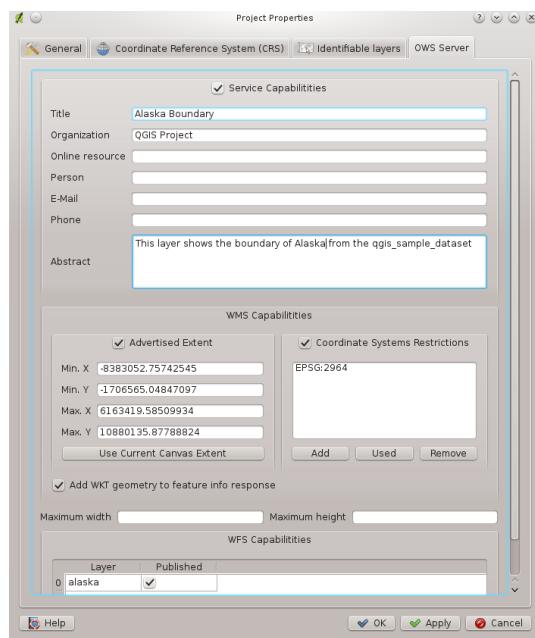


Figure 13.5: Definitions for a qgis project WMS/WFS server (KDE)

http://localhost/cgi-bin/project/qgis_mapserv.fcgi

Working with GPS Data

14.1 GPS Plugin

14.1.1 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. It 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 receivers 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.

14.1.2 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* →  *Plugin Manager...* opens the Plugin Manager Dialog. Activate the *GPS Tools* checkbox. When this plugin is loaded two buttons with a small handheld GPS device will show up in the toolbar:

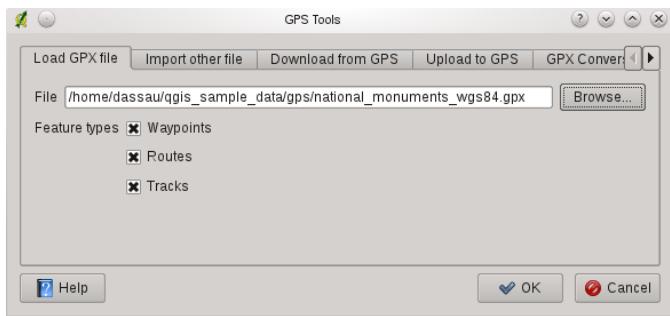
-  Create new GPX Layer
-  GPS Tools

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. Click on the  *GPS Tools* icon 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.

Note: GPS units allow 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 Quantum GIS, be sure that the data stored in the GPX file uses WGS84 (latitude/longitude). Quantum GIS expects this and it is the official GPX specification. See <http://www.topografix.com/GPX/1/1/>

Figure 14.1: The *GPS Tools* dialog window

14.1.3 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.

14.1.4 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.

14.1.5 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.

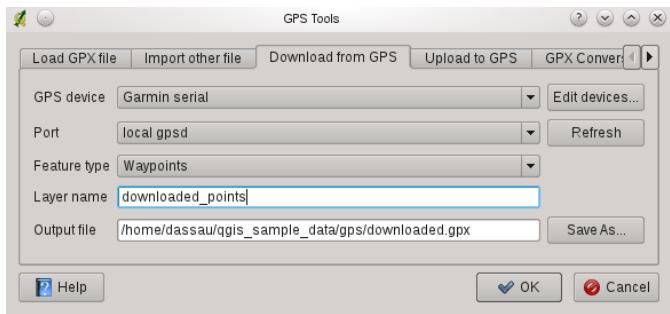


Figure 14.2: The download tool

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`
-  On 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.

14.1.6 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.

14.1.7 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 tabs.

To define a new device you simply click the **[New device]** button, enter a name, a download command and an upload command for your device, and click the **[Update device]** button. The name will be listed in the device menus in the upload and download windows, and 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/ttyS0` to the file `output.gpx`, QGIS will replace the keywords and run the command `gpsbabel -w -i garmin -o gpx /dev/ttyS0 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.

14.2 Live GPS tracking

To activate Live GPS tracking in QGIS you need to select *Settings* →  *GPS information*. You will get a new docked window on the left side of the canvas.

There are 4 possible screens in this GPS tracking window:

-  GPS position coordinates and for manually entering Vertices and Features.

-  GPS signal strength of satellite connections.
-  GPS polar screen showing number and polar position of satellites.
-  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.

Warning: 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.

14.2.1 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.



Figure 14.3: GPS tracking position and additional attributes 

14.2.2 GPS signal strength

 Here you can see the signal strength of the satellites you are receiving signals from.

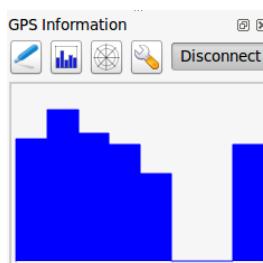


Figure 14.4: GPS tracking signal strength 

14.2.3 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.

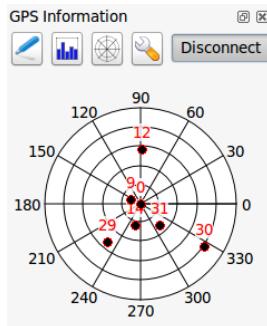


Figure 14.5: GPS tracking polar window 

14.2.4 GPS options

 In case of connection problems you can switch between:

- Autodetect
- Internal,
- Serial device
- gpsd (selecting Host, Port and Device your GPS is connected to).

A click on [Connect] again initiates the connection to the GPS receiver.

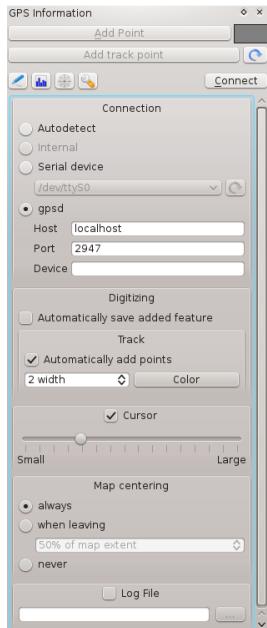


Figure 14.6: GPS tracking options window 

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 to decide in which way the canvas will be updated. This includes ‘always’, ‘when leaving’ if your recorded coordinates start either to move out of canvas or ‘never’ to keep map extent.

Finally you can activate *Log file* and define a path and a file where log messages about the gps tracking a 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**].

GRASS GIS Integration

The GRASS plugin provides access to GRASS GIS (see GRASS-PROJECT *Literature and Web References*) databases and functionalities. This includes visualization of GRASS raster and vector layers, digitizing vector layers, editing vector attributes, creating new vector layers and analysing GRASS 2D and 3D data with more than 300 GRASS modules.

In this Section we'll introduce the plugin functionalities and give some examples on managing and working with GRASS data. Following main features are provided with the toolbar menu, when you start the GRASS plugin, as described in section *Starting the GRASS plugin* :

-  Open mapset
-  New mapset
-  Close mapset
-  Add GRASS vector layer
-  Add GRASS raster layer
-  Create new GRASS vector
-  Edit GRASS vector layer
-  Open GRASS tools
-  Display current GRASS region
-  Edit current GRASS region

15.1 Starting the GRASS plugin

To use GRASS functionalities and/or visualize GRASS vector and raster layers in QGIS, you must select and load the GRASS plugin with the Plugin Manager. Therefore click the menu *Plugins* →  *Manage Plugins*, select *GRASS* and click **[OK]**.

You can now start loading raster and vector layers from an existing GRASS LOCATION (see section *Loading GRASS raster and vector layers*). Or you create a new GRASS LOCATION with QGIS (see section *Creating a new GRASS LOCATION*) and import some raster and vector data (see Section *Importing data into a GRASS LOCATION*) for further analysis with the GRASS Toolbox (see section *The GRASS toolbox*).

15.2 Loading GRASS raster and vector layers

With the GRASS plugin, you can load vector or raster layers using the appropriate button on the toolbar menu. As an example we use the QGIS alaska dataset (see Section [Sample Data](#)). It includes a small sample GRASS LOCATION with 3 vector layers and 1 raster elevation map.

1. Create a new folder `grassdata`, download the QGIS alaska dataset `qgis_sample_data.zip` from <http://download.osgeo.org/qgis/data/> and unzip the file into `grassdata`.
2. Start QGIS.
3. If not already done in a previous QGIS session, load the GRASS plugin clicking on *Plugins* →  *Manage Plugins* and activate **GRASS**. The GRASS toolbar appears in the QGIS main window.
4. In the GRASS toolbar, click the  **Open mapset** icon to bring up the MAPSET wizard.
5. For **Gisdbase** browse and select or enter the path to the newly created folder `grassdata`.
6. You should now be able to select the **LOCATION**  `alaska` and the **MAPSET**  `demo`.
7. Click **[OK]**. Notice that some previously disabled tools in the GRASS toolbar are now enabled.
8. Click on  **Add GRASS raster layer**, choose the map name `gtopo30` and click **[OK]**. The elevation layer will be visualized.
9. Click on  **Add GRASS vector layer**, choose the map name `alaska` and click **OK**. The alaska boundary vector layer will be overlaid on top of the `gtopo30` map. You can now adapt the layer properties as described in chapter [The Vector Properties Dialog](#), e.g. change opacity, fill and outline color.
10. Also load the other two vector layers `rivers` and `airports` and adapt their properties.

As you see, it is very simple to load GRASS raster and vector layers in QGIS. See following sections for editing GRASS data and creating a new LOCATION. More sample GRASS LOCATIONS are available at the GRASS website at <http://grass.osgeo.org/download/data.php>.

Tip: GRASS Data Loading

If you have problems loading data or QGIS terminates abnormally, check to make sure you have loaded the GRASS plugin properly as described in section [Starting the GRASS plugin](#).

15.3 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 **LOCATION**. 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, subregions, or as workspaces for individual team members (Neteler & Mitasova 2008 [Literature and Web References](#)). In order to analyze vector and raster layers with GRASS modules, you must 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 data sets without importing them. But because this is not the usual way for beginners to work with GRASS, this functionality will not be described here.).

15.3.1 Creating a new GRASS LOCATION

As an example here is how the sample GRASS **LOCATION** `alaska`, which is projected in Albers Equal Area projection with unit feet was created for the QGIS sample dataset. This sample GRASS **LOCATION** `alaska`

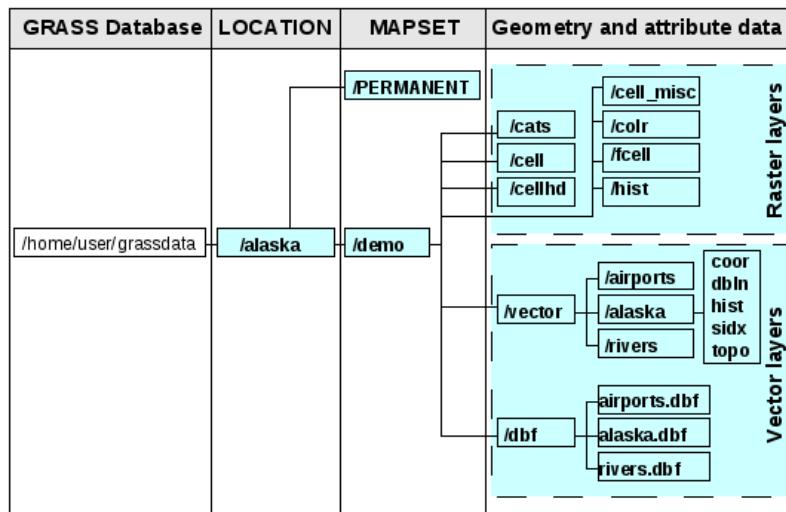


Figure 15.1: GRASS data in the alaska LOCATION

will be used for all examples and exercises in the following GRASS GIS related chapters. It is useful to download and install the dataset on your computer ([Sample Data](#)).

1. Start QGIS and make sure the GRASS plugin is loaded.
2. Visualize the `alaska.shp` Shapefile (see Section [Loading a Shapefile](#)) from the QGIS alaska dataset [Sample Data](#).
3. In the GRASS toolbar, click on the 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. Click on the radio button [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 projector 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 north, south, east, and west direction. Here we simply click on the button *Set current QGIS extent*, to apply the extend of the loaded layer `alaska.shp` as the GRASS default region extend.
12. Click [**Next**].
13. We also need to define a MAPSET within our new LOCATION. You can name it whatever you like - we used `demo` (When creating a new LOCATION). GRASS automatically creates a special MAPSET called `PERMANENT` designed to store the core data for the project, its default spatial extend and coordinate system definitions (Neteler & Mitasova 2008 [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 MAPSET demo, as you defined.
16. Notice that some of the tools in the GRASS toolbar that were disabled are now enabled.



Figure 15.2: 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](#).

15.3.2 Adding a new MAPSET

A user has only write access to a GRASS MAPSET he created. This means that besides access to his own MAPSET, each user can read maps in other user's MAPSETS, but he can modify or remove only the maps in his own MAPSET.

All MAPSETS include a WIND file that stores the current boundary coordinate values and the currently selected raster resolution (Neteler & Mitasova 2008 [Literature and Web References](#), see Section [The GRASS region tool](#)).

1. Start QGIS and make sure the GRASS plugin is loaded.
2. In the GRASS toolbar, click on the  New 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 its owners.
7. Click [Next], check out the summary to make sure it's all correct and click [Finish].

15.4 Importing data into a GRASS LOCATION

This Section gives an example how to import raster and vector data into the alaska GRASS LOCATION provided by the QGIS alaska dataset. Therefore we use a landcover raster map `landcover.img` and a vector GML File

`lakes.gml` from the QGIS alaska dataset *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 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 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.

15.5 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 labeled) 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. Adjacent forest and lake can share the same boundary, but they have separate attribute tables. It is also possible to attach attributes to boundaries. For example, the boundary between lake and forest is a road, so it can have a different attribute table.

The ‘layer’ of the feature is defined by ‘layer’ inside GRASS. ‘Layer’ is the number which defines if there are 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 or 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.

Tip: 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 <http://grass.osgeo.org/gdp/manuals.php> for more information, books and tutorials in several languages.

15.6 Creating a new GRASS vector layer

To create a new GRASS vector layer with the GRASS plugin click the  Create new GRASS vector toolbar icon. Enter a name in the text box and you can start digitizing point, line or polygon geometries, following the procedure described in Section *Digitizing and editing a GRASS vector layer*.

In GRASS it is possible to organize all sort 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 a new Vector layer*).

Tip: Creating an attribute table for a new GRASS vector layer

If you want to assign attributes to your digitized geometry features, make sure to create an attribute table with columns before you start digitizing (see [figure_grass_digitizing_5](#)).

15.7 Digitizing and editing a GRASS vector layer

The digitizing tools for GRASS vector layers are accessed using the  Edit GRASS vector layer icon on the toolbar. Make sure you have loaded a GRASS vector and it is the selected layer in the legend before clicking on the edit tool. Figure [figure_grass_digitizing_2](#) shows the GRASS edit dialog that is displayed when you click on the edit tool. The tools and settings are discussed in the following sections.

Tip: Digitizing polygons in GRASS

If you want to create a polygon in GRASS, you first digitize the boundary of the polygon, setting the mode to ‘No category’. Then you add a centroid (label point) into the closed boundary, setting the mode to ‘Next not used’. The reason is, that a topological vector model links attribute information of a polygon always to the centroid and not to the boundary.

Toolbar

In [figure_grass_digitizing_1](#) you see the GRASS digitizing toolbar icons provided by the GRASS plugin. Table [table_grass_digitizing_1](#) explains the available functionalities.



Figure 15.3: GRASS Digitizing Toolbar

Icon	Tool	Purpose
• •	New Point	Digitize new point
• -	New Line	Digitize new line
• • •	New Boundary	Digitize new boundary (finish by selecting new tool)
○ •	New Centroid	Digitize new centroid (label existing area)
◆ ◆	Move vertex	Move one vertex of existing line or boundary and identify new position
★	Add vertex	Add a new vertex to existing line
✖	Delete vertex	Delete vertex from existing line (confirm selected vertex by another click)
◆ ◆	Move element	Move selected boundary, line, point or centroid and click on new position
✂	Split line	Split an existing line to 2 parts
~	Delete element	Delete existing boundary, line, point or centroid (confirm selected element by another click)
>List	Edit attributes	Edit attributes of selected element (note that one element can represent more features, see above)
ⓧ	Close	Close session and save current status (rebuilds topology afterwards)

Table GRASS Digitizing 1: GRASS Digitizing Tools

Category Tab

The *Category* tab allows you to define the way in which the category values will be assigned to a new geometry element.



Figure 15.4: GRASS Digitizing Category Tab

- **Mode:** what category value shall be applied to new geometry elements.
 - Next not used - apply next not yet used category value to geometry element.
 - Manual entry - manually define the category value for the geometry element in the ‘Category’-entry field.
 - No category - Do not apply a category value to the geometry element. This is e.g. used for area boundaries, because the category values are connected via the centroid.
- **Category** - A number (ID) is attached to each digitized geometry element. It is used to connect each geometry element with its attributes.
- **Field (layer)** - Each geometry element can be connected with several attribute tables using different GRASS geometry layers. Default layer number is 1.

Tip: Creating an additional GRASS ‘layer’ with QGIS

If you would like to add more layers to your dataset, just add a new number in the ‘Field (layer)’ entry box and press return. In the Table tab you can create your new table connected to your new layer.

Settings Tab

The *Settings* tab allows you to set the snapping in screen pixels. The threshold defines at what distance new points or line ends are snapped to existing nodes. This helps to prevent gaps or dangles between boundaries. The default is set to 10 pixels.

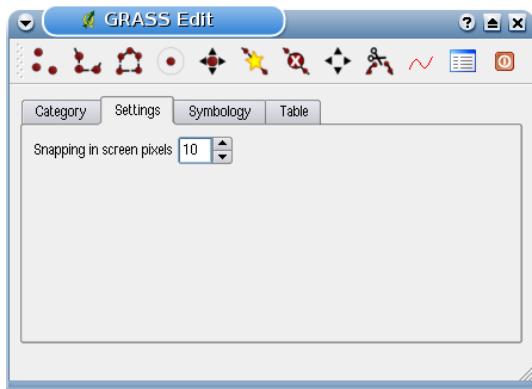
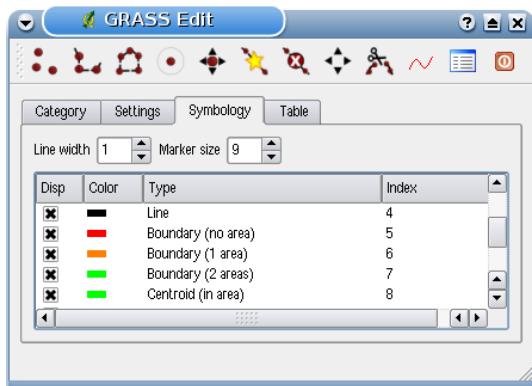


Figure 15.5: GRASS Digitizing Settings Tab

Symbology Tab

The *Symbology* tab allows you to view and set symbology and color settings for various geometry types and their topological status (e.g. closed / opened boundary).



Disp	Color	Type	Index
×	—	Line	4
×	—	Boundary (no area)	5
×	—	Boundary (1 area)	6
×	—	Boundary (2 areas)	7
×	—	Centroid (in area)	8

Figure 15.6: GRASS Digitizing Symbolog Tab

Table Tab

The *Table* tab provides information about the database table for a given ‘layer’. Here you can add new columns to an existing attribute table, or create a new database table for a new GRASS vector layer (see Section [Creating a new GRASS vector layer](#)).

Tip: 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 permissions.

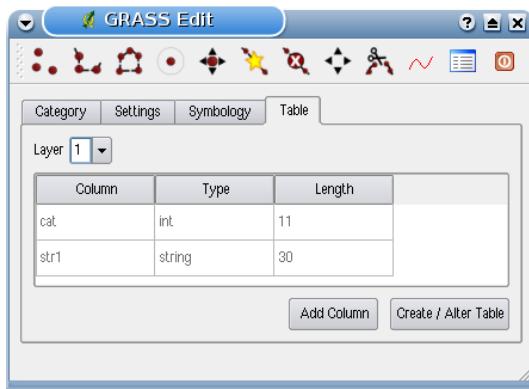


Figure 15.7: GRASS Digitizing Table Tab

15.8 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/off the visualization of the GRASS region in the QGIS canvas using the `Display current GRASS region` button.

With the `Edit current GRASS region` icon you can open a dialog to change the current region and the symbology of the GRASS region rectangle in the QGIS canvas. Type in the new region bounds and resolution and click **[OK]**. It also allows to select a new region interactively with your mouse on the QGIS canvas. Therefore click with the left mouse button in the QGIS canvas, open a rectangle, close it using the left mouse button again and click **[OK]**.

The GRASS module `g.region` provide a lot more parameters to define an appropriate region extend and resolution for your raster analysis. You can use these parameters with the GRASS Toolbox, described in Section [The GRASS toolbox](#).

15.9 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 where you have write-permission (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.

The GRASS Shell inside the GRASS Toolbox provides access to almost all (more than 330) GRASS modules through 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.

15.9.1 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.

A complete list of GRASS modules available in the graphical Toolbox in QGIS version 1.8.0 is available in the GRASS wiki (http://grass.osgeo.org/wiki/GRASS-QGIS_relevant_module_list).

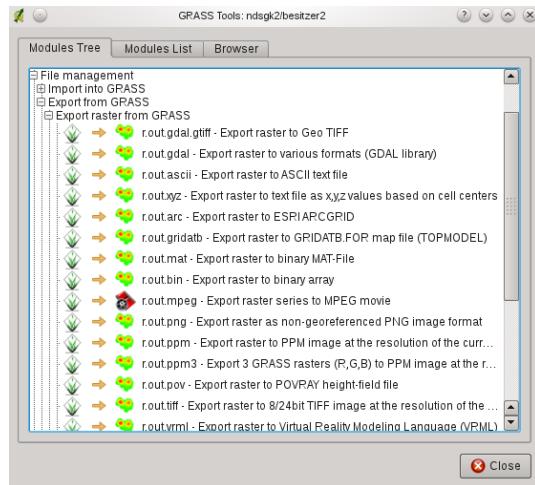


Figure 15.8: GRASS Toolbox and Module Tree 

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.

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.

The provided module parameters are often not complete to keep the dialog clear. 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 in QGIS 1.8.0 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 use, but will probably be part of more / all modules in the GRASS toolbox in future versions of QGIS. This allows to use the complete GRASS module options without the need to switch to the GRASS Shell.

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

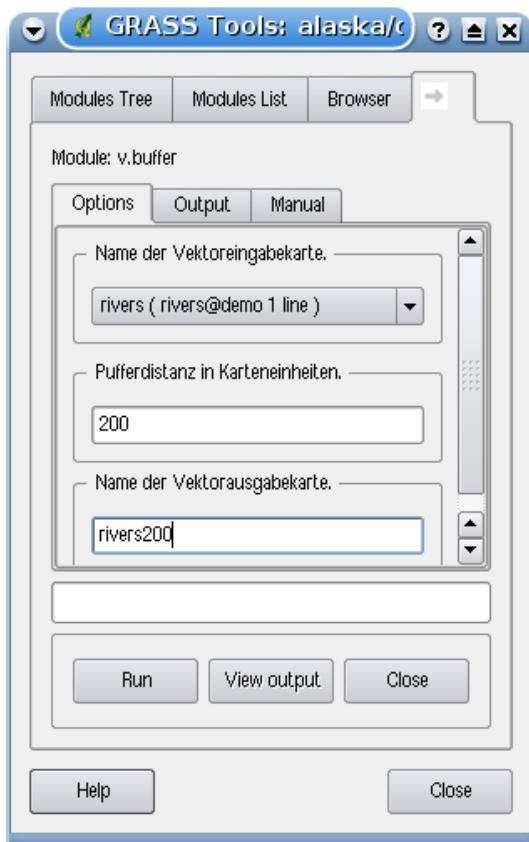
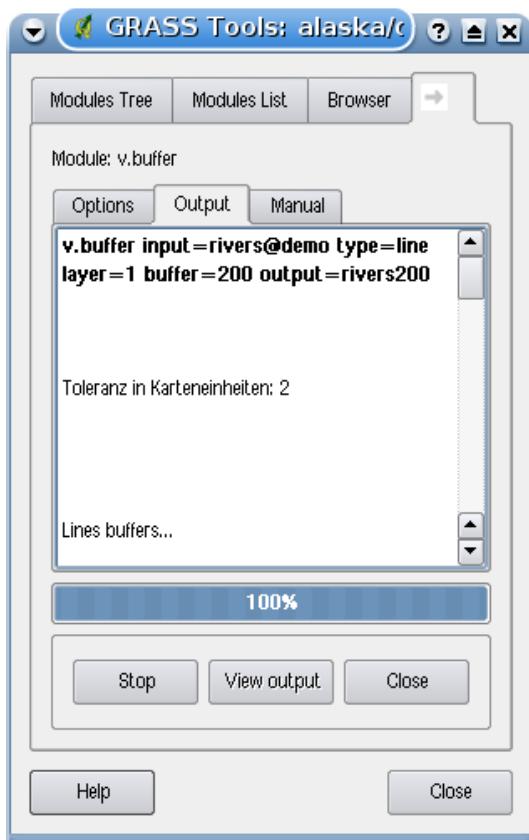
The *Manual* tab shows the HTML help page of the GRASS module. You can use it to check further module parameters and flags or to get a deeper knowledge about the purpose of the module. At the end of each module manual page you see further links to the Main Help index, the Thematic index and the Full index. These links provide the same information as if you use the module `g.manual`.

Tip: 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.

15.9.2 GRASS module examples

The following examples will demonstrate the power of some of the GRASS modules.

Figure 15.9: GRASS Toolbox Module Options Figure 15.10: GRASS Toolbox Module Output 

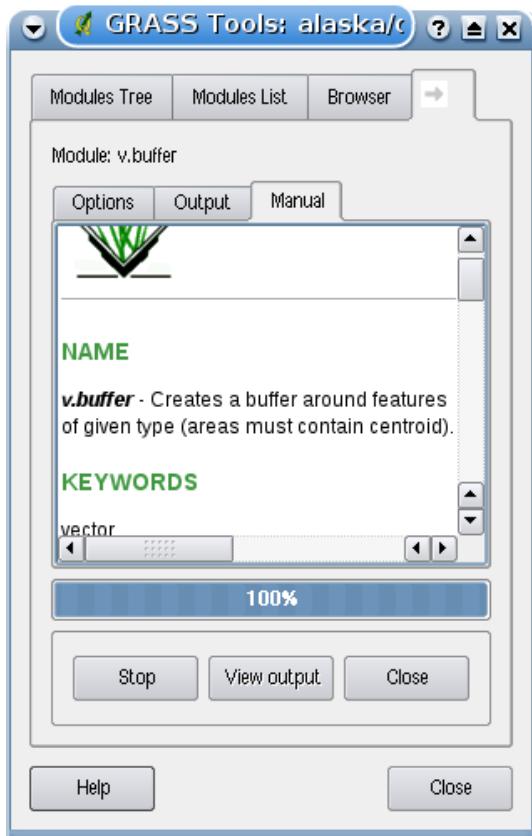


Figure 15.11: GRASS Toolbox Module Manual 🐧

Creating contour lines

The first example creates a vector contour map from an elevation raster (DEM). Assuming 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 load the gtopo30 elevation raster by clicking Add GRASS raster layer and selecting the gtopo30 raster from the demo location.
- Now open the Toolbox with the Open GRASS tools button.
- In the list of tool categories double click *Raster → Surface Management → Generate vector contour lines*.
- Now a single click on the tool **r.contour** will open the tool dialog as explained above [Working with GRASS modules](#). The gtopo30 raster should appear as the *Name of input raster*.
 - Type into the *Increment between Contour levels* 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 will be used when you have a highly detailed vector, but you are creating a very small scale map, so the detail is unnecessary.

Tip: The simplify tool

Note that the QGIS fTools plugin has a *Simplify geometries* → 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 Chaikens 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* → *Develop map* → *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.

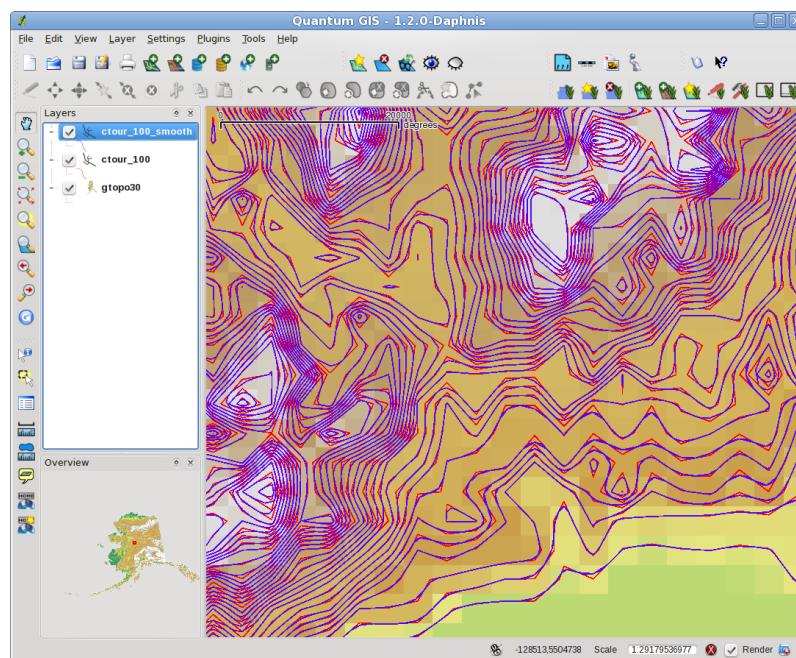


Figure 15.12: GRASS module **v.generalize** to smooth a vector map 

Tip: Other uses for **r.contour**

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 3D effect

Several methods are used to display elevation layers and give a 3D 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 3D 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 and 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* 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 hill shading and the colors of the gtopo30 together shift 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.

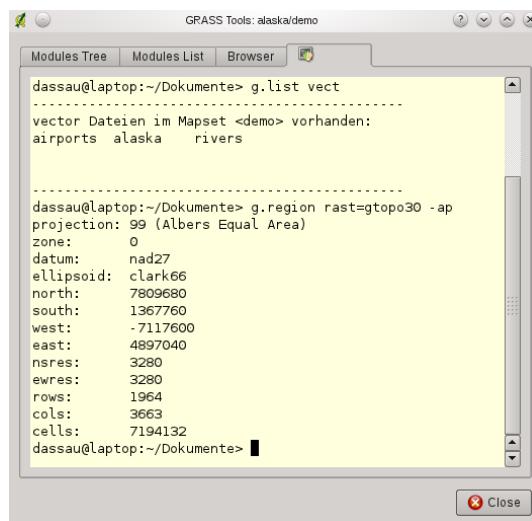


Figure 15.13: The GRASS shell, **r.shaded.relief** module

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 zmultiplication=3` and press [**Enter**].

- After the process finishes shift to the *Browse* tab and double click on the new `gtopo30_shade2` raster to display in QGIS.
- As explained above, shift the shaded relief below the `gtopo30` raster in the Table of Contents, then check transparency of the colored `gtopo30` layer. You should see that the 3D effect stands out more strongly compared to the first shaded relief map.

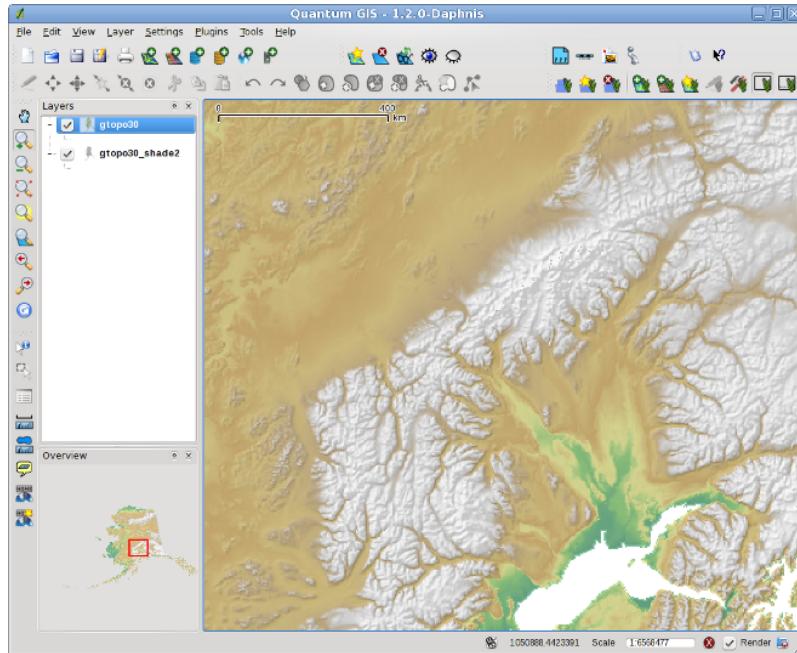


Figure 15.14: Displaying shaded relief created with the GRASS module `r.shaded.relief` 

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 intermediary 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 → 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 :ref:sec_symbology in the vector section).
- Next reopen the GRASS toolbox and open *Vector → 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.

15.9.3 Working with the GRASS LOCATION browser

Another useful feature inside the GRASS Toolbox is the GRASS LOCATION browser. In [figure_grass_module_7](#) you can see the current working LOCATION with its MAPSETS.

In the left browser windows you can browse through all MAPSETS inside the current LOCATION. The right browser window shows some meta information for selected raster or vector layers, e.g. resolution, bounding box, data source, connected attribute table for vector data and a command history.

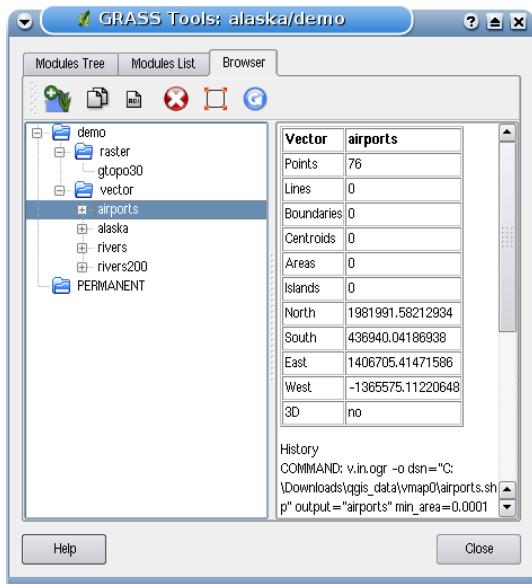


Figure 15.15: GRASS LOCATION browser 

The toolbar inside the *Browser* tab offers following tools to manage the selected LOCATION:

-  *Add selected map to canvas*
-  *Copy selected map*
-  *Rename selected map*
-  *Delete selected map*
-  *Set current region to selected map*
-  *Refresh browser window*

The  *Rename selected map* and  *Delete selected map* only work with maps inside your currently selected MAPSET. All other tools also work with raster and vector layers in another MAPSET.

15.9.4 Customizing the GRASS Toolbox

Nearly all GRASS modules can be added to the GRASS toolbox. A XML interface is provided to parse the pretty simple XML files which configures the modules appearance and parameters inside the toolbox.

A sample XML file for generating the module `v.buffer` (`v.buffer.qgm`) looks like this:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE qgisgrassmodule SYSTEM "http://mrcc.com/qgisgrassmodule.dtd">

<qgisgrassmodule label="Vector buffer" module="v.buffer">
```

```
<option key="input" typeoption="type" layeroption="layer" />
<option key="buffer"/>
<option key="output" />
</qgisgrassmodule>
```

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 the modules group, etc. can be found on the QGIS wiki at http://hub.qgis.org/projects/quantum-gis/wiki/Adding_New_Tools_to_the_GRASS_Toolbox

OpenStreetMap

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

The OpenStreetMap plugin, a core QGIS plugin, provides the basic functionalities for OSM data manipulation; this includes data loading, importing, saving, downloading, editing and uploading data back to the OpenStreetMap server. While implementing the OSM plugin an inspiration was taken from existing OSM data editors. The purpose was to combine their functionalities to get the best possible result.

The following section gives a brief introduction to principles of the OSM project.

Parts of the following paragraphs are copied from the OpenStreetMap web site at <http://www.openstreetmap.org>.

16.1 The OpenStreetMap project

OpenStreetMap is a project to create a free editable map of the world. The maps are created using data from portable GPS devices, aerial photography, other free sources or simply from local knowledge. The project was started because most maps have legal or technical restrictions on their use, restricting people from using them in creative, productive, or unexpected ways. Both rendered images and the vector dataset of OSM are available for download under a Creative Commons Attribution ShareAlike 2.0 license.

OpenStreetMap was inspired by sites such as Wikipedia - the map display (see [Figure_OpenStreetMap_1](#)) features a prominent *Edit* tab and a full revision history is maintained. Registered users can upload GPS track logs and edit the vector data using the given editing tools.

OSM data primitive is an object class that can be stored via the API in the server. The three supported types of data are: **Node**, **Way** and **Relation**.

- A **node** is a latitude/longitude pair of coordinates. It is used as building a block for other features and as a feature itself (Points Of Interest), if they are tagged as required.
- A **way** is a list of at least two nodes that describe a linear feature such as a street, or similar. Nodes can be members of multiple ways.
- A **relation** is a group of zero or more primitives with associated roles. It is used to specify relationships between objects, and may also model an abstract object.

Several different logical features in a common map ‘Point Of Interest’, ‘Street’, ‘Tram Line’, ‘Bus Stop’ etc.) are defined by these primitives. Map features are well-known in the OSM community and are stored as tags, based on a key and a value. OSM is usually distributed in XML format. XML payload is used for the communication with the OSM server as well.

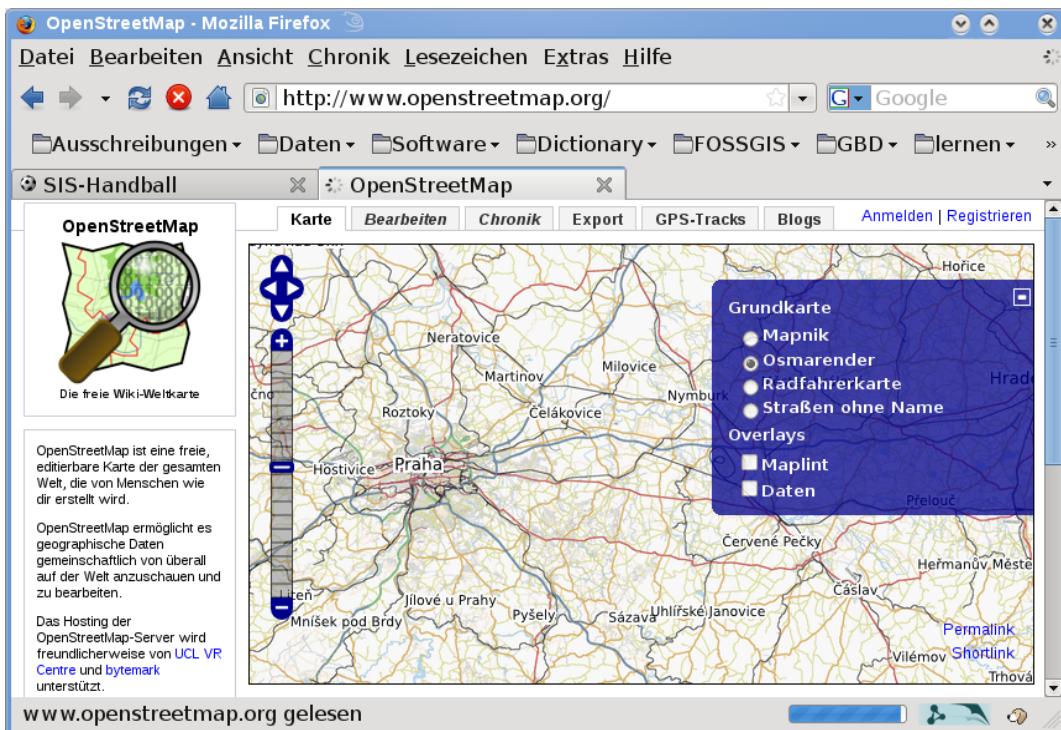


Figure 16.1: OpenStreetMap data in the web

16.2 QGIS - OSM Connection

The first part of this section describes how OSM data primitives are displayed in QGIS vector layers. As previously mentioned, OSM data consists of Nodes, Ways and Relations. In QGIS, they are displayed in three different layer types: Point layer, Line layer and Polygon layer. It is not possible to remove any of these layers and work with the other ones.

- A **Point layer** displays all features of type Node that stands alone. That means that only Nodes that are not included in any Way belongs to the Point layer.
- A **Line layer** displays those OSM features of type Way that are not closed. That means, none of these Ways starts and ends with the same Node.
- A **Polygon layer** displays all Ways that are not included in Line layer.

OpenStreetMap has one more data primitive in addition to the three mentioned above. This is called **Relation**. There is purposely no vector layer to display Relations. A Relation defines a connection between any number of data primitives. After a Point, Line or Polygon is identified on a map, the plugin shows a list of all relations which the identified feature is part of.

It was challenging to design the connection between OSM data and the standard QGIS editing tools. These tools are made to edit a single vector layer at a time, no matter of what feature types it displays. This means that if OSM data are loaded to QGIS through the plugin, you could (theoretically) edit the Point layer, Line layer or Polygon layer with these standard tools separately.

A Line layer consists of two different types of OSM features, Ways and Nodes. In OSM format, a Way is composed of Nodes. If you start editing a Line layer and change the shape of some line, your action affects not only the OSM Way, but also the OSM Nodes that are part of it.

QGIS standard editing tools cannot tell the OSM provider, which members of which line has changed and how. It can tell only what's the new geometry of which line, and that's not enough to propagate changes to the OSM database correctly. The Line layer does also not know the identifiers of the line members. The same problem occurs when you try to edit the Polygon layer.

For this reason, the OSM plugin need its own tools for editing OSM data. While they are used, the OSM layers can be changed correctly. The Plugin editing tools consists of tools for Point, Line, Polygon and Relation creation, deletion and moving.

Note: To create a connection between the OSM plugin and standard editing tools, changes in QuantumGIS core code would be necessary.

16.3 Installation

The OpenStreetMap plugin is a core plugin inside QGIS. The ‘OpenStreetMap’ plugin can be selected in the Plugin Manager as described in section [Loading a QGIS Core Plugin](#).

16.4 Basic user interface

The first time the OSM plugin is started (and after the first data are loaded), several new OSM plugin icons appear in the QGIS toolbar menu together with new dock windows as shown in [figure_OpenStreetMap_2](#).

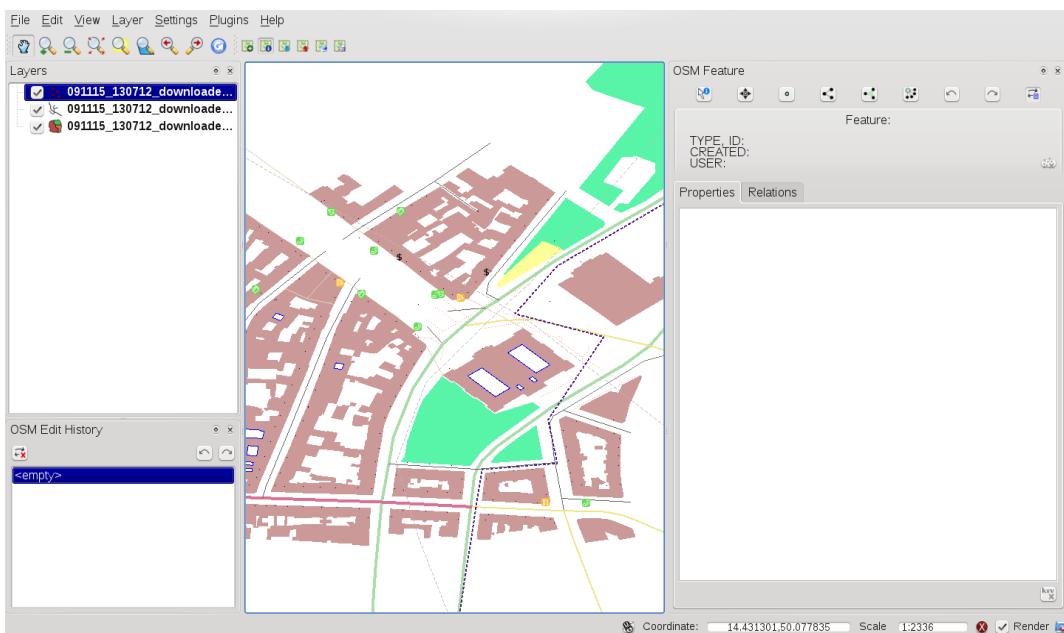


Figure 16.2: OSM plugin user interface

16.4.1 OSM Features widget

The OSM Feature widget helps to identify OSM features. It shows basic information on the feature type and identifier as well as information on who has changed a feature, and when. The OSM Feature widget also provides all editing tools (in the top part of it). More information on those tools can be found in the sections below. The widget is initially disabled. It activates itself after successful loading some OSM data.

16.4.2 OSM Undo/Redo widget

This Undo/Redo widget is used to undo and redo edit actions. It consists not only a classic Undo and Redo button, but also shows a list with a brief description of the edit actions that were done. The OSM Undo/Redo widget is initially closed. You can show it using a button on the OSM Feature widget.

16.4.3 Toolbar menu icons

-  **Load OSM from file** is used to load data from a special OpenStreetMap XML file.
-  **Show/Hide OSM Feature Manager** is used to show or hide the OSM Feature widget. The OSM Feature widget is a panel that helps with OSM feature identification and with OSM data editing.
-  **Download OSM data** is used to download data from the OpenStreetMap server.
-  **Upload OSM data** is used to upload changes (on current data).
-  **Import data from a layer** is used to import data from a vector layer. At least one vector layer must be loaded and current OSM data must be selected.
-  **Save OSM to file** is used to save OSM data back to an XML file.

More detailed information on all the widgets, buttons and dialogs can be found in appropriate sections of this plugin section according to their functionality (editing, identification, etc.).

16.5 Loading OSM data

The first action that should be done after starting the OSM Plugin is opening data from an OSM file. OSM data can be import as shapefile or downloaded directly from the OpenStreetMap server. Here we are focusing on the first mentioned method.

To load data from a file use the  **Load OSM from file** icon. If there is no such button, maybe someone disabled OpenStreetMap toolbar in your QGIS installation. You can enable it again selecting *Settings → Toolbars → OpenStreetMap*.

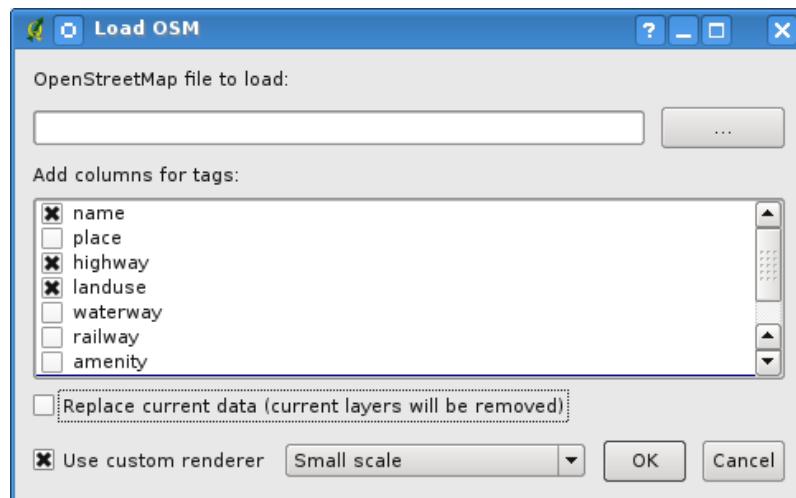


Figure 16.3: Load OSM data dialog

The purpose of its elements is explained below.

OpenStreetMap file to load: Click on the button to select the file:.osm file you want to load data from.

Add columns for tags: This option determines a connection between OSM and QGIS data. Each feature of OSM data has some tags (pairs of key and value), that define the feature properties. Each feature of a QGIS vector layer also has its attributes (key and value). With this option you can define which properties of OSM objects should be visible when displaying detailed information about QGIS features.

Replace current data: Checking this option means that new data should replace current data the user is working with. Layers of current data will be removed and new ones will be loaded. When loading OSM data for the first time, this option is not active, because there is nothing to replace.

Use custom renderer: This option determines how many details of the map will be used. There are three pre-defined OSM styles for map displaying. Use ‘Small scale’ if you want to view OSM data at low level, to see all details and to edit something. If not you can use ‘Medium scale’ or ‘Large scale’. QGIS 1.8.0 doesn’t support changing the renderer style dynamically.

Click [OK] to load your data. If this is the first time the OSM file is loaded, the plugin must first parse the database. This may take few seconds or minutes - it depends on the amount of loaded data.

16.6 Viewing OSM data

After the OSM data are loaded, you can identify map features using the appropriate tool. Use the  Identify feature button on the top-left of the OSM Feature widget. Using this tool you can easily explore all map objects. When the mouse cursor is placed over an object, you can see all information on it directly in the OSM Feature widget. There is also a dynamic rubberband displayed on the map so that the user is able to determine which feature is currently identified.

The *Properties* tab of the widget contains of all feature tags. Clicking on the *Relation* tab shows you a list of all relations connected with identified feature.

If you want to hold a feature for a while to be able to read its properties and relations, move the mouse cursor at the same time, try left-clicking while you are over the feature. Identification process will stop until next left-clicking.

Sometimes there is more than one feature at a point where left-clicking was performed. This happens especially when clicking on cross-roads or if you did not zoom enough into the map. In this situation only one of such features is identified (and marked with the rubberband) but the plugin remembers all of them. Then (still in the pause mode) you can cycle through the identified features by right-clicking.

16.7 Editing basic OSM data

‘Basic data’ in this context means non-relational OSM features - nodes and ways. If you prefer to examine how to perform relational editing, skip this section and move on to the next one.

Basic data editing is a key part of the OSM Plugin. You can change the property, position or shape of any existing basic feature. You can remove features or add new ones. All changes on nodes and ways are remembered by Undo/Redo all changes can be easily uploaded to the OpenStreetMap server.

16.7.1 Changing feature tags

Changing the property/tag of an OSM feature can be done directly in the table of feature tags. The Tags table of basic features can be found on the OSM Feature widget. Don’t forget to identify feature first.

If you want to change a tag value, just double-click in the appropriate row of column ‘Value’ and type, or select a new value. If you want to remove a tag, click in the relevant row, then use the button  Remove selected tags on the right bottom under the table.

To add new tags just type the key and value into the last row of the table where ‘<next tag value>’ is written. Notice that you cannot change the key of an existing tag pair. Conveniently, there are some combo boxes of all existing tag keys and their typical values.

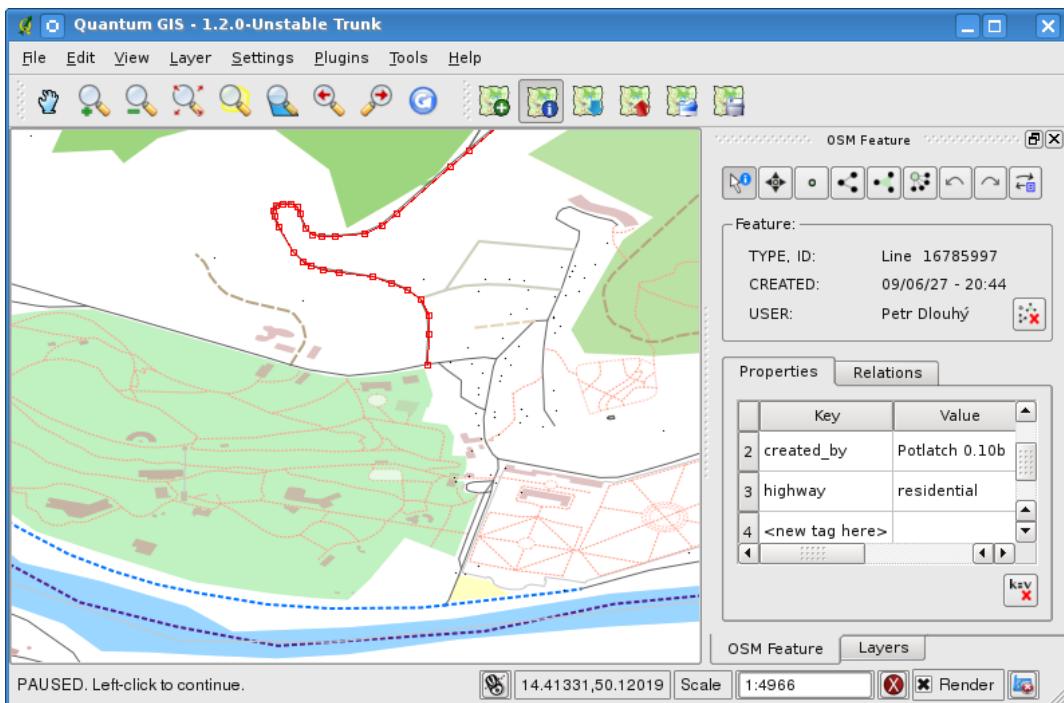


Figure 16.4: Changing an OSM feature tag

16.7.2 Point creation

For point creation there is a Create point button on the OSM Feature widget. To create some points, just click on the button and start clicking on the map. If your cursor is over some map feature, the feature is marked/identified immediately. If you click on the map when a line or polygon is marked, a new point is created directly on such line or polygon as its new member. If your cursor is over an existing point, a new point cannot be created. In such case the OSM plugin will show following message:

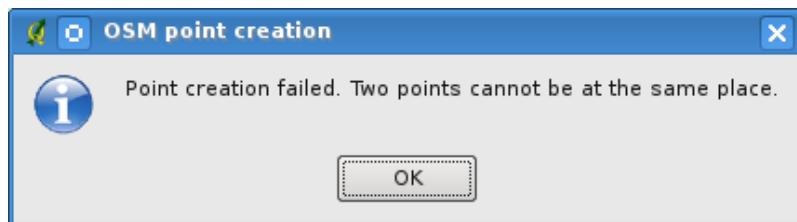


Figure 16.5: OSM point creation message

The mechanism of helping a user to hit the line or polygon is called snapping and is enabled by default. If you want to create a point very close to some line (but not on it) you must disable snapping by holding the **Ctrl** key first.

16.7.3 Line creation

For line creation, there is a Create Line button on the OSM Feature widget. To create a line just click the button and start left-clicking on the map. Each of your left-clicks is remembered as a vertex of the new line. Line creation ends when the first right-click is performed. The new line will immediately appear on the map.

Note: A Line with less than two members cannot be created. In such case the operation is ignored.

Snapping is performed to all map vertices - points from the Point vector layer and all Line and Polygon members. Snapping can be disabled by holding the **Ctrl** key.

16.7.4 Polygon creation

For polygon creation there is a  Create polygon button on the OSM Feature widget. To create a polygon just click the button and start left-clicking on the map. Each of your left-clicks is remembered as a member vertex of the new polygon. The Polygon creation ends when first right-click is performed. The new polygon will immediately appear on the map. Polygon with less than three members cannot be created. In such case operation is ignored. Snapping is performed to all map vertexes - points (from Point vector layer) and all Line and Polygon members. Snapping can be disabled by holding the **Ctrl** key.

16.7.5 Map feature moving

If you want to move a feature (no matter what type) please use the  Move feature button from the OSM Feature widget menu. Then you can browse the map (features are identified dynamically when you go over them) and click on the feature you want to move. If a wrong feature is selected after your click, don't move it from the place. Repeat right-clicking until the correct feature is identified. When selection is done and you move the cursor, you are no more able to change your decision what to move. To confirm the move, click on the left mouse button. To cancel a move, click another mouse button.

If you are moving a feature that is connected to another features, these connections won't be damaged. Other features will just adapt themselves to a new position of a moved feature.

Snapping is also supported in this operation, this means:

- When moving a standalone (not part of any line/polygon) point, snapping to all map segments and vertices is performed.
- When moving a point that is a member of some lines/polylines, snapping to all map segments and vertices is performed, except for vertices of point parents.
- When moving a line/polygon, snapping to all map vertices is performed. Note that the OSM Plugin tries to snap only to the 3 closest-to-cursor vertices of a moved line/polygon, otherwise the operation would be very slow. Snapping can be disabled by holding **Ctrl** key during the operation.

16.7.6 Map feature removing

If you want to remove a feature, you must identify it first. To remove an identified feature, use the  Remove this feature button on the OSM Feature widget. When removing a line/polygon, the line/polygon itself is deleted, so are all its member points that doesn't belong to any other line/polygon.

When removing a point that is member of some lines/polylines, the point is deleted and the geometries of parent lines/polylines are changed. The new parent geometry has less vertices than the old one.

If the parent feature was a polygon with three vertexes, its new geometry has only two vertexes. And because there cannot exist polygon with only two vertices, as described above, the feature type is automatically changed to Line.

If the parent feature was a line with two vertexes, its new geometry has only one vertex. And because there cannot exist a line with only one vertex, the feature type is automatically changed to Point.

16.8 Editing relations

Thanks to existence of OSM relations we can join OSM features into groups and give them common properties - in such way we can model any possible map object: borders of a region (as group of ways and points), routes of a

bus, etc. Each member of a relation has its specific role. There is a pretty good support for OSM Relations in our plugin. Let's see how to examine, create, update or remove them.

16.8.1 Examining relation

If you want to see relation properties, first identify one of its members. After that open the *Relations* tab on the OSM Feature widget. At the top of the tab you can see a list of all relations the identified feature is part of. Please choose the one you want to examine and look at its information below. In the first table called ‘Relation tags’ you find the properties of the selected relation. In the table called ‘Relation members’ you see brief information on the relation members. If you click on a member, the plugin will make a rubberband on it in the map.

16.8.2 Relation creation

There are 2 ways to create a relation:

1. You can use the  Create relation button on OSM Feature widget.
2. You can create it from the *Relation* tab of OSM Feature widget using the  Add relation button.

In both cases a dialog will appear. For the second case, the feature that is currently identified is automatically considered to be the first relation member, so the dialog is pre-filled a little. When creating a relation, please select its type first. You can select one of predefined relation types or write your own type. After that fill the relation tags and choose its members.

If you have already selected a relation type, try using the  Generate tags button. It will generate typical tags to your relation type. Then you are expected to enter values to the keys. Choosing relation members can be done either by writing member identifiers, types and roles or using the  Identify tool and clicking on map.

Finally when type, tags and members are chosen, the dialog can be submitted. In such case the plugin creates a new relation for you.

16.8.3 Changing relation

If you want to change an existing relation, identify it first (follow steps written above in Section [Examining relation](#)). After that click on the  Edit relation button. You will find it on the OSM Feature widget. A new dialog appears, nearly the same as for the ‘create relation’ action. The dialog is pre-filled with information on given relations. You can change relation tags, members or even its type. After submitting the dialog your changes will be committed.

16.9 Downloading OSM data

To download data from OpenStreetMap server click on the  Download OSM data button. If there is no such button, the OSM toolbar may be disabled in your QGIS instalation. You can enable it again at *Settings* → *Toolbars* → *OpenStreetMap*. After clicking the button a dialog occurs and provides following functionalities:

Extent: Specifies an area to download data from intervals of latitude and longitude degrees. Because there is some restriction of OpenStreetMap server on how much data can be downloaded, the intervals must not be too wide.

More detailed info on extent specification can be shown after clicking the  Help button on the right.

Download to: Here you are expected to write a path to the file where data will be stored. If you can't remember the structure of your disk, don't panic. The browse button  will help you.

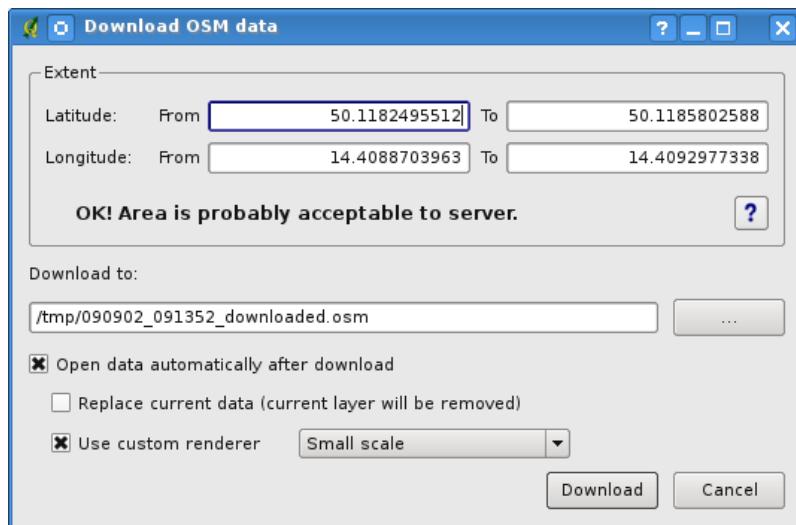


Figure 16.6: OSM download dialog

Open data automatically after download: Determines, if the download process should be followed by loading the data process or not. If you prefer not to load data now, you can do it later by using the  button.

Replace current data: This option is active only if *Open data automatically after download* is checked. Checking this option means that downloaded data should replace current data we are working with now. Layers of the current data will be removed and new ones will be loaded. When starting QGIS and downloading OSM data for the first time, this option is initially inactive, because there is nothing to replace.

Use custom renderer: This option is active only if the *Open data automatically after download* checkbox is checked. It determines how many details will be in the map. There are three predefined OSM styles for map displaying. Use ‘Small scale’ if you want to view OSM data at low level, to see all details and to edit something. If not you can use ‘Medium scale’ or ‘Large scale’. QGIS 1.8.0 does not support changing the renderer style dynamically.

Click the [**Download**] button to start the download process.

A progress dialog will continuously inform you about how much of data is already downloaded. When an error occurs during the download process, a dialog tells you why. When action finishes successfully both the progress dialog and download dialog will close themselves.

16.10 Uploading OSM data

Note that the upload is always done on current OSM data. Before opening the OSM Upload dialog, please be sure that you really have the right active layer with OSM data.

To upload current data to the OSM server click on the  **Upload OSM data** button. If there is no such button, OSM toolbar in your QGIS installation is disabled. You can enable it again in *Settings → Toolbars → OpenStreetMap*. After clicking the [**Upload**] button a new dialog will appear.

At the top of the dialog you can check, if you are uploading the correct data. There is a short name of a current database. In the table you find information on how many changes will be uploaded. Statistics are displayed separately for each feature type.

In the ‘Comment on your changes’ box you can write brief information on meaning of your upload operation. Just write in brief what data changes you’ve done or let the box empty. Fill ‘OSM account’ arrays so that the server could authenticate you. If you don’t have an account on the OSM server, it’s the best time to create one at <http://www.openstreetmap.org>. Finally use [**Upload**] to start an upload operation.

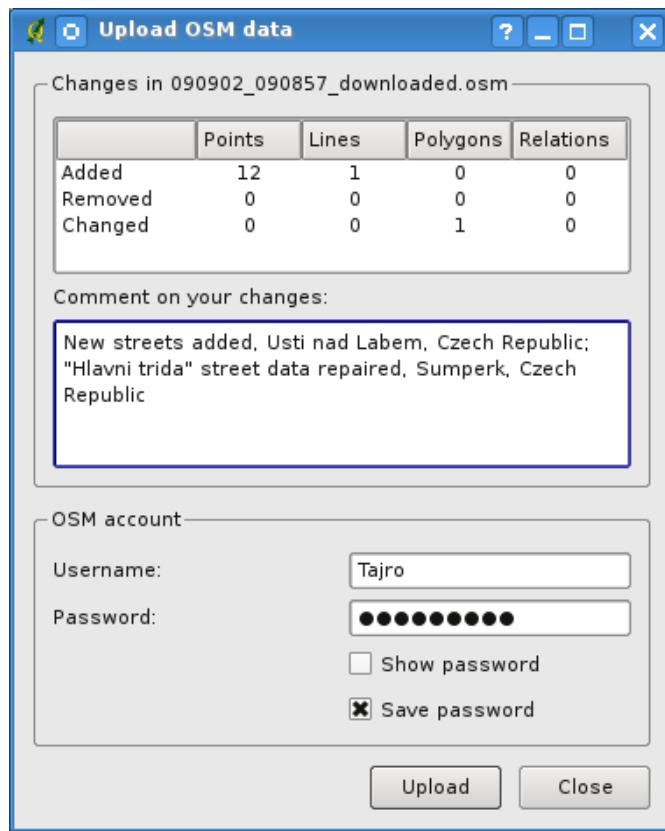


Figure 16.7: OSM upload dialog

16.11 Saving OSM data

To save data from a current map extent to an XML file click on the Save OSM to file button. If there is no such button, the OSM toolbar in your QuantumGIS installation is probably disabled. You can enable it again in *Settings* → *Toolbars* → *OpenStreetMap*. After clicking on the button a new dialog appears.



Figure 16.8: OSM saving dialog

Select features you want to save into XML file and the file itself. Use the [OK] button to start the operation. The process will create an XML file, in which OSM data from your current map extent are represented. The OSM version of the output file is 0.6. Elements of OSM data (<node>, <way>, <relation>) do not contain information on their changesets and uids. This information are not compulsory yet, see DTD for OSM XML version 0.6. In the output file OSM elements are not ordered.

Notice that not only data from the current extent are saved. Into the output file the whole polygons and lines are

saved even if only a small part of them is visible in the current extent. For each saved line/polygon all its member nodes are saved too.

16.12 Import OSM data

To import OSM data from an opened non-OSM vector layer follow this instructions. Choose current OSM data by clicking on one of their layers. Click on the  Import data from a layer button. If there is no such button, someone has probably disabled the OpenStreetMap toolbar in your QGIS installation. You can enable it again in *Settings → Toolbars → OpenStreetMap*.

After clicking on the button following message may show up:

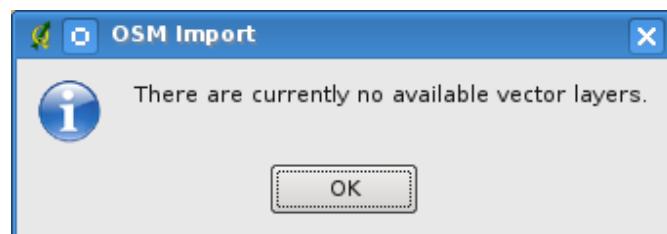


Figure 16.9: OSM import message dialog

In such case there is no vector layer currently loaded. The import must be done from a loaded layer - please load a vector layer from which you want to import data. After a layer is opened, your second try should give you a better result (don't forget to mark the current OSM layer again):



Figure 16.10: Import data to OSM dialog

Use the submit dialog to start the process of OSM data importing. Reject it if you are not sure you want to import something.

SEXTANTE

17.1 Introduction

This chapter introduces SEXTANTE, the powerful geospatial analysis framework of QGIS. SEXTANTE is 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 SEXTANTE and take the most out of each one of them

17.1.1 Basic elements of the SEXTANTE GUI

There are four basic elements in the SEXTANTE GUI, which are used to run SEXTANTE 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, as we will see) can be accessed from the *SEXTANTE* 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 SEXTANTE toolbox. The main element of the SEXTANTE GUI, it is used to execute a single algorithm or run a batch process based on that algorithm.

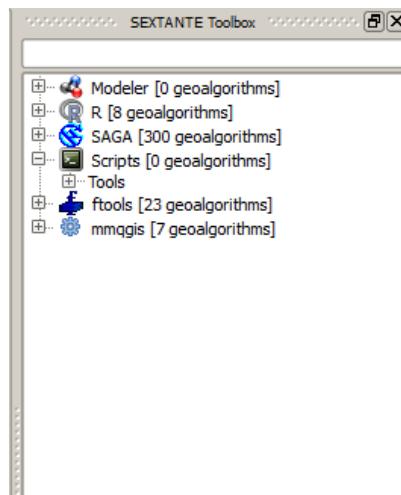


Figure 17.1: SEXTANTE Toolbox

- The SEXTANTE graphical modeler. Several algorithms can be combined graphically using the modeler to define a workflow, creating a single process that involves several sub-processes
- The SEXTANTE 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

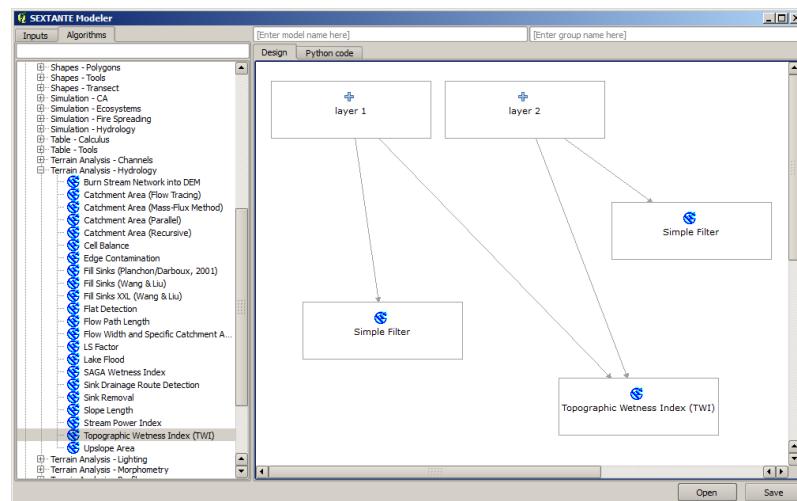


Figure 17.2: SEXTANTE Models

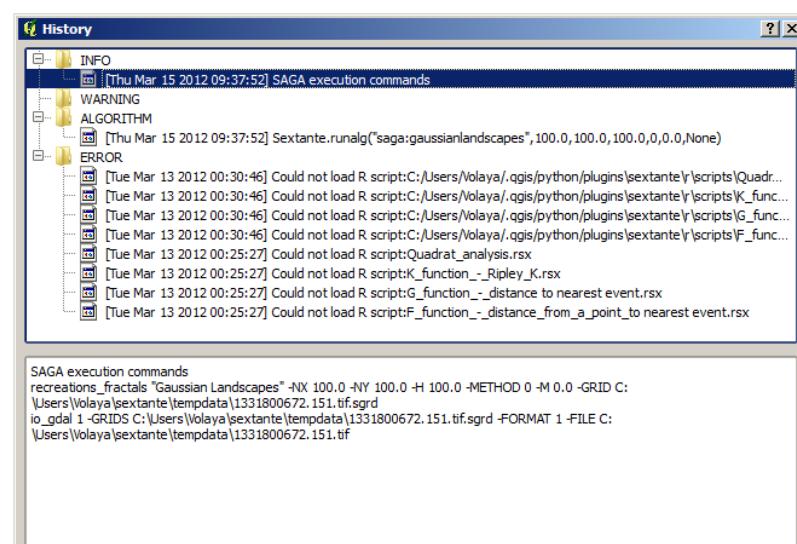


Figure 17.3: SEXTANTE History

- The SEXTANTE batch processing interface manager. This interface allows you to execute batch processes and automate the execution of a single algorithm on multiple datasets.

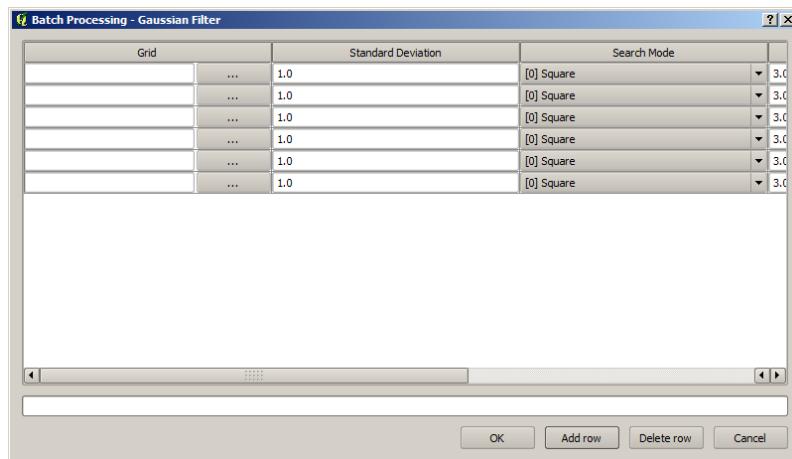


Figure 17.4: SEXTANTE Batch Processing

Along the following sections we will review each one of this elements in detail.

17.2 The SEXTANTE toolbox

17.2.1 Introduction

The *Toolbox* is the main element of the SEXTANTE 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 is the access point to run them whether as a single process or as a batch process involving several executions of a same algorithm on different sets of inputs.

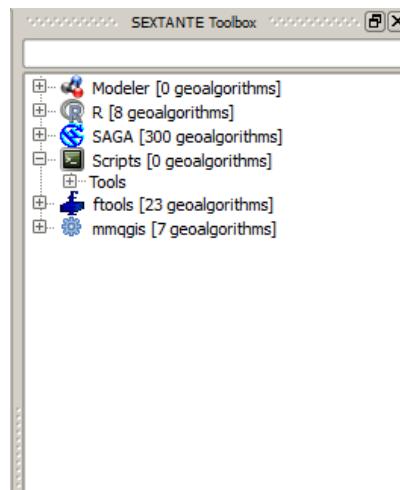


Figure 17.5: SEXTANTE Toolbox

The toolbox contains all the algorithms available, divided into groups. Each group represents a so-called ‘algorithm provider’, which is a set of algorithms coming from the same source, for instance, from a third-party application with geoprocessing capabilities. Some of this groups represent algorithms from one of such third-party applications (like SAGA, GRASS or R), while other contain algorithms directly coded along with SEXTANTE elements, not relying on any additional software. Currently, these providers all reuse code from already existing QGIS plugins (more specifically, from the fTools vector library shipped along with QGIS and the contributed

mmqgis plugin that you can install using the Plugin Manager), making them more useful, since they can be executed from elements such as the modeler or the batch processing interface, which we will soon describe.

Additionally, two more providers can be found, namely ‘Models’ and ‘Scripts’. These providers include user-created algorithms, and allow you to define your own workflows and processing tasks. We will devote a full section to them a bit later.

In the upper part of the toolbox you can 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 which contain the text you have entered in their names.

To execute an algorithm, just double-click on its name in the toolbox.

17.2.2 The algorithm dialog

Once you double-click on the name of the algorithm that you want to execute, a dialog similar to the next one is shown (in this case, the dialog corresponds to the SAGA ‘Convergence index’ algorithm).

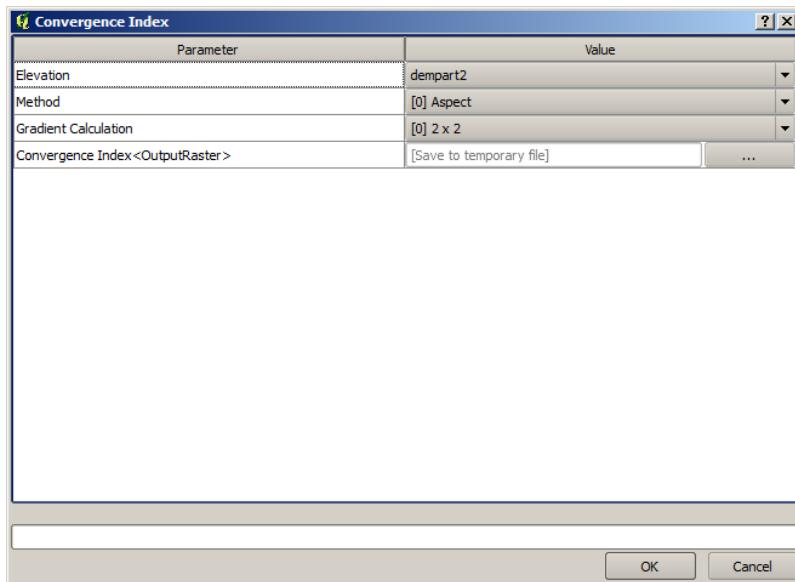


Figure 17.6: Parameters Dialog

This dialog is used to set the input values that the algorithm needs to be executed. It shows a table where input values and configuration parameters are 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. On the left side, the name of the parameter is shown. On the right side the value of the parameter can be set.

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 on the table can be of one of the following types.

- A raster layer, to select from a list of all the ones 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 the ones available in the 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. 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 features. We will see more about this kind of execution at the end of this section.

- A table, to select from a list of all the ones 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 a SEXTANTE algorithm that needs one of them is restricted to tables coming from files in DBBase (.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 this variables such as the cellsize of a layer or the northern most coordinate of another one.

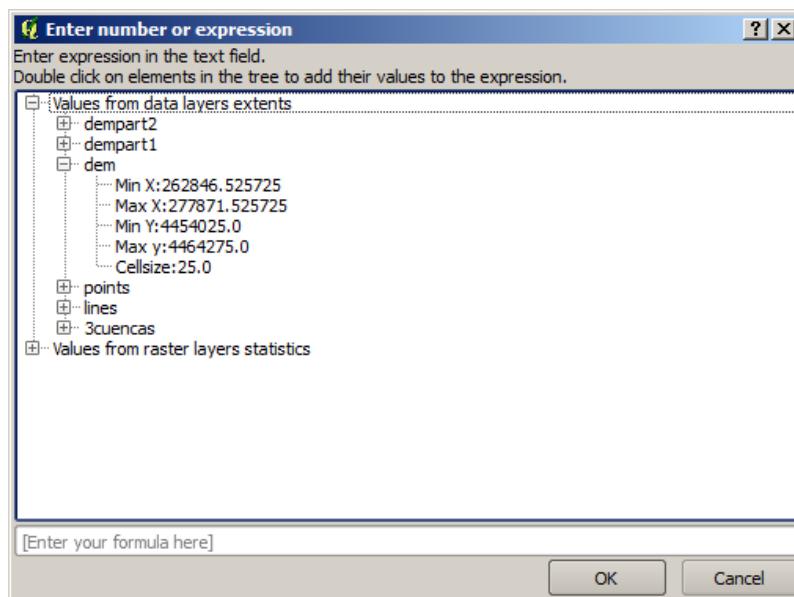


Figure 17.7: Number Selector

- 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 (CRS). You can type the EPSG code directly in the text box, or select it from the CRS selection dialog that appear when you click on the button on the right-hand size
- A extent, to be entered by four number 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 option: to select the value from a layer or the current canvas extent, or to define it by dragging directly onto the map canvas.

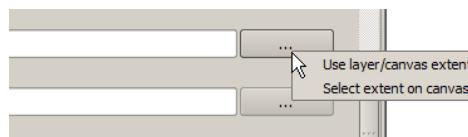


Figure 17.8: SEXTANTE Extent

If you select the first option, you will see a window like the next one.

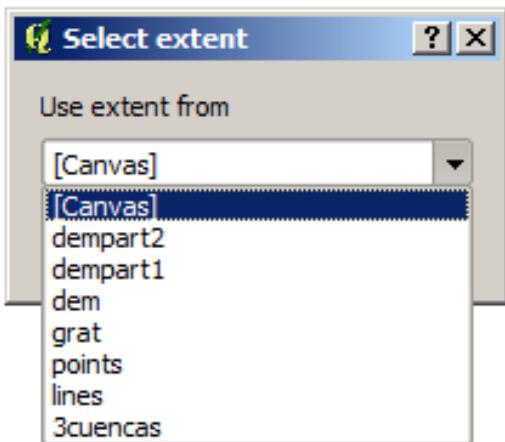


Figure 17.9: SEXTANTE Extent List

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.

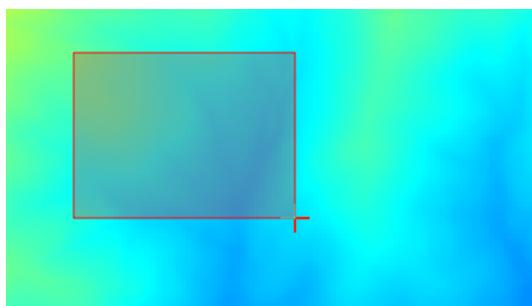


Figure 17.10: Extent Drag

- A list of elements (whether raster layers, vector ones or tables), to select from the list of the ones 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.
- 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.

Depending on the algorithm, the number of rows can be modified or not, using the buttons on the right side of the window.

You will find a **[Help]** button in the lower part of the parameters dialog. If a help file is available, it will be shown, giving you more information about the algorithms and detailed descriptions of what each parameter does. Unfortunately, most algorithms lack good documentation, but if you feel like contributing to the project, this would be a good place to start.

A note on projections

SEXTANTE — and also most of the external applications whose algorithms are available from SEXTANTE — does not perform any reprojection on input layers and assumes 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.

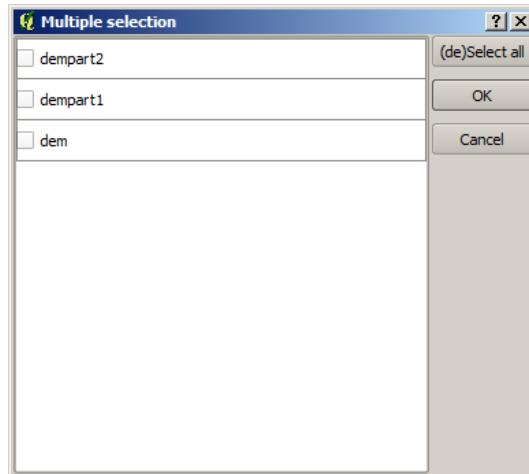


Figure 17.11: Multiple Selection

A screenshot of a Windows-style dialog box titled "Fixed Table". It features a table with three rows and three columns labeled "minimum", "maximum", and "new". All cells in the table contain the value "0". To the right of the table are buttons for "Add row", "Remove row", "OK", and "Cancel".

minimum	maximum	new
0	0	0
0	0	0
0	0	0

Figure 17.12: Fixed Table

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 use the resulting files as input to SEXTANTE. Also note that the reprojection process can be performed with SEXTANTE, which incorporates tools to do so.

17.2.3 Data objects generated by SEXTANTE algorithms

Data objects generated by SEXTANTE 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)

They are all saved to disk (there are no in-memory results), 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 the architecture of SEXTANTE allows for any other way of storing it. For instance, a vector layer can be stored in a database or even uploaded to a remote server using a WFS-T service. Although solutions like these are not yet implemented, SEXTANTE is prepared to handle them, and we expect to add new kinds of output channels in a near feature.

To select an output channel, just click on the button on the right side of the text box. That will open a save-file dialog, where you can select the desired filepath. 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 the ones supported by the algorithm itself. To select a format, just select the corresponding file extension (or add it if you are directly typing the filepath instead). If the extension of the filepath you entered does not match any of the supported ones, a default extension (usually `.dbf` for tables, `.tif` for raster layers and `.shp` for vector ones) will be appended to the filepath and the file format corresponding to that extension will be used to save the layer or table.

If you do not enter any filename, the result will be saved as a temporary file and in the corresponding default file format, and 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 configuration dialog (you can open it from the *SEXTANTE* 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.

Apart from raster layers and tables, SEXTANTE also generates graphics and texts 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 SEXTANTE during the current session, and can be shown at any time by selecting in menu *SEXTANTE* → *SEXTANTE results viewer*.

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 outut files will not be processed by QGIS (opened or included into the current QGIS project), since most of the times 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 outputs, you will find a check box that you can use to tell SEXTANTE not whether to load the file once it is generated by the algorithm or not. By default, all files are opened.

SEXTANTE does not support optional outputs, so all outputs are created, but you can uncheck the corresponding check box if you are not interested in a given output, which virtually makes it behave like an optional output (although 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)

17.2.4 Configuring SEXTANTE

As it has been mentioned, the configuration menu gives access to a new dialog where you can configure how SEXTANTE works. 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 SEXTANTE layers (that is, layers generated by using algorithms from any of the SEXTANTE 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 SEXTANTE 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.

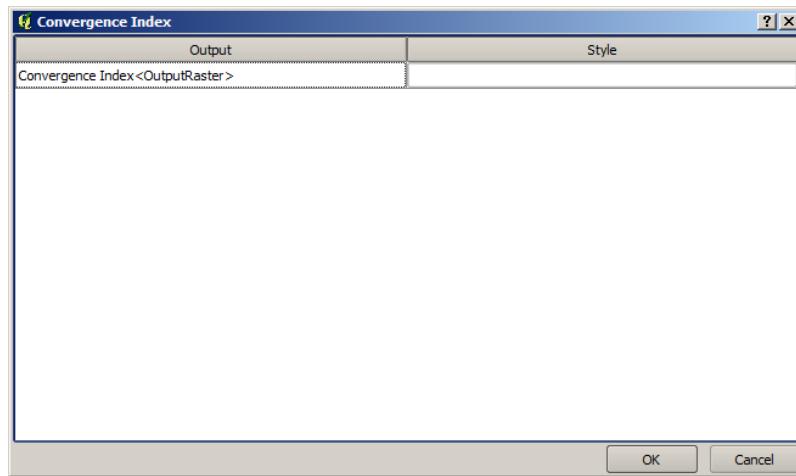


Figure 17.13: Rendering Styles

Select the style file (`.qml`) that you want for each output and press **[OK]**.

Other configuration parameters in the *General* group are explained below:

- **Use filename as layer name.** The name of each resulting layer created by SEXTANTE is defined by the algorithm generating it. In some cases, a fixed name might be used, that meaning that the same 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 long and meaningless one intended to avoid collision with other already existing filenames.
- **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 of them will be used.

Apart from the *General* block in the settings dialog, you will also find one for each algorithm provider. They contain 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, that we will explain later when covering particular algorithm providers.

17.3 The SEXTANTE graphical modeler

17.3.1 Introduction

The *graphical modeler* allows to create complex models using a simple and easy-to-use interface. When working with a GIS, most analysis operations are not isolated, but 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 easier and more convenient to execute than a single process later on a different set on inputs. No matter how many steps and different algorithms it involves, a model is executed as a single algorithm, thus saving time and effort, specially for larger models.

The modeler can be opened from the *SEXTANTE* menu, but also from the toolbox. In the *Modeler* branch of the algorithms tree you will find a group named *Tools*, which contains an entry called *Create new model*.

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.

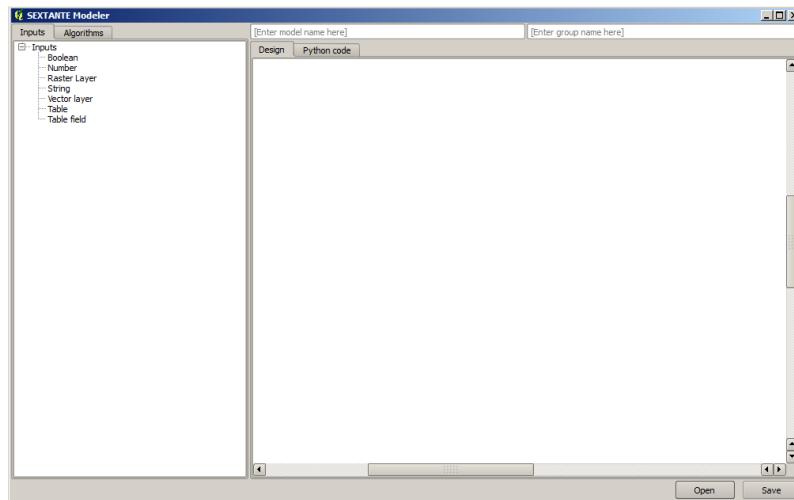


Figure 17.14: Modeler

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 a SEXTANTE algorithm, so the parameters window is generated automatically as it happens with all the algorithms included in SEXTANTE.
2. Definition of the workflow. Using the input data of the model, the workflow is defined adding algorithms and selecting how they use those inputs or the outputs generated by other algorithms already in the model.

17.3.2 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* tabs on the left side of the modeler window:

- Raster layer
- Vector layer
- String
- Table field
- Table
- Numerical value
- Boolean value

Double-clicking on any of them, a dialog is shown to define its characteristics. Depending on the parameter itself, the dialog will 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 it 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.

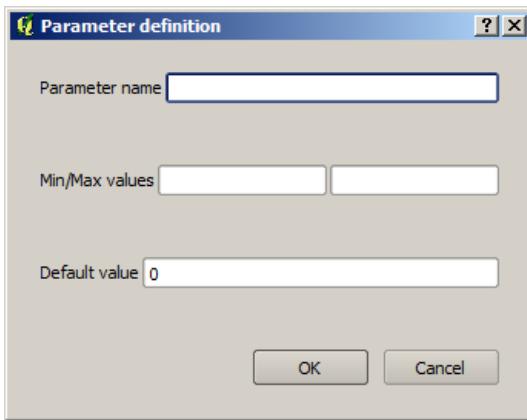


Figure 17.15: Model Parameters

For each added input, a new element is added to the modeler canvas.

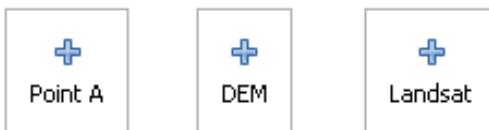


Figure 17.16: Model Parameters

17.3.3 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.

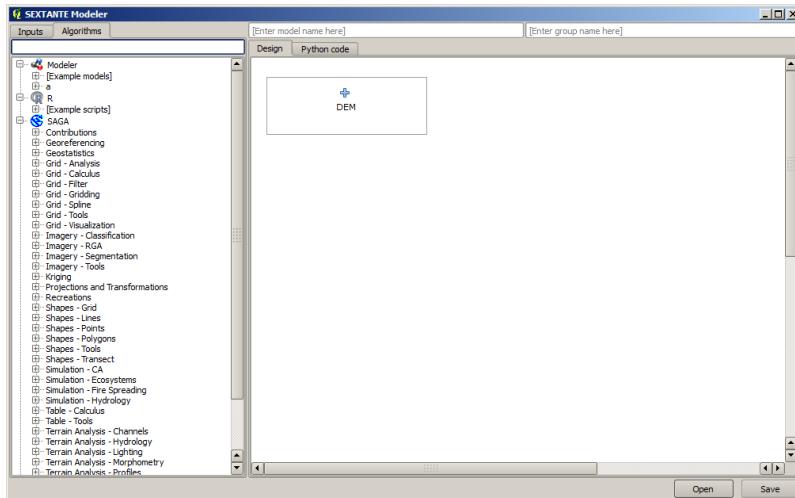


Figure 17.17: Model Parameters

To add an algorithm, double-click on its name. An execution dialog will appear, with a content similar to the one found in the execution panel that SEXTANTE shows when executing the algorithm from the toolbox. the one

shown next correspond to the SAGA ‘Convergence index’ algorithm, the same one we saw in the section dedicated to the SEXTANTE toolbox.

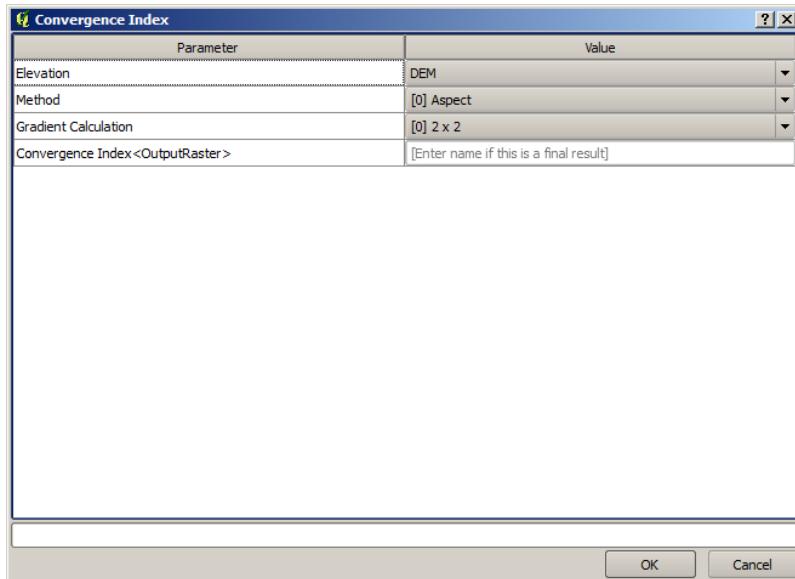


Figure 17.18: Model Parameters

As you can see, some differences exist. Instead of the file output box that was used to set the filepath for output layers and tables, a simple text box is. 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 textbox. Typing anything on it means that the result is a final one, and the text that you supply will be the description for the output, which will be the one 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 the toolbox one. Let’s see how to introduce the values for each type of parameter.

- Layers (raster and vector) and tables. They 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 on the textbox. But this textbox 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.
- String. Like 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 of 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 textbox, or use the list to select a table field input already added to the model. The validity of the selected field will be checked by SEXTANTE at run-time.

Once all the parameter 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, which 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 update automatically.

You can run your algorithm anytime clicking on the [Run] button. However, in order to use it from the toolbox, it has to be saved and the modeler dialog closed, to allow the toolbox to refresh its contents.

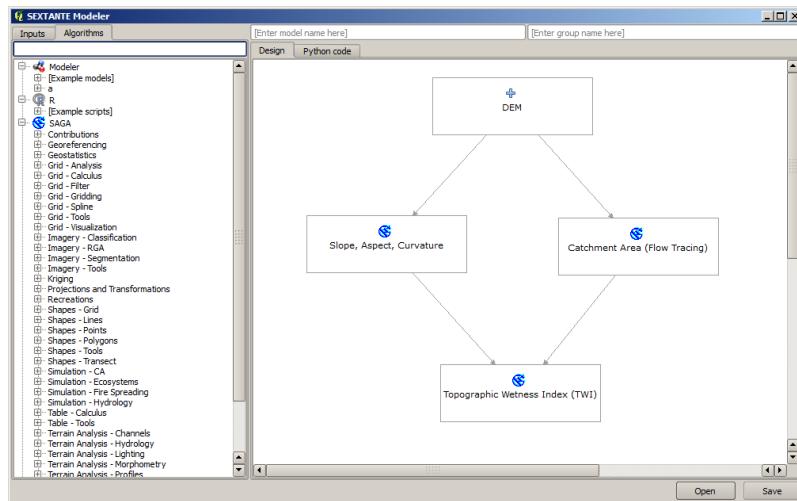


Figure 17.19: Model Parameters

17.3.4 Saving and loading models

Use the [Save] button to save the current model and the [Open] one to open any model previously saved. Model 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, and it will be used.

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, SEXTANTE searches the `models` folder for files with .model extension and loads the models they contain. Since a model is itself a SEXTANTE algorithm, it can be added to the toolbox just like any other algorithm.

The `models` folder can be set from the SEXTANTE 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.

In some cases, SEXTANTE might not be able to load a model because it cannot find all the algorithms included in its workflow. If you have used a given algorithm as part of your model, it should be available (that is, it should appear on the toolbox) in order to load that model. Deactivating an algorithm provider in the SEXTANTE configuration window renders all the algorithms in that provider unusable by the modeler, which might cause problems when loading models. Keep that in mind when you have trouble loading or executing models.

17.3.5 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:

Selecting the *Remove* option will cause the selected algorithm to be removed. An algorithm can be removed only if there are no other algorithms dependind 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, SEXTANTE will show you a warning message like the one you can see below:

Selecting the *Edit* option or simply double-clicking on the algorithm icon 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

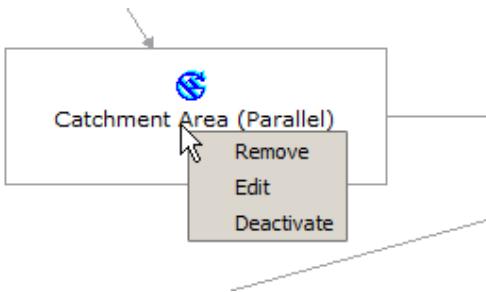


Figure 17.20: Modeler Right Click

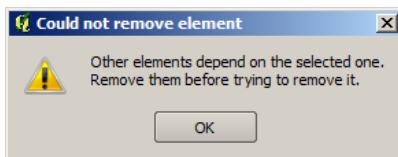


Figure 17.21: Cannot Delete ALG

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.

17.3.6 Activating and deactivating algorithms

Algorithms can be deactivated in the modeler, so they will not be executed once the model is run. This can be used to test just a given part of the model, or when you do not need all the outputs it generates.

To deactivate an algorithm, right-click on its icon in the model canvas and select the *Deactivate* option. You will see that the algorithm is represented now with a red label under its name indicating that is not active.

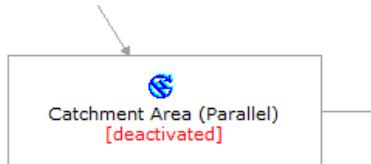


Figure 17.22: Deactivate

All algorithms depending (directly or indirectly) on that algorithm will also appear as inactive, since they cannot be executed now.

To activate an algorithm, just right-click on its icon and select the *Activate* option.

17.3.7 Editing model help files and meta-information

You can document your models from SEXTANTE. Just click on the [Edit model help] button and a dialog like the one shown next will appear.

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 those 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 the write its description in the textbox below.

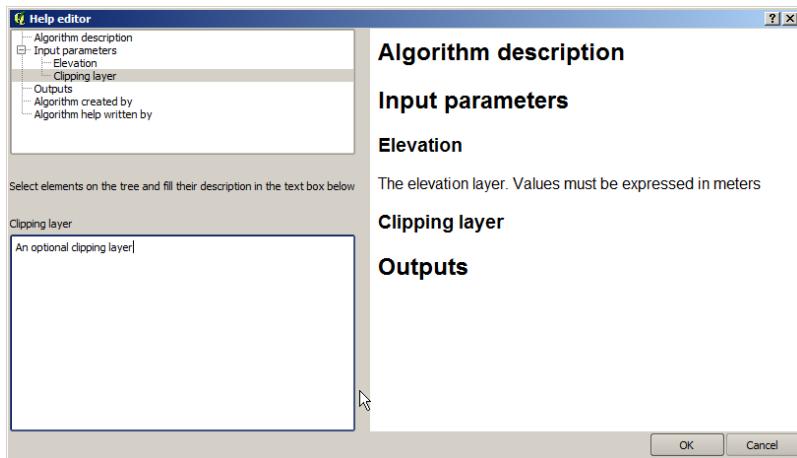


Figure 17.23: Help Edition

Model help is saved in a file in the same folder as the model itself. You do not have to worry about saving it, since it is done automatically.

17.3.8 About available algorithms

You might notice that some algorithms that can be executed from the toolbox do not appear in the list of available ones 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 other in the workflow. If an algorithm does not have such 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 does not appear in the list of them 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.

17.3.9 SEXTANTE models as Python code

This feature is temporarily unavailable

Along with the tab that contains the graphical design of the model, you will find another one containing a Python script which performs the same task as the model itself. Using that code, you can create a console script (we will explain them later in this same manual) and modify it to incorporate actions and methods not available in the graphical modeler, such as loops or conditional sentences.

This feature is also a very practical way of learning how to use SEXTANTE from the console and how to create SEXTANTE algorithms using Python code, so you can use it as a learning tool when you start creating your own SEXTANTE scripts.

You will find a button below the text field containing the Python code. Click on it to directly create a new script from that code, without having to copy and paste it in the SEXTANTE script editor.

17.4 The SEXTANTE batch processing interface

17.4.1 Introduction

SEXTANTE algorithms (including models) can be executed as a batch process. That is, they can be executed using not 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.

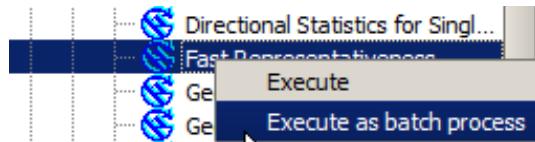


Figure 17.24: Batch Processing Right Click

17.4.2 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.

Grid	Standard Deviation	Search Mode
...	1.0	[0] Square ▾ 3.0
...	1.0	[0] Square ▾ 3.0
...	1.0	[0] Square ▾ 3.0
...	1.0	[0] Square ▾ 3.0
...	1.0	[0] Square ▾ 3.0
...	1.0	[0] Square ▾ 3.0

Figure 17.25: Batch Processing

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.

17.4.3 Filling the parameters table

For most parameters, setting its value is trivial. Just type the value or select it from the list of available options, depending on the parameter type.

The main differences are found for parameters representing layers or tables, and for output filepaths. Regarding input layers and tables, when an algorithm is executed as part of a batch process those input data objects are taken directly from files, and not from the set of them already opened in QGIS. For this reason, any algorithm can be executed as a batch process even if no data objects at all are opened and the algorithm cannot be run from the toolbox.

Filenames for input data objects are introduced directly typing or, more conveniently, clicking on the button on the right hand of the cell, which 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 it represents a multiple input, all the selected files will be added to a single cell, separated by semicolons (;).

Output data objects are always saved to a file and, unlike when executing an algorithm from the toolbox, saving to a temporary one 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).

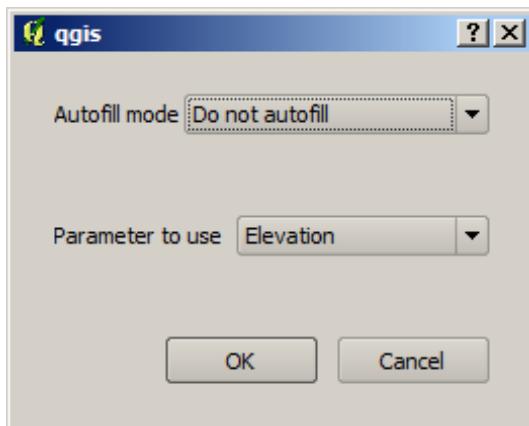


Figure 17.26: Batch Processing Save

If the default value ('Do not autocomplete') is selected, SEXTANTE 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 simply adding correlative numbers to the selected filepath, or appending the value of another field at the same row. This is particularly useful for naming output data object according to input ones.

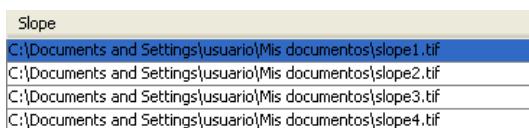


Figure 17.27: Batch Processing File Path

17.4.4 Executing the batch process

To execute the batch process once you have introduced all the necessary values, just click on [OK]. SEXTANTE will show the progress of the global batch process in the progress bar in the lower part of the dialog.

17.5 Using SEXTANTE from the console

17.5.1 Introduction

The console allows advanced users to increase their productivity and perform complex operations that cannot be performed using any of the other elements of the SEXTANTE GUI. 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 SEXTANTE console in QGIS, but all SEXTANTE commands are available instead from QGIS built-in Python console. That means that you can incorporate those command to your console work and connect SEXTANTE 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 call any SEXTANTE method, can be converted into a new SEXTANTE algorithm that you can later call from the toolbox, the graphical modeler or any other SEXTANTE component, just like you do with any other SEXTANTE algorithm. In fact, some algorithms that you can find in the toolbox, like all the ones in the *mmqgis* group, are simple scripts.

In this chapter we will see how to use SEXTANTE from the QGIS Python console, and also how to write your own algorithms using Python.

17.5.2 Calling SEXTANTE from the Python console

The first thing you have to do is to import the SEXTANTE functions with the following line:

```
>>> import sextante
```

Now, there is basically just one (interesting) thing you can do with SEXTANTE from the console: to 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 parameter 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 `algslist()` method. Type the following line in you console:

```
>>> sextante.algslist()
```

You will see something like this.

```
Accumulated Cost (Anisotropic)----->saga:accumulatedcost(anisotropic)
Accumulated Cost (Isotropic)----->saga:accumulatedcost(isotropic)
Add Coordinates to points----->saga:addcoordinatesstopoints
Add Grid Values to Points----->saga:addgridvaluestopoints
Add Grid Values to Shapes----->saga:addgridvaluestoshapes
Add Polygon Attributes to Points----->saga:addpolygonatributestopoints
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 algorithm, 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 `algslist("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 know 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. SEXTANTE has a method to describe an algorithm in detail, which can be used to get a list of the parameters that an algorithms require and the outputs that it will generate. To do it, 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.

```
>>> sextante.alghelp("saga:slopeaspectcurvature")
ALGORITHM: Slope, Aspect, Curvature
ELEVATION <ParameterRaster>
METHOD <ParameterSelection>
SLOPE <OutputRaster>
ASPECT <OutputRaster>
CURV <OutputRaster>
HCURV <OutputRaster>
VCURV <OutputRaster>
```

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:

```
>>> sextante.runalg{name_of_the_algorithm, param1, param2, ..., paramN,
                    Output1, Output2, ..., OutputN}
```

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 one is 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:

```
>>> sextante.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 of such such parameters, with 7 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 filepath.

- 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 2D array of value 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, use `None` in the corresponding parameter entry.

For output data objects, type the filepath 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 included in the ones supported by the algorithm, the default file format for that output type will be used, and its corresponding extension appended to the given filepath.

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 it, 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 by SEXTANTE for such task.

The `runalg()` method returns a dictionary with the output names (the ones shown in the algorithm description) as keys and the filepaths of those outputs as values. To add all the outputs generated by an algorithm, pass that dictionary to the `loadFromAlg()` method. You can also load an individual layer passing its filepath to the `load()` method.

17.5.3 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 by SEXTANTE. You can find a *Create new script* 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 low hyphens with blank spaces.

Let's have the following code, which calculates the Topographic Wetness Index (TWI) directly from a DEM

```
##dem=raster
##twi=output
ret_slope = sextante.runalg("saga:slopeaspectcurvature", dem, 0, None,
                           None, None, None, None)
ret_area = sextante.runalg("saga:catchmentarea(mass-fluxmethod)", dem,
                           0, False, False, False, None, None, None, None, None)
sextante.runalg("saga:topographicwetnessindex(twi)", ret_slope['SLOPE'],
                ret_area['AREA'], None, 1, 0, twi)
```

As you can see, it involves 3 algorithms, all of them coming from SAGA. The last one of them calculates de TWI, but it needs a slope layer and a flow accumulation layer. We do not have these ones, but since we have the DEM, we can calculate them 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 SEXTANTE the information it needs to turn your code into an algorithm that can be run from any of its 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 SEXTANTE supports in its 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, SEXTANTE will edit it to improve its appearance, replacing low hyphens with blankspaces. 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 `sextante.getObjectFromUri()` function. Multiple inputs also have a string value, which contains the filepaths 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 filepath. It will correspond to a temporary filepath in case the user has not entered any output filename.

When you declare an output, SEXTANTE will try to add it to QGIS once the algorithm 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
```

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 available methods: `setText(text)` and `setPercentage(percent)` to modify the progress text and the progress bar.

Several examples are provided with SEXTANTE. Please, check them to see real examples of how to create algorithms using this feature of SEXTANTE. You can right-click on any script algorithm and select *Edit script* to edit its code or just to see it.

17.5.4 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 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 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 to a filename, saving is done automatically.

17.6 The SEXTANTE history manager

17.6.1 The SEXTANTE history

Every time you execute a SEXTANTE algorithm, information about the process is stored in the SEXTANTE 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 SEXTANTE, and easily reproduce it.

The SEXTANTE 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.

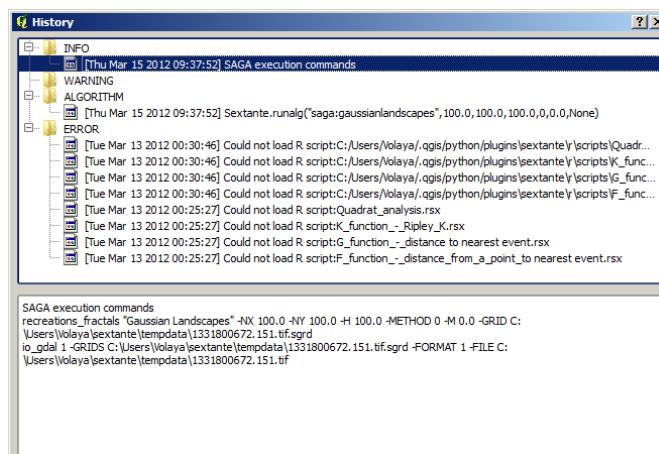


Figure 17.28: History

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, processes can be re-executed, simply double-clicking on the corresponding entry.

Along with algorithm executions, SEXTANTE communicates with the user using the other groups of the registry, namely *Errors*, *Warnings* and *Information*. In case something is not working properly, having a look at the *Errors* might help you to see what is happening. If you get in contact with a SEXTANTE developer to report a bug or error, the information in that group will be very useful for him to find out what is going wrong.

When executing third party algorithms, this is usually done calling their command-line interfaces, which communicate with the user using the console. Although that console is not shown, a full dump of it is stored in the *Information* group each time you run one of those algorithms. If, for instance, you are having problems executing a SAGA algorithm, look for an entry name ‘SAGA execution console output’ to check all the messages generated by SAGA and try to find out where the problem is.

Some algorithms, even if they can produce a result with the given input data, might add comments or additional information to *Warning* in case they detect potential problems from that data, in order to warn you about them. Make sure you check those messages in case you are having unexpected results.

17.7 Configuring external applications

17.7.1 Introduction

SEXTANTE can be extended using additional applications, calling them from within SEXTANTE. 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 application are managed by their own algorithm provider.

This chapter will show you how to configure SEXTANTE to include these additional applications, and will explain some particular features of the algorithm based on them. Once you have correctly configured the system, you will be able to execute external algorithms from any SEXTANTE component like the toolbox or the graphical modeler, just like you do with any other SEXTANTE geoalgorithm.

By default, all algorithms that rely on an external application not shipped with QGIS are not enabled. You can enable them in the SEXTANTE configuration dialog. Make sure that the corresponding application is already installed in your system. Enabling an algorithm provider without installing the application it needs will cause the algorithms to appear in the toolbox, but an error will be thrown when you try to execute them.

This is because the algorithm descriptions (needed to create the parameters dialog and give SEXTANTE the information it needs about the algorithm) are not included with each application, but with SEXTANTE instead. That is, they are part of SEXTANTE, so you have them in your installation even if you have not installed any other software. Running the algorithm, however, needs the application binaries to be installed in your system.

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 on that other software. In most cases, it can read what you have opened in QGIS, but in some cases, that might not be the case. 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 that are understood by both programs, and check to console output (in the history and log dialog) for knowing 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 SEXTANTE algorithms (we are currently working on solving this, and expect to have it ready soon).

You should, however, find no problems at all with vector layers, since SEXTANTE automatically converts from the original file format to one accepted by the external application before passing the layer to it. This adds an extra processing time, which might be significant if the layer has a large size, so do not be surprised if it takes more to process a layer from a DB connection than 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, raster layers can be saved as TIFF (.tif) files, while vector layers are saved as shapefiles (.shp). These have been chosen as the ‘lingua franca’ between supported third party applications and QGIS. If the output filename that you select is not one of the above, it will be modified, adding the corresponding suffix, and the default file format will be used.

In the case of GDAL, the number of supported output formats is larger. When you open the file selection dialog, you will see that you have more formats (and their corresponding extensions available). For more information about which formats are supported, check the GDAL documentation.

A note on vector layer selections

By default, when an external algorithm takes a vector layer, it will use all its features, even if a selection exists in QGIS. You can make an external algorithm aware of that selection by checking the *Use selected features in external applications* item in the *General* settings group. When you do so, each time you execute an external algorithm that uses a vector layer, the selected features of that layer will be exported to a new layer, and the algorithm will work with that new layer instead.

Notice that if you select this option, a layer with no selection will behave like a layer with all its features selected, not like an empty layer.

17.7.2 SAGA

SAGA algorithms can be run from SEXTANTE if you have SAGA installed in your system and you configure SEXTANTE properly so it can find SAGA executables. In particular, the SAGA command-line executable is needed to run SAGA algorithms. SAGA binaries are not included with SEXTANTE, so you have to download and install the software yourself. Please check the SAGA website at for more information. SAGA 2.0.8 is needed.

Once SAGA is installed, and if you are running Windows, open the SEXTANTE 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 SEXTANTE.

In case you are using Linux, there is no need to configure that, and you will not see those folders. 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 SAGA binaries are located.

About SAGA grid system limitations

Most of SAGA algorithms that require several input raster layers, require them to have the same grid system. That is, to cover the same geographic area and have the same cellsize, so their corresponding grids match. When calling SAGA algorithms from SEXTANTE, you can use any layer, regardless of its cellsize and extent. When multiple raster layers are used as input for a SAGA algorithm, SEXTANTE 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 setting window to do so. There are two ways of setting the target grid system:

- Setting it manually. You define the extent setting the values of the following parameters:
 - Resampling min X
 - Resampling max X
 - Resampling min Y

- Resampling max Y
- Resampling cellsize

Notice that SEXTANTE 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 cellsize of the target layer is the maximum of all cellsizes 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 multiband layers. If you want to use a multiband layer (such as an RGB or multispectral image), you first have to split it into singlebanded images. To do so, you can use the ‘SAGA/Grid - Tools/Split RGB image’ algorithm (which creates 3 images from an RGB image) or the ‘SAGA/Grid - Tools/Extract band’ algorithm (to extract a single band).

Limitations in cellsize

SAGA assumes that raster layers have the same cellsize in the X and Y axis. If you are working with a layer with different values for its horizontal and vertical cellsizes, you might get unexpected results. In this case, a warning will be added to the SEXTANTE log, indicating that an input layer might not be suitable to be processed by SAGA.

Logging

When SEXTANTE calls SAGA, it does it using its command-line interface, thus passing a set of commands to perform all the required operation. 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 by SEXTANTE and used to update the progress bar while the algorithm is running.

Both the commands sent by SEXTANTE and the additional information printed by SAGA can be logged along with other SEXTANTE log messages, and you might find them useful to track in detail what is going on when SEXTANTE 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 SEXTANTE settings list.

17.7.3 R and R scripts

R integration in SEXTANTE 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 chapter dedicated to SEXTANTE scripts. This chapter shows you the syntax to use to call those R commands from SEXTANTE and how to use SEXTANTE objects (layers, tables) in them.

The first thing you have to do, as we saw in the case of SAGA, is to tell SEXTANTE where your R binaries are located. You can do so using the *R folder* entry in the SEXTANTE configuration dialog. Once you have set that parameter, you can start creating your own R scripts and executing them.

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 SEXTANTE), you have to create a script file that tells SEXTANTE how to perform that operation and the corresponding R commands to do so.

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 SEXTANTE settings dialog), just like you do with the folder for regular SEXTANTE scripts.

Let's have a look at a very simple file 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 belong to the `maptools` package. Since almost all the algorithms that you might like to incorporate into SEXTANTE will use or generate spatial data, knowledge of spatial packages like `maptools` and, specially, `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 SEXTANTE the inputs of the algorithm described in the file and the outputs that it will generate. They work exactly with the same syntax as the SEXTANTE scripts that we have already seen, so they will not be described here again. Check the corresponding section for more information.

When you declare an input parameter, SEXTANTE 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 be later used as input for R commands.

In the above example, we are declaring an input of type `vector` named `polyg`. When executing the algorithm, SEXTANTE 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 accesing 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 `readGDAL()` commands (you do not have to worry about adding those commands to your description file, SEXTANTE will do it) and 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 in R.

Knowing that, we can now understand the first line of our example script (the first line not starting with a Python comment).

```
pts=spsample(polyg,numpoints,type="random")
```

The variable `polyg` 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 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 retuned to SEXTANTE.

If your algorithm does not generate any layer, but a text result in the console instead, you have to tell SEXTANTE 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 algorithms 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 SEXTANTE).

If your algorithm creates any kind of graphics (using the `plot()` method), add the following line:

```
##showplots
```

This will cause SEXTANTE to redirect all R graphical outputs to a temporary file, which will be later opened once R execution has finished.

Both graphics and console results will be shown in the SEXTANTE results manager.

For more information, please check the script files provided with SEXTANTE. Most of them are rather simple and will greatly help you understand how to create your own ones.

17.7.4 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, SEXTANTE 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 do it manually. Also, if you want to use a different GRASS version, you can change that setting and point to the folder where that other version is kept. 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 this is the behaviour you prefer, just check the *Use min covering region* option in the GRASS configuration parameters.

GRASS includes help files describing each algorithm. If you set the *GRASS help folder* parameter, SEXTANTE will open them when you use the **[Show help]** button from the parameters window of the algorithm.

The last parameter that has to be configured is related to the mapset. A mapset is needed to run GRASS, and SEXTANTE creates a temporary one for each execution. You have to tell SEXTANTE if the data you are working with uses geographical (lat/lon) coordinates or projected ones.

17.7.5 GDAL

No additional configuration is needed to run GDAL algorithms, since it is already incorporated to QGIS and SEXTANTE can infer its configuration from it.

17.7.6 Orfeo ToolBox

Orfeo ToolBox (OTB) algorithms can be run from SEXTANTE if you have OTB installed in your system and configured SEXTANTE properly so it can find all necessary files (command-line tools and libraries). Please note that OTB binaries are not included in SEXTANTE, 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 SEXTANTE configuration dialog and configure 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 path to the folder where OTB command-line tools and libraries are installed:

-  usually *OTB applications folder* point to /usr/lib/otb/applications and *OTB command line tools folder* is /usr/bin
-  if you use OSGeo4W installer, than install otb-bin package and enter C:\OSGeo4W\apps\orfeotoolbox\applications as *OTB applications folder* and C:\OSGeo4W\bin as *OTB command line tools folder*

17.7.7 TauDEM

To use this provider you need to install TauDEM command line tools.

Windows

Please visit [TauDEM homepage](#) for installation instructions and precompiled binaries for 32bit and 64bit systems.
IMPORTANT: you need TauDEM 5.0.6 executables, version 5.2 currently not supported.

Linux

There are no packages for most Linux distribution, so you should compile TauDEM by yourself. As TauDEM uses MPICH2, first install it using your favorite package manager. Also TauDEM works fine with OpenMPI, so you can use it instead of MPICH2.

Download TauDEM 5.0.6 [source code](#) and extract files in some folder.

Open linearpart.h file and add after line

```
#include "mpi.h"
```

add new line with

```
#include <stdint.h>
```

so you'll get

```
#include "mpi.h"
#include <stdlib.h>
```

Save changes and close file. Now open tiffIO.h, find line #include "stdint.h" and replace quotes ("") with <>, so you'll get

```
#include <stdint.h>
```

Save changes and close file. Create build directory and cd into it

```
mkdir build
cd build
```

Configure your build with command

```
CXX=mpicxx cmake -DCMAKE_INSTALL_PREFIX=/usr/local ..
```

and then compile

```
make
```

Finally, to install TauDEM into /usr/local/bin, run

```
sudo make install
```

Print Composer

The print composer provides growing layout and printing capabilities. It allows you to add elements such as the QGIS map canvas, legend, scalebar, images, basic shapes, arrows and text labels. You can size, group, align and position each element and adjust the 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 individual on your system). You can save the layout as template and load it again in another session. See a list of tools in [table_composer_1](#):

Icon	Purpose	Icon	Purpose
	Load from template		Save as template
	Export to an image format		Export as PDF
	Export print composition to SVG		Print or export as Postscript
	Zoom to full extent		Zoom in
	Zoom out		Refresh view
	Revert last change		Restore last change
	Add new map from QGIS map canvas		Add image to print composition
	Add label to print composition		Add new legend to print composition
	Add new scalebar to print composition		Add basic shape to print composition
	Add arrow to print composition		Add attribute table to print composition
	Select/Move item in print composition		Move content within an item
	Group items of print composition		Ungroup items of print composition
	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

Table Composer 1: Print Composer Tools

All Print Composer tools are available in menus and as icons in a toolbar. The toolbar can be switched off and on using the right mouse button holding the mouse over the toolbar.

18.1 Open a new Print Composer Template

Before you start to work with the print composer, you need to load some raster and vector layers in the QGIS map canvas and adapt their properties to suite your own convenience. After everything is rendered and symbolized to your liking you click the  New Print Composer icon in the toolbar or choose *File → New Print Composer*.

18.2 Using Print Composer

Opening the print composer provides you with a blank canvas to which you can add the current QGIS map canvas, legend, scalebar, images, basic shapes, arrows and text. [Figure_composer_1](#) shows the initial view of the print composer with an activated *Snap to grid* mode but before any elements are added.

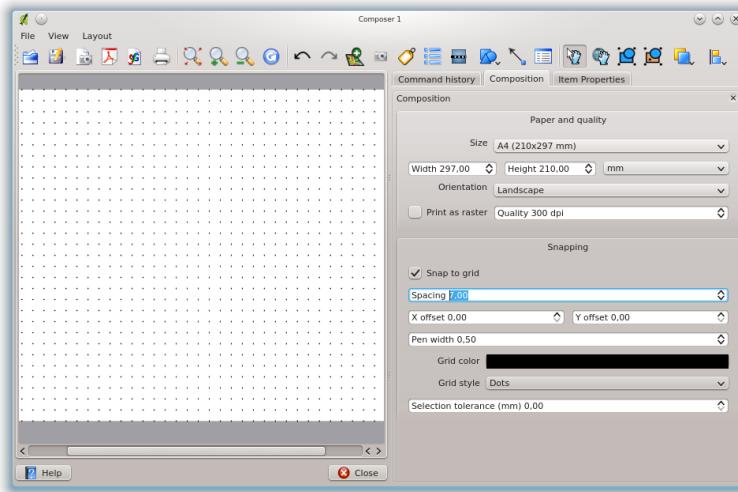


Figure 18.1: Print Composer 

The print composer provides three tabs:

- The *Composition* tab allows you to set paper size, orientation, the print quality for the output file in dpi and to activate snapping to a grid of a defined resolution. Please note, the *Snap to grid* feature only works, if you define a grid resolution > 0. Furthermore you can also activate the *Print as raster* checkbox. This means all elements will be rastered before printing or saving as Postscript or PDF.
- The *Item Properties* tab displays the properties for the selected map element. Click the  Select/Move item icon to select an element (e.g. legend, scalebar or label) on the canvas. Then click the *Item Properties* tab and customize the settings for the selected element.
- 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.

You can add multiple elements to the composer. It is also possible to have more than one map view or legend or scalebar in the print composer canvas. 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.

18.3 Adding a current QGIS map canvas to the Print Composer

Click on the  Add new map toolbar button in the print composer toolbar, to add the QGIS map canvas. Now drag a rectangle on 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 case you zoom in or out the composer window, the map is not rendered again but the image will be scaled.
- **Render** means, that if you zoom in or out the composer window, the map will be rendered again, but for space reasons, only up to a maximum resolution.

Cache is default preview mode for newly added print composer maps.

You can resize the map element by clicking on the  Select/Move item button, selecting the element, and dragging one of the blue handles in the corner of the map. 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 element frame with the left mouse button. After you found the right place for an element, you can lock the element position within the print composer canvas. Select the map element and click on the right mouse button to  Lock the element position and again to unlock the element. You can lock the map element also activating the  Lock layers for map item checkbox in the *Map* dialog of the *Item Properties* tab.

Note: QGIS is now able to show labels from the new labeling plugin also in the map composer, but it is not yet scaled correctly. So it might be necessary to switch back to the standard labeling in some cases.

18.3.1 Map item properties tab — Map and Extents dialog

Map dialog

The *Map* dialog of the map *Item Properties* tab provides following functionalities (see [figure_composer_2](#)):

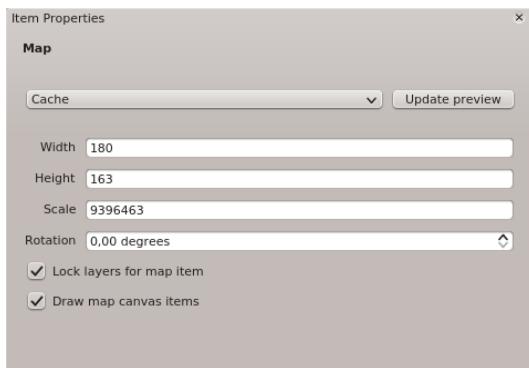


Figure 18.2: Map Dialog 

- The **Preview** area allows to define the preview modes ‘Rectangle’, ‘Cache’ and ‘Render’, as described above. Click on the [**Update preview**] button to apply changes to the map view.
- The **Map** area allows to resize the map element specifying the width and height or the scale. The field **Rotation** **1,00**  allows to rotate the map element content clockwise in degrees. Note, a coordinate frame can only be added with the default value 0. Furthermore you can enable the checkboxes  *Lock layers for map items* and  *Draw map canvas items*.

If you change the view on the QGIS map canvas by zooming or panning or changing vector or raster properties, you can update the print composer view selecting the map element in the print composer and clicking the [Update preview] button.

Extents dialog

The *Extents* dialog of the map item tab provides following functionalities (see Figure [figure_composer_3](#)):

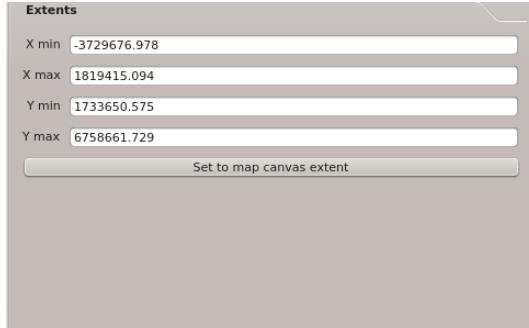


Figure 18.3: Extents Dialog

- The **Map extent** area allow to specify the map extent using Y and X min/max values or clicking the [Set to map canvas extent] button.

If you change the view on the QGIS map canvas by zooming or panning or changing vector or raster properties, you can update the print composer view selecting the map element in the print composer and clicking the [Update preview] button in the map *Item Properties* tab (see Figure [figure_composer_2 a](#)).

18.3.2 Map item properties tab — Grid and General options dialog

Grid dialog

The *Grid* dialog of the map *Item Properties* tab provides following functionalities (see Figure [figure_composer_4](#)):

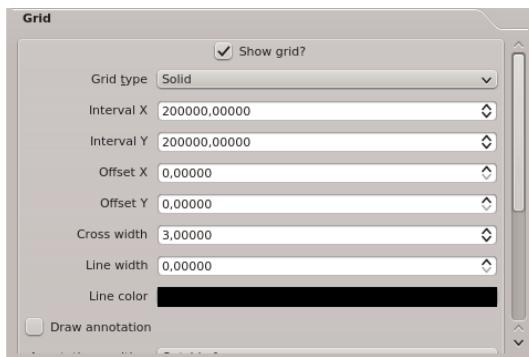


Figure 18.4: Grid Dialog

- The *Show grid* checkbox allows to overlay a grid to the map element. As grid type you can specify to use solid line or cross. Furthermore you can define an interval in X and Y direction, an X and Y offset, and the width used for cross or line grid type.
- The *Draw annotation* checkbox allows to add coordinates to the map frame. The annotation can be drawn inside or outside the map frame. The annotation direction can be defined as horizontal, vertical, horizontal and vertical, or boundary direction. And finally you can define the grid color, the annotation font, the annotation distance from the map frame and the precision of the drawn coordinates.

General options dialog

The *General options* dialog of the map *Item Properties* tab provides following functionalities (see Figure_composer_5):

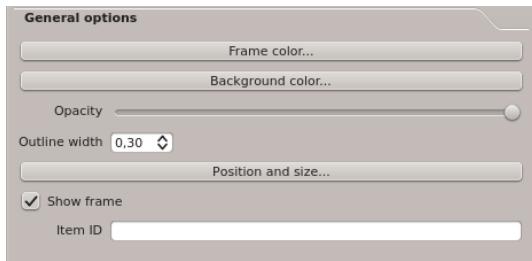


Figure 18.5: General Options Dialog

- Here you can define color and outline width for the element frame, set a background color and opacity for the map canvas. The **[Position and size]** button opens the *Set item position* dialog and allows to set the map canvas position using reference points or coordinates. Furthermore you can select or unselect to display the element frame with the *Show frame* checkbox. With the *Item ID* you can create a relationship to the other print composer items.

18.4 Adding other elements to the Print Composer

Besides adding a current QGIS map canvas to the Print Composer, it is also possible to add, position, move and customize legend, scalebar, images and label elements.

18.4.1 Label item properties tab - Label and General options dialog

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 their appearance in the label *Item Properties* tab.

Label dialog

The *Label* dialog of the label item tab provides following functionalities:

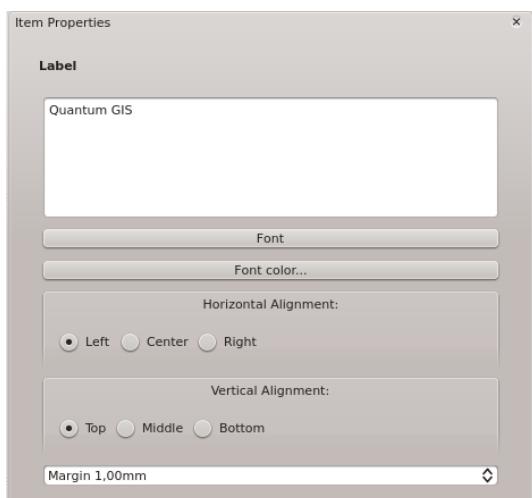


Figure 18.6: Label Options Dialog

- The *Label* dialog offers to add text labels to the composer canvas. You can define the horizontal and vertical alignment, select font and font color for the text and it is possible to define a text margin in mm.

General options dialog

The *General options* dialog of the label *Item Properties* tab provides following functionalities:

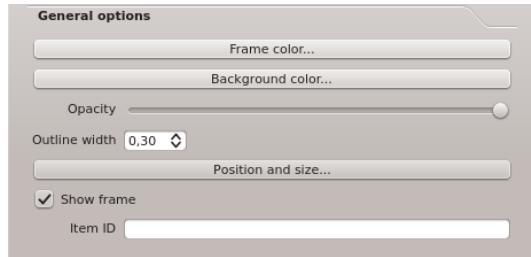


Figure 18.7: General Options Dialog

- Here you can define color and outline width for the element frame, set a background color and opacity for the label. The *Position* button opens the *Set items position* dialog and allows to set the map canvas position using reference points or coordinates. Furthermore you can select or unselect to display the element frame with the *Show frame* checkbox. Use the *Item ID* to create a relationship to other print composer items.

18.4.2 Image item properties tab - Picture options and General options dialog

To add an image, click the *Add image* icon, place the element with the left mouse button on the print composer canvas and position and customize their appearance in the image *Item Properties* tab.

Picture options dialog

The *Picture options* dialog of the image *Item Properties* tab provides following functionalities (see figure_composer_5 a):

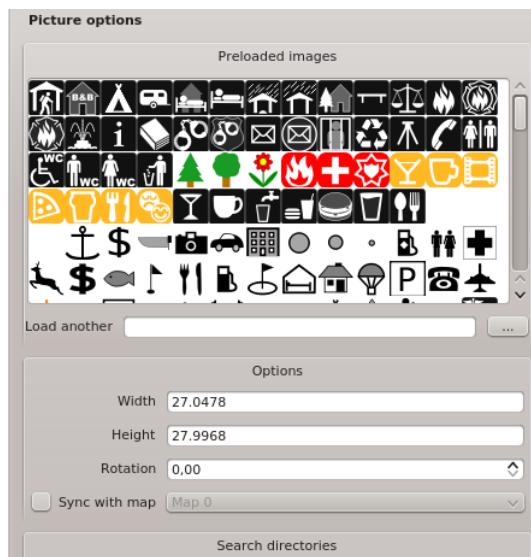


Figure 18.8: Picture Options Dialog

- The **Preloaded Images** field then shows all pictures stored in the selected directories.
- The **Options** area shows the current selected picture and allows to define width, height and clockwise rotation of the picture. It is also possible to add a user specific SVG path. Activating the *Sync with map* checkbox synchronizes the rotation of a picture in the QGIS map canvas (i.e. a rotated north arrow) with the appropriate print composer image.

- The **Search directories** area allows to add and remove directories with images in SVG format to the picture database.

General options dialog

The *General options* dialog of the image *Item Properties* tab provides following functionalities:

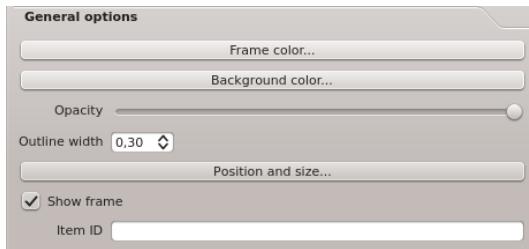


Figure 18.9: General Options Dialog

- Here you can define color and outline width for the element frame, set a background color and opacity for the picture. The **[Position and size]** button opens the *Set item position* dialog and allows to set the map canvas position using reference points or coordinates. Furthermore you can select or unselect to display the element frame with the *Show frame* checkbox. With the *Item ID* you can create a relationship to other print composer items.

18.4.3 Legend item properties tab - General, Legend items and Item option dialog

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 their appearance in the legend *Item Properties* tab.

General dialog

The *General* dialog of the legend item tab provides following functionalities (see [figure_composer_10](#)):

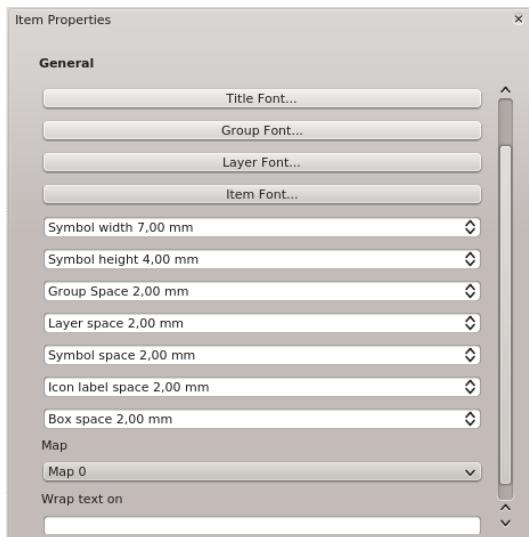


Figure 18.10: General Dialog

- Here you can adapt the legend title. You can change the font of the legend title, layer and item name. You can change width and height of the legend symbol and you can add layer, symbol, icon label and box space. Since QGIS 1.8, you can wrap the text of the legend title to a given character.

Legend items dialog

The *Legend items* dialog of the legend *Item Properties* tab provides following functionalities (see figure_composer_11):

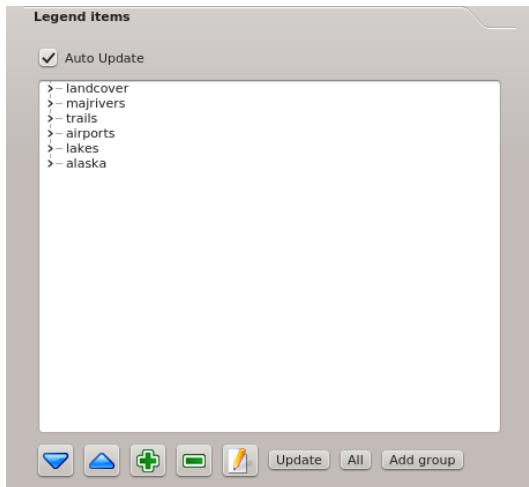


Figure 18.11: Legend Items Dialog 

- The legend items window lists all legend items and allows to change item order, edit layer names, remove and restore items of the list. After changing the symbology in the QGIS main window you can click on [Update] to adapt the changes in the legend element of the print composer. The item order can be changed using the [Up] and [Down] buttons or with ‘drag and drop’ functionality.

General options dialog

The *General options* dialog of the legend *Item Properties* tab provides following functionalities (see figure_composer_12):



Figure 18.12: General Options Dialog 

- Here you can define color and outline width for the element frame, set a background color and opacity for the legend. The [Position and size] button opens the *Set item position* dialog and allows to set the map canvas position using reference points or coordinates. Furthermore you can select or unselect to display the element frame with the *Show frame* checkbox. Use the *Item ID* to create a relationship to other print composer items.

18.4.4 Scalebar item properties tab - Scalebar and General options dialog

To add a scalebar, click the  *Add new scalebar* icon, place the element with the left mouse button on the print composer canvas and position and customize their appearance in the scalebar *Item Properties* tab.

Scalebar dialog

The *Scalebar* dialog of the scalebar *Item Properties* tab provides following functionalities (see figure_composer_13):

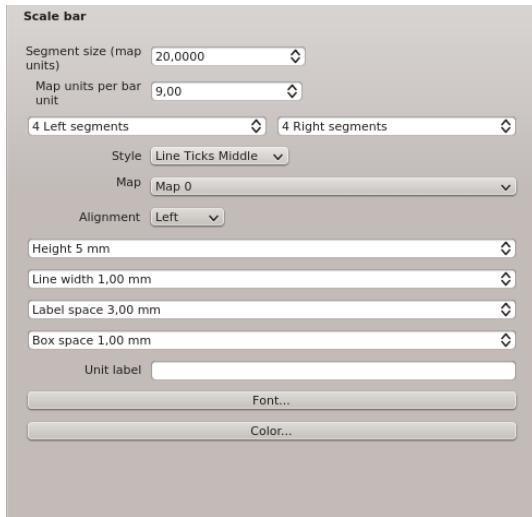


Figure 18.13: Scalebar Options Dialog 🐧

- The *Scalebar* dialog allows to define the segment size of the scalebar in map units, the map units used per bar units, and how many left and right segments units from 0 should be used.
- You can define the scalebar style, available is single and double box, line ticks middle, up and down and a numeric style.
- Furthermore you can define height, line width, label and box space of the scalebar. Add a unit label and define the scalebar font and color.

General options dialog

The *General options* dialog of the scalebar *Item Properties* tab provides following features (see figure_composer_7 b)):

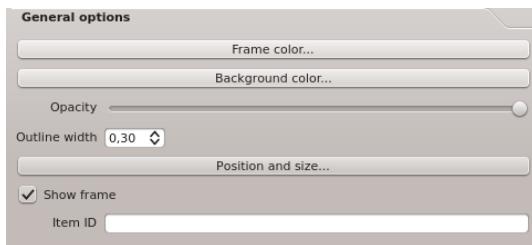


Figure 18.14: General Options Dialog 🐧

- Here you can define color and outline width for the element frame, set a background color and opacity for the scalebar. The **[Position and size]** button opens the *Set items position* dialog and allows to set the map canvas position using reference points or coordinates. Furthermore you can select or unselect to display the element frame with the *Show frame* checkbox. With the *Item ID* you can create a relationship to the other print composer items.

18.5 Navigation tools

For map navigation the print composer provides 4 general tools:

- Zoom in

- Zoom out
- Zoom to full extend
- Refresh the view (if you find the view in an inconsistent state)

18.6 Revert and Restore tools

During the layout process it is possible to revert and restore changes. This can be done with the revert and restore tools:

- Revert last changes
- Restore last changes

or by mouse click within the *Command history* tab (see figure_composer_9).

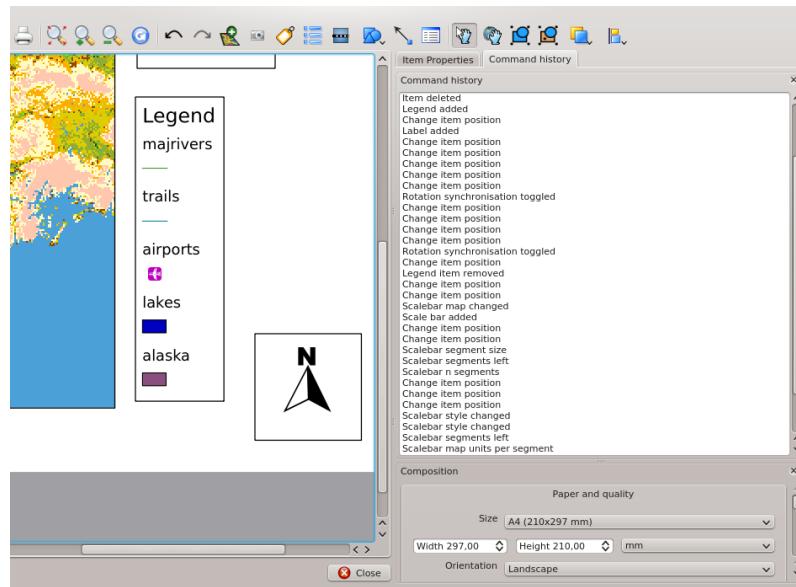


Figure 18.15: Command history in the Print Composer

18.7 Add Basic shape and Arrow

It is possible to add basic shapes (Ellipse, Rectangle, Triangle) and arrows to the print composer canvas.

The *Shape* dialog allows to draw an ellipse, rectangle, or triangle in the print composer canvas. You can define its outline and fill color, the outline width and a clockwise rotation.

The *Arrow* dialog allows to draw an arrow in the print composer canvas. You can define color, outline and arrow width and it is possible to use a default marker and no marker and a SVG marker. For the SVG marker you can additionally add a SVG start and end marker from a directory on your computer.

18.8 Add attribute table values

It is possible to add parts of a vector attribute table to the print composer canvas.

Table dialog



Figure 18.16: Shape Dialog 🐧

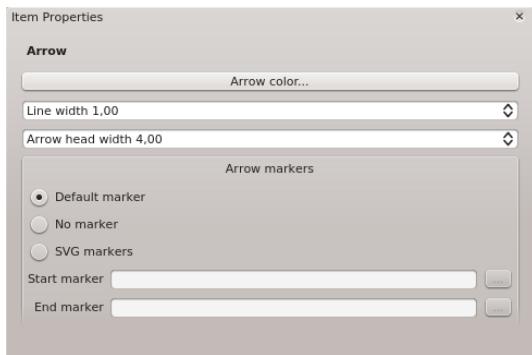


Figure 18.17: Arrow Dialog 🐧

The *Table* dialog of the attribute table item tab provides following functionalities (see [figure_composer_20](#)):

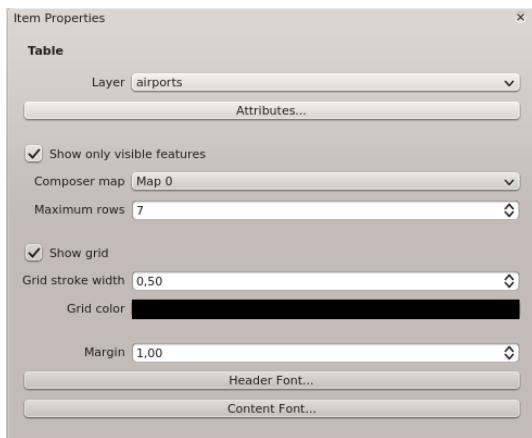


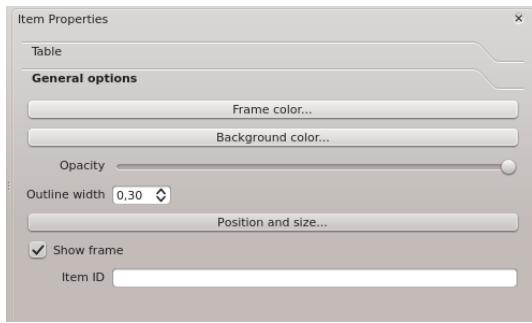
Figure 18.18: Table Dialog 🐧

- The *Table* dialog allows to select the vector layer and columns of the attribute table. Attribute columns can be sorted and you can define to show its values ascending or descending.
- You can define the maximum number of rows to be displayed and if attributes are only shown for visible features of the current composer canvas.
- Additionally you can define the grid characteristics of the table and the header and content font.

General options dialog

The *General options* dialog of the attribute table item tab provides following functionalities (see [figure_composer_21](#)):

- Here you can define color and outline width for the element frame, set a background color and opacity for the table. The **[Position and size]** button opens the *Set item position* dialog and allows to set the map

Figure 18.19: General Options Dialog 

canvas position using reference points or coordinates. Furthermore you can select or unselect to display the element frame with the *Show frame* checkbox. Use the Item ID to create a relationship to the other print composer items.

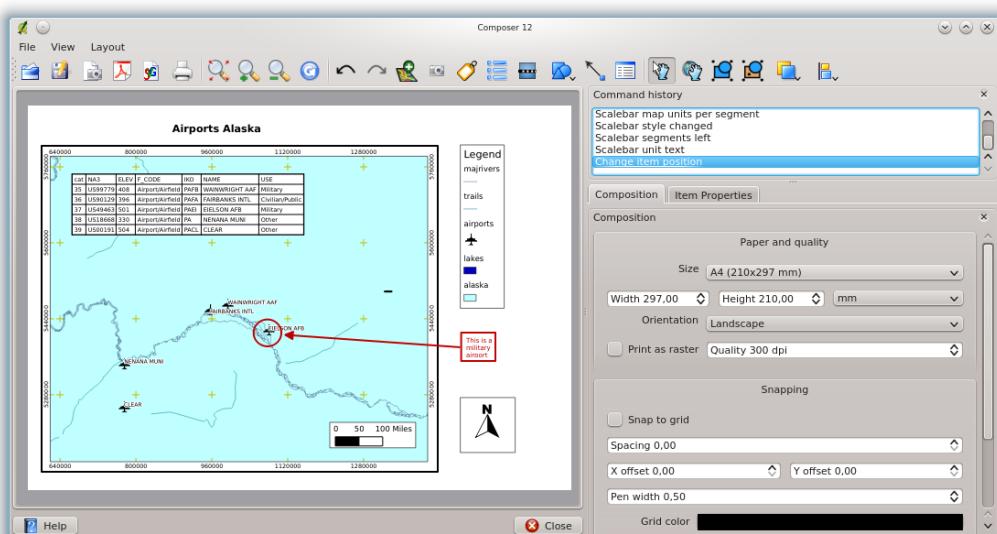
18.9 Raise, lower and align elements

Raise or lower functionalities for elements are inside the  *Raise selected items* pulldown 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 (see [table_composer_1](#)).

There are several alignment functionalities available within the  *Align selected items* pulldown menu (see [table_composer_1](#)). To use an alignment functionality , you first select some elements and then click on the matching alignment icon. All selected will then be aligned within to their common bounding box.

18.10 Creating Output

[Figure_composer_22](#) shows the print composer with an example print layout including each type of map element described in the sections above.

Figure 18.20: Print Composer with map view, legend, scalebar, coordinates and text added 

The print composer allows you to create several output formats and it is possible to define the resolution (print quality) and paper size:

- The  Print icon allows 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, BMP, TIF, JPG,...
- The  Export as PDF saves the defined print composer canvas directly as a PDF.
- The  Export as SVG icon saves the print composer canvas as a SVG (Scalable Vector Graphic).

Note: Currently the SVG output is very basic. This is not a QGIS problem, but a problem of the underlying Qt library. This will hopefully be sorted out in future versions.

18.11 Saving and loading a print composer layout

With the  Save as template and  Load from template icons you can save the current state of a print composer session as a .qpt template and load the template again in another session.

The  Composer Manager button in the QGIS toolbar and in *File → Composer Manager* allows to add a new composer template or to manage already existing templates.

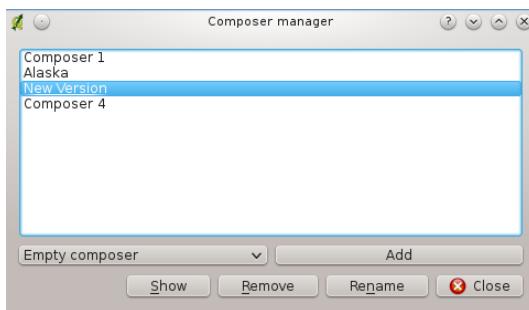


Figure 18.21: The Print Composer Manager 

Plugins

19.1 QGIS Plugins

QGIS has been designed with a plugin architecture. This allows many new features/functions to be easily added to the application. Many of the features in QGIS are actually implemented as either **core** 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. More information about core plugins are provided in Section [Using QGIS Core Plugins](#)
- **External Plugins** are currently all written in Python. They are stored in external repositories and maintained by the individual authors. They can be added to QGIS using the *Python Plugin Installer*. More information about external plugins is provided in Section [Loading an external QGIS Plugin](#).

19.1.1 Managing Plugins

Managing plugins in general means loading or unloading them using the *Plugin Manager*. External plugins can be installed and directly activated or uninstalled using the *Python Plugin Installer*. To deactivate and reactivate external plugins, the *Plugin Manager* is used again.

Loading a QGIS Core Plugin

Loading a QGIS Core Plugin is done from the main menu *Plugins → Manage Plugins*

The *Plugin Manager* lists all the available plugins and their status (loaded or unloaded), including all core plugins and all external plugins that have been installed and automatically activated using the *Python Plugin Installer* (see Section [Loading an external QGIS Plugin](#)). Those plugins that are already loaded have a check mark to the left of their name. [Figure_plugins_1](#) shows the *Plugin Manager* dialog.

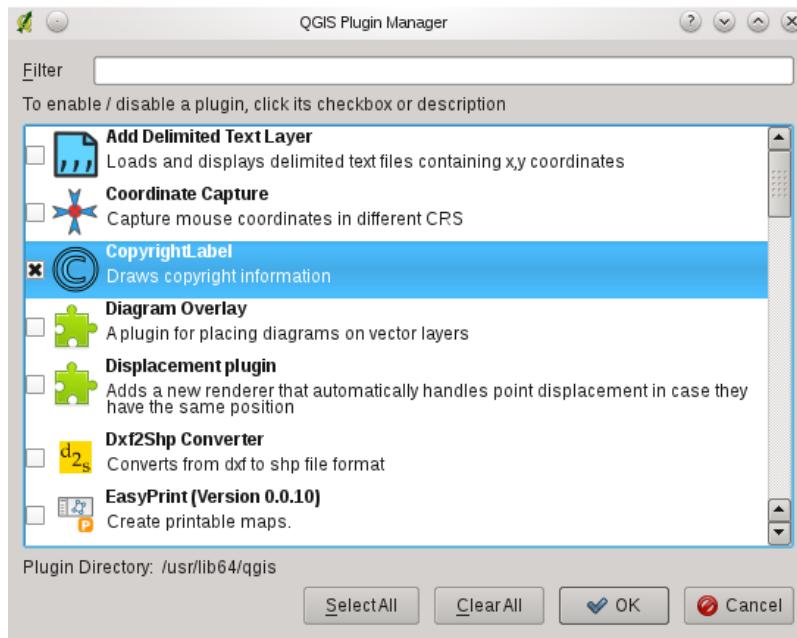
To enable a particular plugin, click on the checkbox to the left of the plugin name, and click **[OK]**. When you exit the application, a list of loaded plugins is retained, and the next time you run QGIS these plugins are automatically loaded.

Tip: Crashing Plugins

If you find that QGIS crashes on startup, a plugin may be at fault. You can stop all plugins from loading by editing your stored settings file (see [Options](#) for location). Locate the plugins settings and change all the plugin values to `false` to prevent them from loading.

 For example, to prevent the ‘Delimited text’ plugin from loading, the entry in `$HOME/.config/QuantumGIS/qgis.conf` on Linux should look like this: `Add Delimited Text Layer=false`.

Do this for each plugin in the [Plugins] section. You can then start QGIS and add the plugins one at a time from the *Plugin Manager* to determine which plugin is causing the problem.

Figure 19.1: Plugin Manager 

Loading an external QGIS Plugin

External QGIS plugins are written in Python. They are by default stored in either the ‘Official’ QGIS Repository, or in various other external repositories maintained by individual authors. The ‘Official’ QGIS Repository is added by default in *Python Plugin installer*.

Detailed documentation about the usage, minimum QGIS version, homepage, authors, and other important information are provided for the ‘Official’ QGIS Repository at <http://plugins.qgis.org/plugins/>. For other external repositories, they might be available with the external plugins themselves. In general it is not included in this manual.

Note: Updates of core python plugins may be available in this repository as external overlays.

Note: fTools, Mapserver Export, and the Plugin Installer are Python plugins, but they are also part of the QGIS sources, and are automatically loaded and enabled inside the QGIS Plugin Manager (see Section [Loading an external QGIS Plugin](#)).

Currently there are over 150 external plugins available from the ‘Official’ QGIS Repository. Some of these plugins offer functionality that will be required by many users (for example: providing the user with the ability to view and edit OpenStreetMap data, or to add GoogleMap layers) while others offer very specialized functions (for example: Calculate economic pipe diameters for water supply networks).

It is, however, quite straightforward to search through all the available external plugins by providing keywords, choosing a named repository and/or filtering on the status of plugins (currently installed or uninstalled in your system). Searching and filtering is done from the QGIS Python Plugin Installer (see [figure_plugins_2](#)).

Tip: Add more repositories

To add external author repositories, open the Plugin Installer (*Plugins → Fetch Python Plugins*), go to the tab *Repositories*, and click [**Add**]. 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.

There is only one step required to integrate external plugins into QGIS:

- Download an external plugin from a repository using the *Python Plugin Installer* (see [Using the QGIS Python Plugin Installer](#)). The new external plugin will be added to the list of available plugins in the *Plugin*

Manager and is automatically loaded.

Using the QGIS Python Plugin Installer

In order to download and install an external Python plugin, go to *Plugins* →  *Fetch Python Plugins*. The *Plugin Installer* window will appear (figure_plugins_2) with the tab *Plugins*, containing a list of all locally installed Python plugins, as well as plugin available in remote repositories.

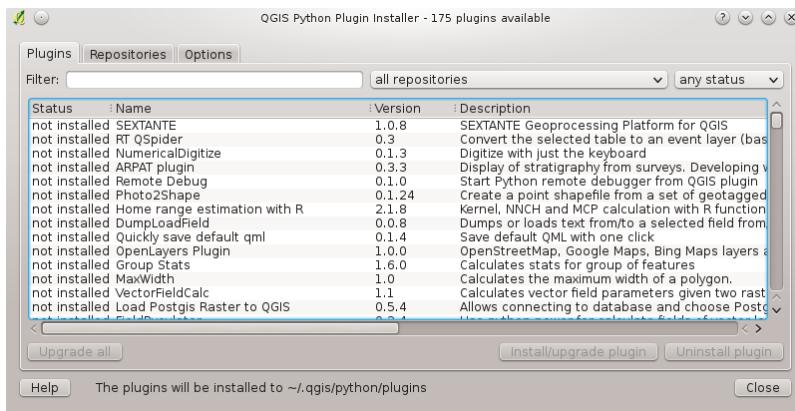


Figure 19.2: Installing external python plugins 

Each plugin can be either:

- **not installed** - this means the plugin is available in the repository, but is not installed yet. In order to install it, select the plugin from the list and click the button [**Install plugin**].
- **new** - this means that the plugin is newly available in the repository.
- **installed** - this indicates that the plugin is already installed. If it is also available in any repository the [**Reinstall plugin**] button will be enabled. If the available version is older than the installed version, the [**Downgrade plugin**] button will appear instead.
- **upgradeable** - this means that the plugin is installed, but there is an updated version available. In this case, the [**Upgrade plugin**] and [**Upgrade all**] buttons will be enabled.
- **invalid** - this means that the plugin is installed, but is unavailable or broken. The reason will be explained in the plugin description field.

Plugins tab

To install a plugin, select it from the list and click the [**Install plugin**] button. The plugin is then activated and installed in its own directory.

-  Linux and other unices
 - /share/qgis/python/plugins
 - \$HOME/.qgis/python/plugins
-  Mac OS X
 - /Contents/MacOS/share/qgis/python/plugins
 - /Users/\$USERNAME/.qgis/python/plugins
-  Windows
 - C:\Program Files\QGIS\python\plugins
 - C:\Documents and Settings\\$USERNAME\.qgis\python\plugins

If the installation is successful, a confirmation message will appear.

If the installation fails, the reason for the failure will be displayed in a warning dialog. Most often, errors are the result of connection problems and/or missing Python modules. In the former case you will likely need to wait before trying the install again, in the latter case, you should install the missing modules relevant to your operating system prior to using the plugin. For Linux, most required modules should be available via a package manager. For install instructions in Windows visit the module home page.

If you are using a proxy, you may need to configure it under *Edit → Options* (Gnome, OSX) or *Settings → Options* (KDE, Windows)‘ on the *Proxy* tab.

The [**Uninstall plugin**] button is enabled only if the selected plugin is installed and is not a core plugin. Note that if you have installed an update to a core plugin, you can uninstall this update with the [**Uninstall plugin**] and revert to the version shipped with Quantum GIS. This default version however, cannot be uninstalled.

Repositories tab

The second tab *Repositories*, contains a list of plugin repositories available for the *Plugin Installer*. By default, only the QGIS Official Repository is enabled. You can add several user-contributed repositories, including the central QGIS Contributed Repository and other external repositories by clicking the [**Add ...**] button. The added repositories contain a large number of useful plugins which are not maintained by the QGIS Development Team. As such, we cannot take any responsibility for them. You can also manage the repository list manually, that is add, remove, and edit the entries. Temporarily disabling a particular repository is possible by clicking the [**Edit ...**] button.

Options tab

The *Options* tab is where you can configure the settings of the *Plugin Installer*. The *Check for updates on startup* checkbox tells QGIS to automatically look for plugin updates and news. By default, if this feature is enabled all repositories listed and enabled in the *Repositories* tab are checked for updates each time the program is started. The frequency of update checking can be adjusted using the dropdown menu, and may be adjusted from once a day right up to once a month. If a new plugin or update is available for one of the installed plugins, a notification will appear in the Status Bar. If the checkbox is disabled, looking for updates and news is performed only when the *Plugin Installer* is manually launched from the menu.

Although the plugin installer update can handle ports different from 80, some internet connections will cause problems when attempting to automatically check for updates. In these cases, a *Looking for new plugins...* indicator will remain visible in the Status Bar during your entire QGIS session, and may cause a program crash when exiting. In this case please disable the checkbox.

In addition, you may specify the type of plugins that are displayed by the *Python Plugin Installer*. Under *Allowed plugins*, you can specify whether you would like to:

- *Only show plugins from the official repository*
- *Show all plugins except those marked as experimental*
- *Show all plugins, even those marked as experimental*

Tip: Using experimental plugins

Experimental plugins are generally unsuitable for production use. These plugins are in the early stages of development, and should be considered ‘incomplete’ or ‘proof of concept’ tools. The QGIS development team does not recommend installing these plugins unless you intend to use them for testing purposes.

19.1.2 Data Providers

Data Providers are ‘special’ plugins that provides access to a data store. By default, QGIS supports PostGIS layers and disk-based data stores supported by the GDAL/OGR library. A Data Provider plugin extends the ability of QGIS to use other data sources.

Data Provider plugins are registered automatically by QGIS at startup. They are not managed by the Plugin Manager but used behind the scenes when a data type is added as a layer in QGIS.

19.2 Using QGIS Core Plugins

Icon	Plugin	Description	Manual Reference
	Add Delimited Text Layer	Loads text files containing x,y coordinates	<i>Delimited Text Plugin</i>
	Coordinate Capture	Capture mouse coordinate in different CRS	<i>Coordinate Capture Plugin</i>
	DB Manager Diagram Overlay	Manage your databases within QGIS Add Diagrams for vectors	<i>DB Manager Plugin</i> <i>Diagram Overlay Plugin</i>
	DXF2Shape Converter	Converts from DXF to SHP file format	<i>Dxf2Shp Converter Plugin</i>
	eVis	Event Visualization Tool	<i>eVis Plugin</i>
	fTools	A suite of vector tools	<i>fTools Plugin</i>
	GPS Tools	Tools for loading and importing GPS data	<i>GPS Plugin</i>
	GRASS	GRASS functionality	<i>GRASS GIS Integration</i>
	GDAL Tools	GDAL raster functionality	<i>GDAL Tools Plugin</i>
	Georeferencer GDAL	Georeference Raster with GDAL	<i>Georeferencer Plugin</i>
	Heatmap	Create heatmap raster from input vector points	<i>Heatmap Plugin</i>
	Interpolation plugin	Interpolation on base of vertices of a vector layer	<i>Interpolation Plugin</i>
	MapServer Export Plugin	Export a QGIS project file to a MapServer map file	<i>MapServer Export Plugin</i>
	Offline Editing	Offline editing and synchronizing with database	<i>Offline Editing Plugin</i>
	OpenStreetMap	Access OpenStreetMap	<i>OpenStreetMap</i>
	Oracle Spatial Georaster	Access Oracle Spatial GeoRasters	<i>Oracle GeoRaster Plugin</i>
	Plugin Installer	Download and install python plugins	<i>Using the QGIS Python Plugin Installer</i>
	Raster Terrain Analysis Road graph Plugin	Compute geomorphological features from DEMs Shortest path analysis	<i>Raster Terrain Analysis Plugin</i> <i>Road Graph Plugin</i>
	SPIT	Shapefile to PostGIS Import Tool	<i>Importing Data into PostgreSQL</i>
	SQL Anywhere plugin	Access SQL anywhere DB	<i>SQL Anywhere Plugin</i>
	Spatial Query	Spatial queries on vectors	<i>Spatial Query Plugin</i>
	Zonal Statistics	Calculate raster statistics for vector polygons	<i>Zonal Statistics Plugin</i>

19.3 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).

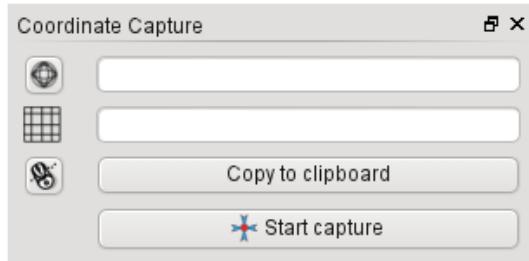


Figure 19.3: Coordinate Capture Plugin 

1. Start QGIS, select  *Project Properties* from the *Settings* (KDE, Windows) or *File* (Gnome, OSX) menu and click on the *Projection* tab. As an alternative you can also click on the  CRS status icon in the lower right-hand corner of the statusbar.
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. Load the coordinate capture plugin in the Plugin Manager (see [Loading a QGIS Core Plugin](#)) 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](#).
4. Click on the  Click to 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  mouse tracking icon.
7. You can also copy selected coordinates to the clipboard.

19.4 DB Manager Plugin

The DB Manager Plugin is officially part of QGIS core and intends to replace the SPIT Plugin and the PostGIS Manager Plugin and additionally to integrate all other database formats supported by QGIS 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. 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.

The *Database* menu allows to connect to an existing database, to start the SQL-window and to exit the DB Manager Plugin. 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 menu *Table* allows to create and edit tables and to delete tables and views. It is also possible to empty tables and to move tables from one to another schema. Finally you can also run Vacuum Analyze and add Versioning Support to a table.

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.

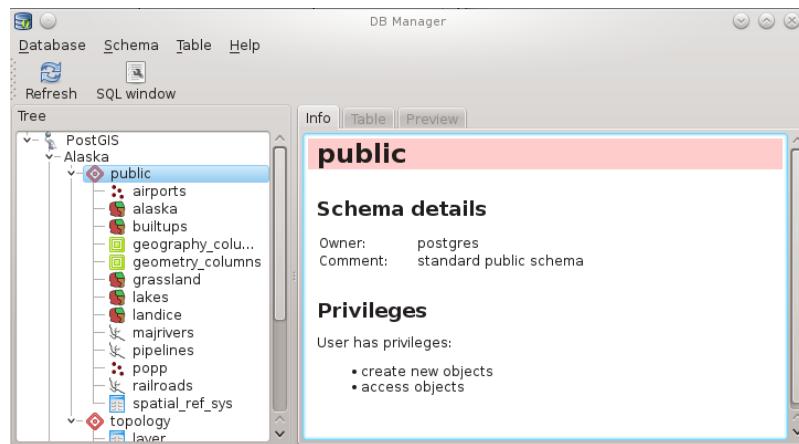


Figure 19.4: DB Manager dialog (KDE) 

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 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.

19.5 Delimited Text Plugin

The Delimited Text plugin allows you to load a delimited text file as a layer in QGIS.

19.5.1 Requirements

To view a delimited text file as layer, the text file must contain:

1. A delimited header row of field names. This must be the first line in the text file.
2. The header row must contain an X and Y field. These fields can have any name.
3. The x and y coordinates must be specified as a number. The coordinate system is not important.

As an example of a valid text file we import the elevation point data file `elevp.csv` coming with the QGIS sample dataset (See Section [Sample Data](#)):

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

Some items of note about the text file are:

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.

19.5.2 Using the Plugin

To use the plugin you must first enable it as described in Section [Managing Plugins](#).

Click the new toolbar icon  Add Delimited Text Layer to open the *Delimited Text* dialog as shown in figure_delimited_text_1.

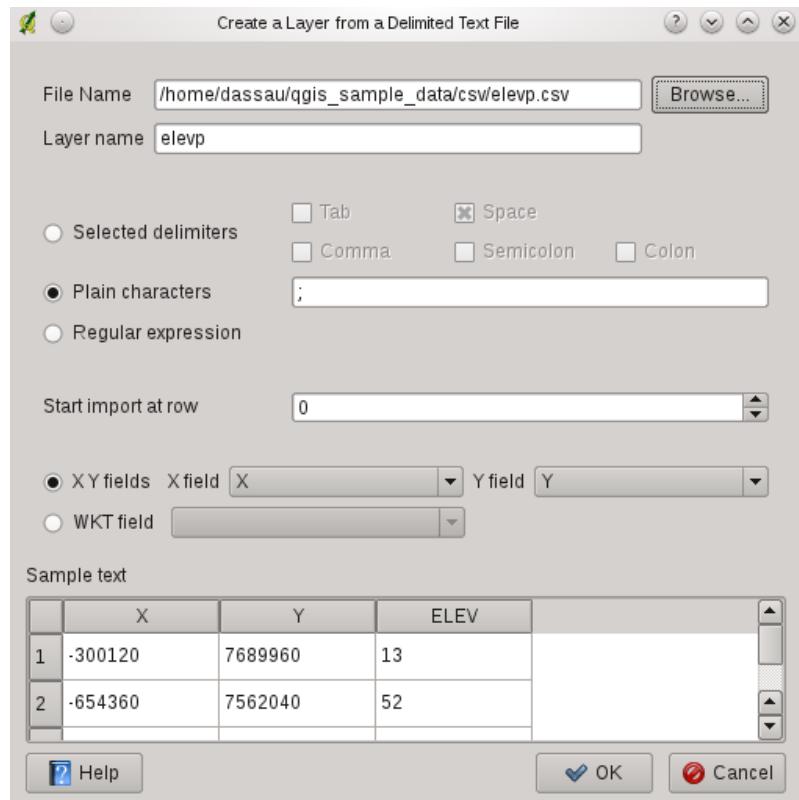


Figure 19.5: Delimited Text Dialog 

First select the file (e.g., `qgis_sample_data/csv/elevp.csv`) to import by clicking on the [Browse] button. Once the file is selected, the plugin attempts to parse the file using the last used delimiter, in this case a semicolon (`;`). To properly parse the file, it is important to select the correct delimiter. To change the delimiter to tab use `\t` (this is a regular expression for the tab character).

Once the file is parsed, choose the X and Y fields from the dropdown lists and if available also the WKT field for the CRS information. 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.

19.6 Diagram Overlay Plugin



The *Diagram Overlay* Plugin allows you to add a graphic overlay to a vector layer (see figure_overlay_1). It provides additional and not yet implemented features to the *Diagrams* tab, described in section *Diagrams Tab*.

Before starting, the *Diagram Overlay* Plugin needs to be activated using the Plugin Manager (see Section *Loading a QGIS Core Plugin*). It will then appear as *Overlay* tab in the *Layer Properties* dialog next to the *Diagrams* tab.

The *Overlay* tab provides support for Pie charts, Bar charts and proportional SVG symbols.

Similar to the *Diagrams* tab, we will demonstrate an example and overlay the alaska boundary layer a piechart diagram showing some 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`.

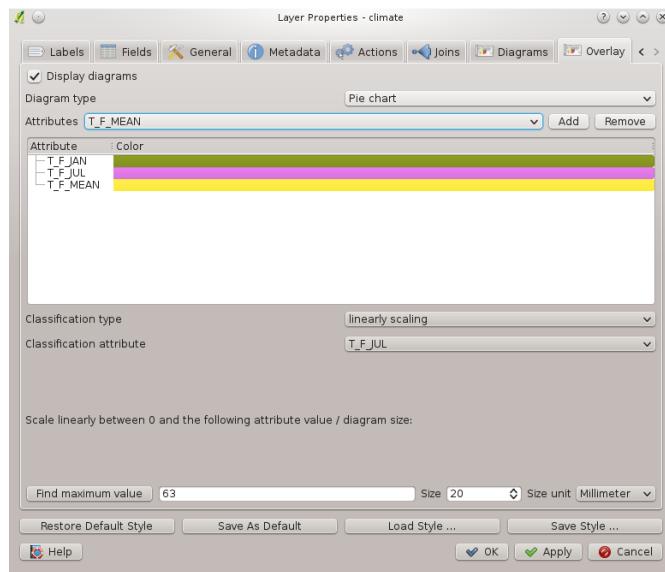


Figure 19.6: Vector properties dialog with overlay tab

2. Double click the `climate` layer in the map legend to open the *Layer Properties* dialog.
3. Click on the *Overlay* tab, activate *Display diagrams* and select ‘Pie Chart’ from *Diagram type* combobox.
4. We want to display the values of the three columns `T_F_JAN`, `T_F_JUL` and `T_F_MEAN`. First select `T_F_JAN` as Attributes and click the **[Add]** button, then `T_F_JUL` and finally `T_F_MEAN`.
5. Diagram size is based on linear scaling of a classification attribute. We choose `T_F_JUL`, click on **[Find maximum value]** and set size to 20 and *Size unit* to ‘Millimeter’.
6. Now click **[Apply]** to display the diagram in the QGIS main window.
7. You can now adapt the chart size, or change the attribute colors double clicking on the color values in the attribute field. [Figure_overlay_2](#) gives an impression.
8. Finally click **[Ok]**.

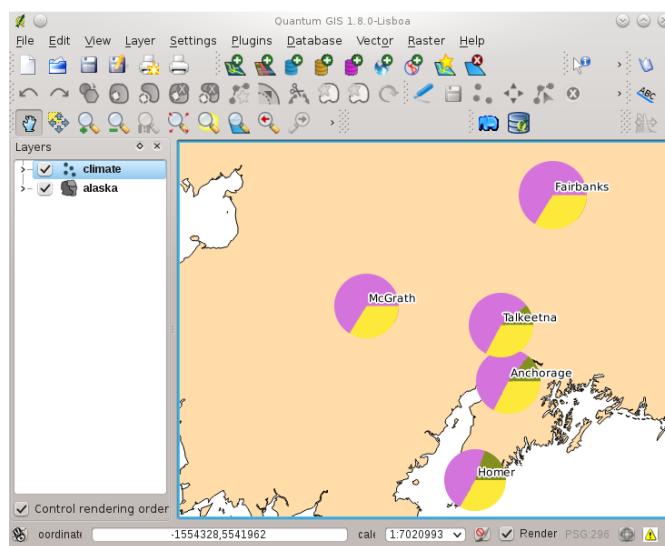


Figure 19.7: Pie chart diagram from temperature data overlayed on a map

Additionally in the *Settings → Options* dialog, there is a *Overlay* tab where it is possible to select the placement

algorithm of the diagrams. The ‘Central point’ method is a generic one, the others use algorithms of the PAL library. They also consider diagram objects and labels in different layers.

19.7 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:

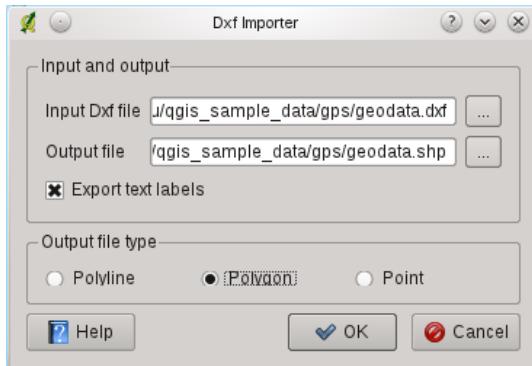


Figure 19.8: Dxf2Shape Converter Plugin

- **Input DXF file:** Enter 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.

19.7.1 Using the Plugin

1. Start QGIS, load the Dxf2Shape plugin in the Plugin Manager (see Section [Loading a QGIS Core Plugin](#)) and click on the icon which appears in the QGIS toolbar menu. The Dxf2Shape plugin dialog appears as shown in [Figure_dxf2shape_1](#).
2. Enter 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].

19.8 eVis Plugin

The Biodiversity Informatics Facility at the American Museum of Natural History’s (AMNH) Center for Biodiversity and Conservation (CBC) (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.) 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 [Managing Plugins](#)).

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.

19.8.1 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 either click on the  eVis Event Browser icon or click on *Database* → *eVis* → *eVis Event Browser*. This will open the *Generic Event Browser* window.

The *Generic 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 *Generic Event Browser* window. The *Display* window is used to view geocoded photographs and their associated attribute data.

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.
7. **Feature indicator:** This heading indicates which feature is being displayed and how many features are available for display.

Understanding the Options window

1. **File path:** A dropdown 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

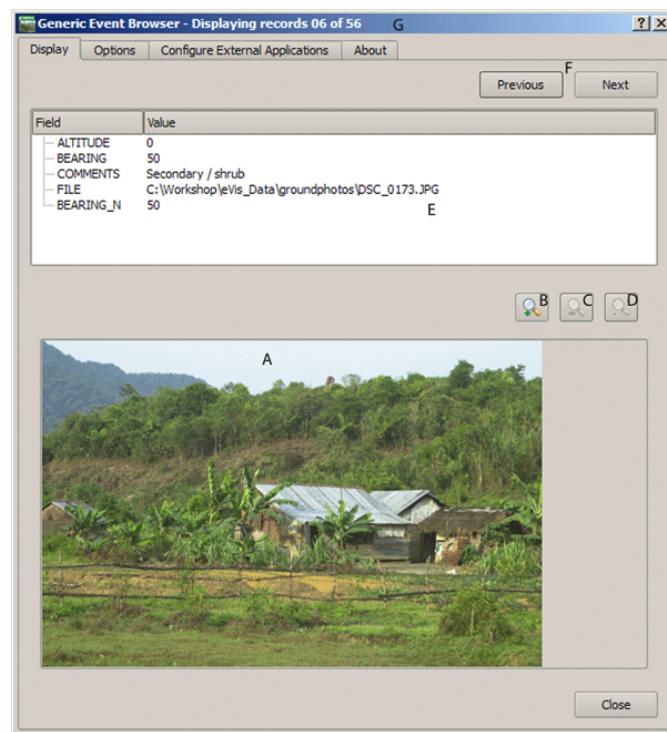


Figure 19.9: The *eVis* display window

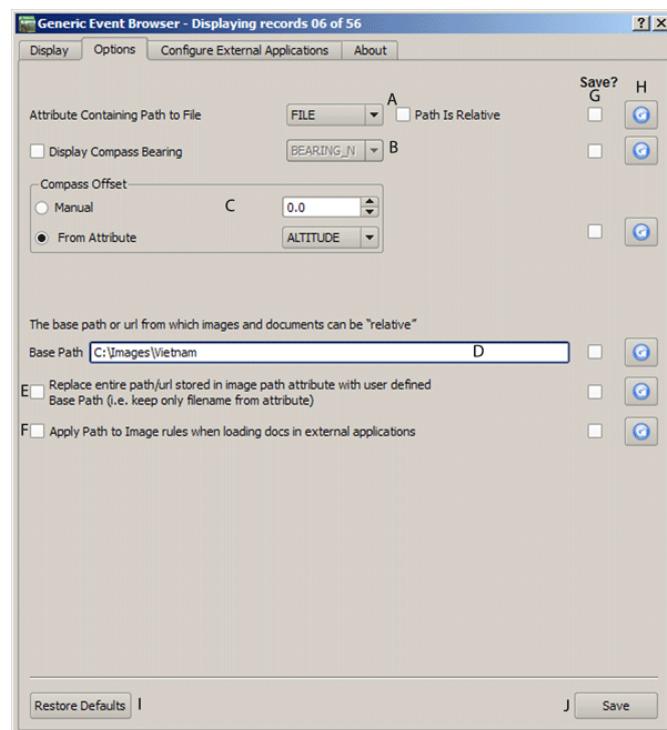


Figure 19.10: The *eVis* Options window

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 display field:** A dropdown 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 to the left of the dropdown menu title.
3. **Compass offset setting:** Compass offsets can be used to compensate for declination (adjust bearings collected using magnetic bearings to true north bearings). Click the *Manual* radiobutton to enter the offset in the text box or click the *From Attribute* radiobutton 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 the 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. **Save 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

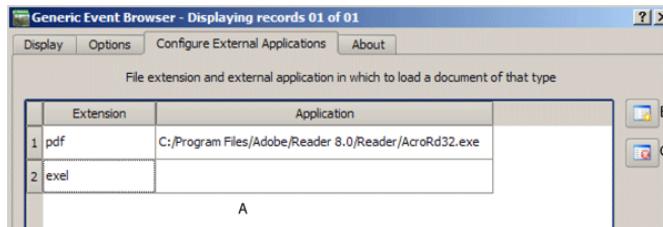


Figure 19.11: The *eVis* External Applications window

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.

19.8.2 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://biodiversityinform.org/testdata/DSC_0170.JPG	10
780596	1784017	pdf:http://www.test.com/attach.php?attachment_id=12	76

19.8.3 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, and 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](#)).

19.8.4 Using the Generic 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 *Generic Event Browser* window. The arrow will be centered over the point that is associated with the photograph or other document.

To close the *Generic Event Browser* window click on the **[Close]** button from the *Display* window.

19.8.5 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  Event ID icon or click on *Plugins* → *eVis* → *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 *Generic 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 [ref:evis_browser](#) section of this guide.

19.8.6 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 four types of databases: Microsoft Access, PostgreSQL, MySQL, SQLite, and can also read from ODBC connections. 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  eVis Database Connection or click on *Plugins* → *eVis* → *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*



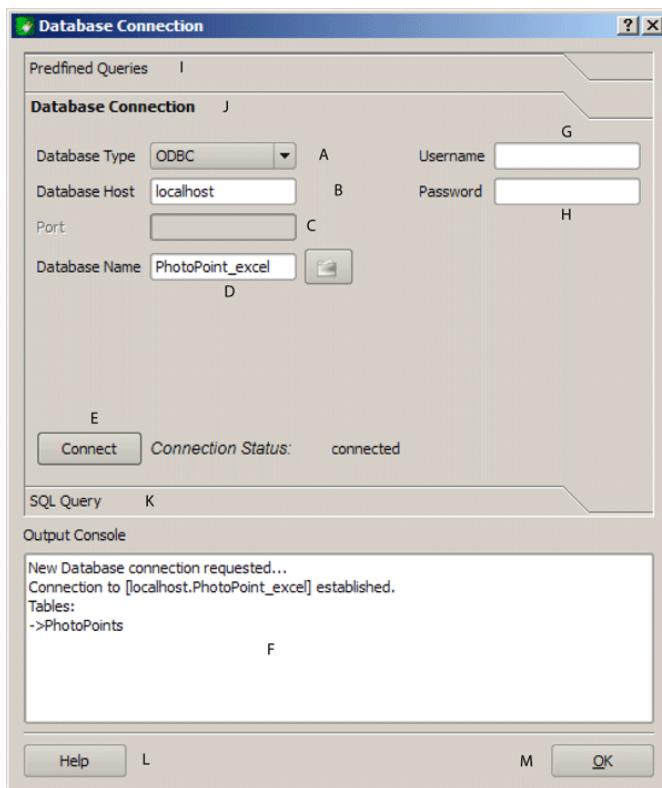
combobox to select the type of database that you want to connect to. If a password or username is required, that information can be entered in the *Username* and *Password* textboxes.

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 dropdown 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.
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 on line help.
13. **OK:** Close the main “Database Connection” window.

Figure 19.12: The *eVis* 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 <http://www.w3schools.com/sql>. 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 on line help.
5. **OK:** Closes the main *Database Connection* window.

Use the *X Coordinate* and *Y Coordinate* comboboxes to select the field from the database that store 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...’

Tip: Creating a vector layer from a Microsoft Excel Worksheet

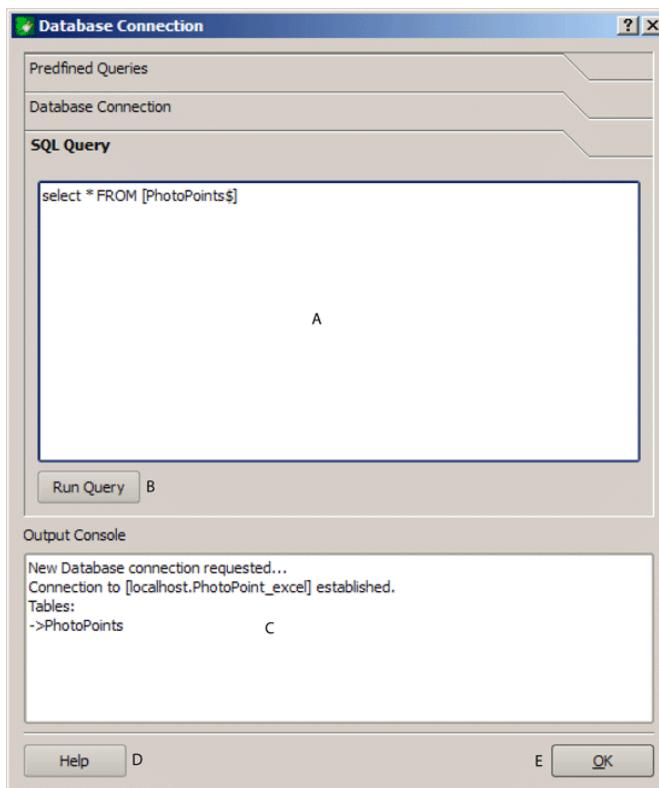


Figure 19.13: The eVis SQL query tab

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 there if you are connected to the file to allow you to edit the file) and then use *Edit → 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 → 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 dropdown menu located just below the Open File icon, the full description of the query is displayed in the text window under the dropdown menu.

Select the query you want to run from the dropdown 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.

1. **Open Query File:** Launches the “Open File” file browser to search for the XML file holding the predefined queries.
2. **Predefined Queries:** A dropdown list with all of the queries defined by the predefined queries XML file.

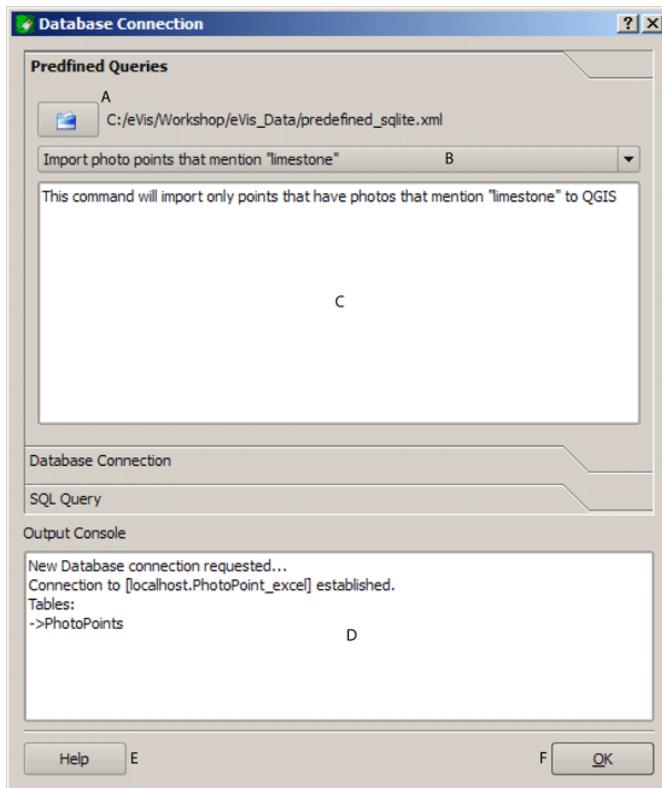


Figure 19.14: The *eVis* Predefined queries tab

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 on line 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.
shortdescription	A short description of the query that appears in the eVis dropdown menu.
description	A more detailed description of the query displayed in the Predefined Query text window.
database-type	The database type as defined in the Database Type dropdown menu in the Database Connection tab.
database-port	The port as defined in the Port textbox in the Database Connection tab.
database-name	The database name as defined in the Database Name textbox in the Database Connection tab.
databaseusername	The database username as defined in the Username textbox in the Database Connection tab.
databasepassword	The database password as defined in the Password textbox in the Database Connection tab.
sqlstatement	The SQL command.
autoconnect	A flag ("true" or "false") to specify if the above tags should be used to automatically connect to 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<br/>
    </description>
  <databasestype>SQLITE</databasestype>
  <databasehost />
  <databaseport />
  <databasefilename>C:\textbackslash Workshop\textbackslash eVis\_Data\textbackslash PhotoPoints.db</databasefilename>
  <databaseusername />
  <databasepassword />
  <sqlstatement>SELECT Attributes.*, Points.x, Points.y FROM Attributes LEFT JOIN<br/>
    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<br/>
    a valley" to QGIS</description>
  <databasestype>SQLITE</databasestype>
  <databasehost />
  <databaseport />
  <databasefilename>C:\Workshop\Workshop\PhotoPoints.db</databasefilename>
  <databaseusername />
  <databasepassword />
  <sqlstatement>SELECT Attributes.*, Points.x, Points.y FROM Attributes LEFT JOIN<br/>
    Points ON Points.rec_id=Attributes.point_ID where COMMENTS='Looking across<br/>
    valley'</sqlstatement>
  <autoconnect>false</autoconnect>
</query>
<query>
  <shortdescription>Import photograph points that mention "limestone"</shortdescription>
  <description>This command will import only points that have photographs that mention<br/>
    "limestone" to QGIS</description>
  <databasestype>SQLITE</databasestype>
  <databasehost />
  <databaseport />
```

```

<dbname>C:\Workshop\eVis_Data\PhotoPoints.db</dbname>
<username />
<password />
<sqlstatement>SELECT Attributes.*, Points.x, Points.y FROM Attributes LEFT JOIN
    Points ON Points.rec_id=Attributes.point_ID where COMMENTS like '%limestone%'
</sqlstatement>
<autoconnect>false</autoconnect>
</query>
</doc>

```

19.9 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 workarounds. 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 Section [Loading a QGIS Core Plugin](#)). 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.

19.9.1 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 statistic	Compute basic statistics (mean, std dev, N, sum, CV) on an input field.
	Nearest Neighbor analysis	Compute nearest neighbor statistics assess the level of clustering in a point vector layer
	Mean coordinate(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

19.9.2 Research tools

Icon	Tool	Purpose
	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.
	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

19.9.3 Geoprocessing tools

Icon	Tool	Purpose
	Convex hull(s)	Create minimum convex hull(s) for an input layer, or based on an ID field.
	Buffer(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.

Table Ftools 3: fTools Geoprocessing tools

19.9.4 Geometry tools

Icon	Tool	Purpose
	Check geometry	Check polygons for intersections, closed-holes, and fix node ordering.
	Export/Add geometry columns	Add vector layer geometry info to point (XCOORD, YCOORD), line (LENGTH), or polygon (AREA, PERIMETER) layer.
	Polygon centroids	Calculate the true centroids for each polygon in an input polygon layer.
	Delaunay triangulation	Calculate and output (as polygons) the delaunay triangulation of an input point vector layer.
	Voronoi Polygons	Calculate voronoi polygons of an input point vector layer.
	Simplify geometry	Generalize lines or polygons with a modified Douglas-Peucker algorithm.
	Densify geometry	Densify lines or polygons by adding vertices
	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.
	Polygons to lines	Convert polygons to lines, multipart polygons to multiple singlepart lines.
	Lines to polygons	Convert lines to polygons, multipart lines to multiple singlepart polygons.
	Extract nodes	Extract nodes from line and polygon layers and output them as points.

Table Ftools 4: fTools Geometry tools

Note: The *Simplify geometry* tool can be used to remove duplicate nodes in line and polygon geometries, just set the *Simplify tolerance* parameter to 0 and this will do the trick.

19.9.5 Data management tools

Icon	Tool	Purpose
	Define 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.
	Split vector layer	Split input layer into multiple separate layers based on input field.
	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

19.10 GDAL Tools Plugin

19.10.1 What is GDALTools?

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 GDALTools plugin offers an easy interface to the tools, exposing only the most popular options.

19.10.2 List of GDAL tools

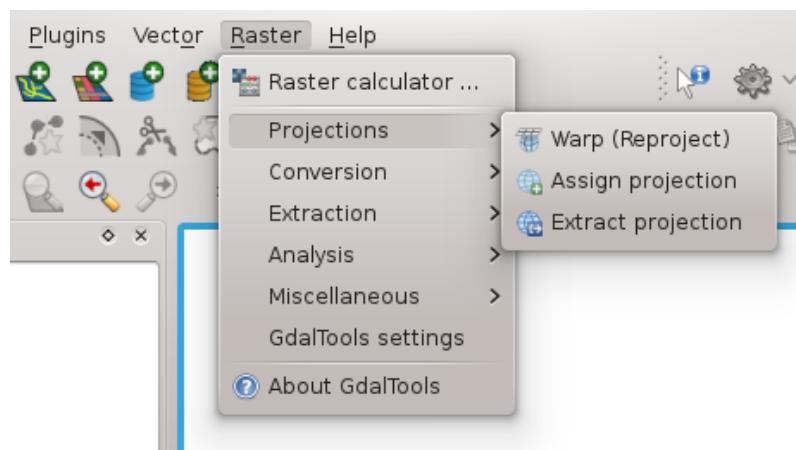


Figure 19.15: The *GDALTools* menu list

Projections

 Warp (Reproject)	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 http://www.gdal.org/gdalwarp.html
 Assign projection	This tool allows to assign projection to rasters that already georeferenced but miss projection information. Also with it help it is possible to alter existing projection definition. Both single file and batch mode are supported. For more information please visit utility page at GDAL site http://www.gdal.org/gdalwarp.html
 Extract projection	This utility helps you to extract projection information from an input file. If you want to extract projection from a whole directory you can use the Batch mode. It creates both .prj and .wld files.

Conversion

 <i>Rasterize</i>	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
 <i>Polygons</i>	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 http://www.gdal.org/gdal_polygonize.html
 <i>Translate</i>	This utility can be used to convert raster data between different formats, potentially performing some operations like subsettings, resampling, and rescaling pixels in the process. For more information you can read on http://www.gdal.org/gdal_translate.html
 <i>RGB to PCT</i>	This utility will compute an optimal pseudo-color table for a given RGB image using a median cut algorithm on a downsampled RGB histogram. Then it converts the image into a pseudo-colored 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 http://www.gdal.org/rgb2pct.html
 <i>PCT to RGB</i>	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

 <i>Contour</i>	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.
 <i>Clipper</i>	This utility allows to clip (extract subset) raster using selected extent or based on mask layer bounds. More information can be found at http://www.gdal.org/gdal_translate.html .

Analysis

 <i>Sieve</i>	This utility removes raster polygons smaller than a provided threshold size (in pixels) and replaces them with the pixel value of the largest neighbor polygon. The result can be written back to the existing raster band, or copied into a new file. For more information see http://www.gdal.org/gdal_sieve.html .
 <i>Near Black</i>	This utility will scan an image and try to set all pixels that are nearly black (or nearly white) around the edge to exactly black (or white). This is often used to “fix up” lossy compressed aerial photos so that color pixels can be treated as transparent when mosaicing. See also http://www.gdal.org/nearblack.html .
 <i>Fill nodata</i>	This utility fills selection raster regions (usually nodata areas) by interpolation from valid pixels around the edges of the area. On http://www.gdal.org/gdal_fillnodata.html you can find more information.
 <i>Proximity</i>	This utility generates a raster proximity map indicating the distance from the center of each pixel to the center of the nearest pixel identified as a target pixel. Target pixels are those in the source raster for which the raster pixel value is in the set of target pixel values. For more information see http://www.gdal.org/gdal_proximity.html .
 <i>Grid</i>	This utility creates regular grid (raster) from the scattered data read from the OGR datasource. Input data will be interpolated to fill grid nodes with values, you can choose from various interpolation methods. The utility is also described on the GDAL website http://www.gdal.org/gdal_grid.html .
 <i>DEM terrain models</i>	Tools to analyze and visualize DEMs. It can create a shaded relief, a slope, an aspect, a color relief, a Terrain Ruggedness Index, a Topographic Position Index and a roughness map from any GDAL-supported elevation raster. For more information you can read on http://www.gdal.org/gdaldem.html

Miscellaneous

 <i>Build Virtual Raster</i>	This program builds a VRT (Virtual Dataset) that is a mosaic of the list of input gdal datasets. See also http://www.gdal.org/gdalbuildvrt.html .
 <i>Merge</i>	This utility will automatically mosaic a set of images. All the images must be in the same coordinate system and have a matching number of bands, but they may be overlapping, and at different resolutions. In areas of overlap, the last image will be copied over earlier ones. The utility is also described on http://www.gdal.org/gdal_merge.html .
 <i>Information</i>	This utility lists various information about a GDAL supported raster dataset. On http://www.gdal.org/gdalinfo.html you can find more information.
 <i>Build Overviews</i>	The gdaladdo utility can be used to build or rebuild overview images for most supported file formats with one of several downsampling algorithms. For more information see http://www.gdal.org/gdaladdo.html .
 <i>Tile Index</i>	This utility builds a shapefile with a record for each input raster file, an attribute containing the filename, and a polygon geometry outlining the raster. See also http://www.gdal.org/gdaltindex.html .

19.11 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 their coordinates.

Features

Icon	Purpose	Icon	Purpose
	Open raster		Start georeferencing
	Generate GDAL Script		Load GCP Points
	Save GCP Points As		Transformation settings
	Add Point		Delete Point
	Move GCP Point		Pan
	Zoom In		Zoom Out
	Zoom To Layer		Zoom Last
	Zoom Next		Link Georeferencer to QGIS
	Link QGIS to Georeferencer		

Table Georeferencer 1: Georeferencer Tools

19.11.1 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 the projection you want to have your image. In this case you can enter the coordinates by clicking on the reference dataset loaded in QGIS map canvas.

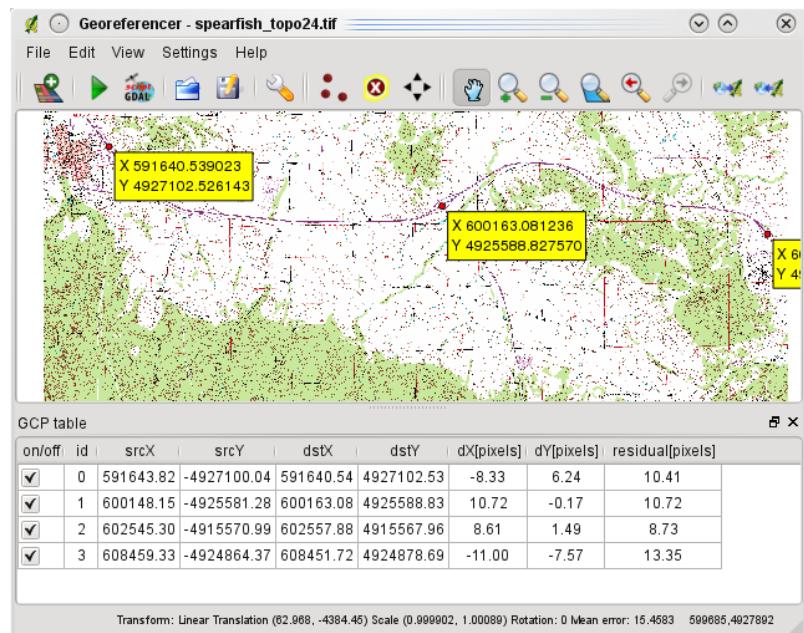
The usual procedure for georeferencing an image involves selecting multiple points on the raster, specifying their coordinates, and choosing a relevant transformation type. Based on the input parameters and data, the plugin will compute the world file parameters. The more coordinates you provide, the better the result will be.

The first step is to start QGIS, load the Georeferencer Plugin (see Section [Loading a QGIS Core Plugin](#)) and click on the icon which appears in the QGIS toolbar menu. The Georeferencer Plugin dialog appears as shown in [figure_georeferencer_1](#).

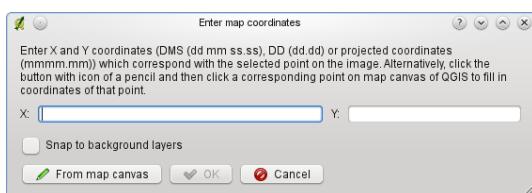
For this example, we are using a topo sheet of South Dakota from SDGS. It can later be visualized together with the data from the GRASS spearfish60 location. You can download the topo sheet here: http://grass.osgeo.org/sampleddata/spearfish_toposheet.tar.gz.

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.

Figure 19.16: Georeferencer Plugin Dialog 

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.
 - Click on a point in the raster image and choose the button  from map canvas 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 4 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.

Figure 19.17: 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 buttons to manage the files.

Within the GCP table you can click on a column header and therewith enable e.g. numerical sorting. The GCP list is automatically updated.

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.

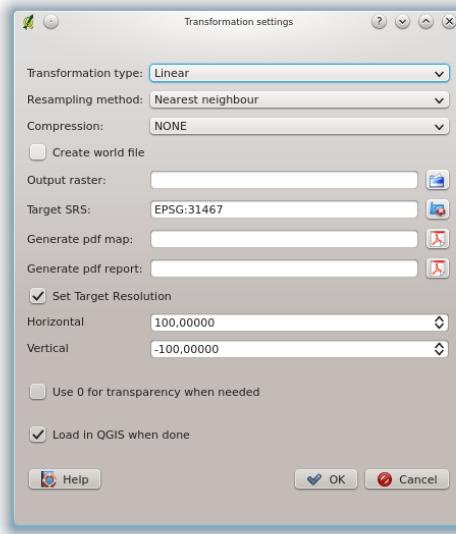


Figure 19.18: Defining the georeferencer transformation settings 

Available Transformation algorithms

Depending on how many ground control point 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 final result.

Currently, following algorithms 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 for georeferencing, and each one differs by the degree of distortion 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 checkbox *Create world file* 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 field *Output raster* is not activated, because only a new world-file will be created.
- For all other transformation type you have to define an *Output raster*. As default a new file ([file-name]_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 section [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 pixel resolution of the output raster. Default horizontal and vertical resolution is 1,
- The *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 if 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 button  **Start georeferencing** to create the new georeferenced raster.

19.12 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 layers (See [Figure_interpolation_1](#)). The plugin requires the following parameters to be specified before running:

- **Input vector layer:** 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*  combobox.
- **Interpolation attribute:** Select attribute column to be used for interpolation or enable the *Use Z-Coordinate* checkbox to use the layers stored Z values.
- **Interpolation Method:** Select interpolation method. This can be either ‘Triangulated Irregular Network (TIN)’ or ‘Inverse Distance Weighted (IDW)’.
- **Number of columns/rows:** Specify the number row and columns for the output raster file.
- **Output file:** Specify a name for the output raster file.

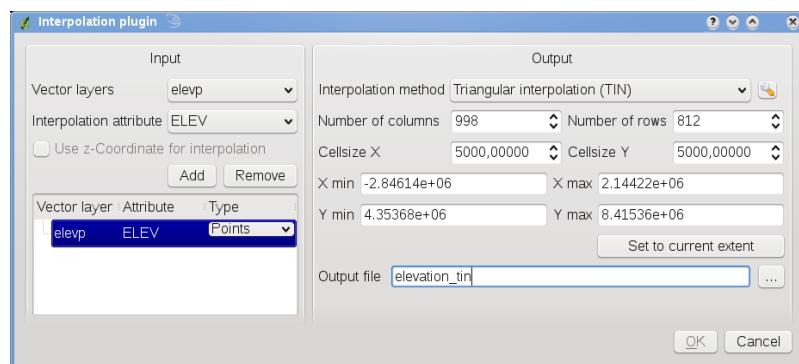


Figure 19.19: Interpolation Plugin 

19.12.1 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 Section [Loading a QGIS Core Plugin](#)) and click on the  *Interpolation* icon which appears in the QGIS toolbar menu. 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 cellsize of 5000 as well as the raster output filename (e.g., `elevation_tin`).
5. Click **[OK]**.
6. For the current example, double click `elevation_tin` in the layer list to open the raster *Layer Properties* dialog and select ‘Pseudocolor’ as *Color Map*  in the *Symbology* tab. Or you can define a new color table as described in section [Working with Raster Data](#).

19.13 MapServer Export Plugin

You can use QGIS to ‘compose’ your map by adding and arranging layers, symbolizing them, customizing the colors and then creating a map file for MapServer.

Note: Currently the plugin only works when you use ‘Old Symbology’ in QGIS. ‘New Symbology’ is not yet supported.

19.13.1 Creating the Project File

The MapServer Export Plugin operates on a saved QGIS project file and **not** on the current contents of the map canvas and legend. This has been a source of confusion for a number of users. As described below, before you start using the MapServer Export Plugin, you need to arrange the raster and vector layers you want to use in MapServer and save this status in a QGIS project file.

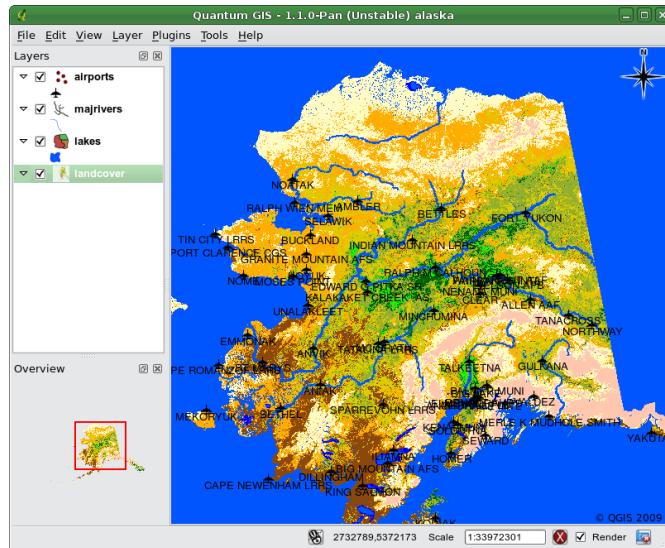


Figure 19.20: Arrange raster and vector layers for QGIS project file

In this example, we demonstrate the four steps required to create a simple project file which can be used to create the MapServer map file. We use raster and vector files from the QGIS sample dataset *Sample Data*.

1. Add the raster layer `landcover.tif` clicking on the icon.
2. Add the vector Shapefiles `lakes.shp`, `majrivers.shp` and `airports.shp` from the QGIS sample dataset clicking on the icon.
3. Change the colors and symbolize the data as you like (for example see `figure_mapserver_export_1`)
4. Save a new project named `mapserverproject.qgs` using *File* → *Save Project*.

19.13.2 Creating the Map File

To use the Mapserver Export plugin from within QGIS, you need to enable the MapServer Export Plugin first using the Plugin Manager (see *Loading a QGIS Core Plugin*).

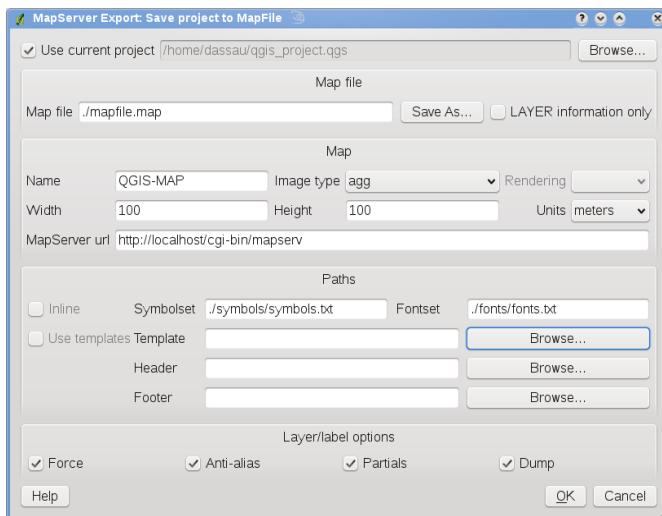


Figure 19.21: Export to MapServer Dialog 

Map file	Enter the name for the map file to be created. You can use the button at the right to browse for the directory where you want the map file created.
Qgis project file	Enter the full path to the QGIS project file (.qgs) you want to export. You can use the button at the right to browse for the QGIS project file.
Map Name	A name for the map. This name is prefixed to all images generated by the mapserver.
Map Width	Width of the output image in pixels.
Map Height	Height of the output image in pixels.
Map Units	Units of measure used for output.
Image type	Format for the output image generated by MapServer
Web Template	Full path to the MapServer template file to be used with the map file
Web Header	Full path to the MapServer header file to be used with the map file
Web Footer	Full path to the MapServer footer file to be used with the map file

Only the inputs *Map file* and *QGIS project file* are required to create a map file, however by omitting the other parameters, you may end up creating a non-functional map file, depending on your intended use. Although QGIS is good at creating a map file from your project file, it may require some tweaking to get the results you want. For this example, we will create a map file using the project file `mapserverproject.qgs` we just created (see Figure_mapserver_export_2):

1. Click the  `MapServer Export` icon in the toolbar menu to start the MapServer dialog (see Figure_mapserver_export_2).
2. Enter the name (e.g., `qgisproject.map`) for your new map file.
3. Browse and find the QGIS project file (e.g., `mapserverproject.qgs`) you previously saved.
4. Enter a name (e.g., `MyMap`) for the map.
5. Enter the width and height (e.g., 600 for the width and 400 for the height) for your output image.
6. For this example, the layers are in meters, so we change the units to meters.

7. Choose *png* for the image type.
8. Click [OK] to generate the new map file `qgisproject.map`. QGIS displays the success of your efforts.

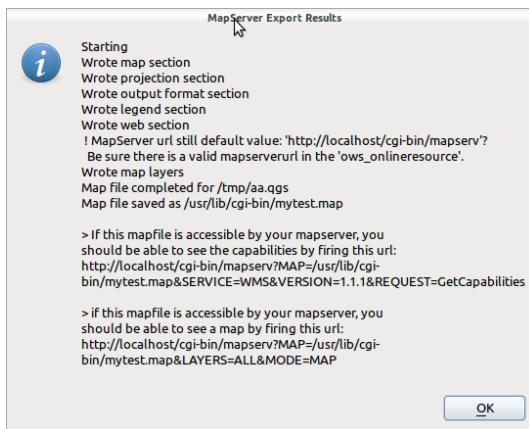


Figure 19.22: Export to MapServer Succesfull Dialog 🐧

You can view the map file in any text editor or visualizer. If you take a look, you'll notice that the export tool adds the metadata needed to enable our map file for WMS.

19.13.3 Troubleshooting

If you get error messages from mapserver like:

```
loadSymbolSet(): Unable to access file. (./symbols/symbols.txt)
```

or:

```
msLoadFontset(): Unable to access file. Error opening fontset ./fonts/fonts.txt.
```

This means that that the map file is requesting for fonts or symbol definition files but that Mapserver cannot find those.

Either comment the lines containing those names in the map file (this is possible if you do not have labels or use styles from the `symbols.txt`). Or create those files (see below).

The most simple `fonts.txt` file (because arial is used in the QGIS generated map files) contains the following line

```
# either relative to the map file or a full path:  
arial /usr/share/fonts/truetype/msttcorefonts/arial.ttf
```

The most simple `symbols.txt` file contains the definition of a circle symbol (because a circle symbol is used for point layers)

```
SYMBOLSET  
  SYMBOL  
    NAME "circle"  
    TYPE ellipse  
    FILLED true  
    POINTS  
      1 1  
    END  
  END  
END
```

19.13.4 Testing the Map File

We can now test our work.

If the map file is accessible for your mapserver.cgi you can use the one of the URL's from the success dialog.

Another option is using the **shp2img** tool to create an image from the map file. The **shp2img** utility is part of MapServer and FWTools. To create an image from our map:

- Open a terminal window
- If you didn't save your map file in your home directory, change to the folder where you saved it.
- Run `shp2img -m qgisproject.map -o mapserver_test.png` and display the image

This creates a PNG with all the layers included in the QGIS project file. In addition, the extent of the PNG will be the same as when we saved the project. As you can see in [figure_mapserver_export_4](#), all information except the airport symbols are included.

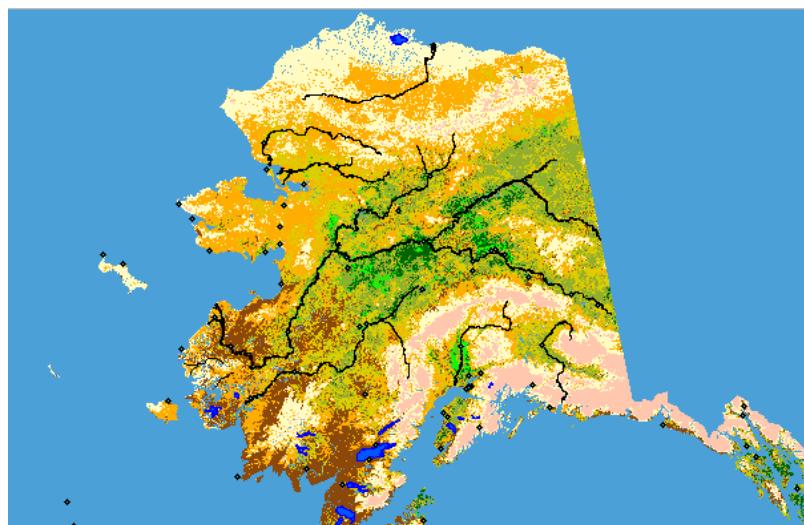


Figure 19.23: Test PNG created by shp2img with all MapServer Export layers 

19.13.5 Using Map File

If you plan to use the map file to serve WMS requests, you probably don't have to tweak anything. If you plan to use it with a mapping template or a custom interface, you may have a bit of manual work to do. To see how easy it is to go from QGIS to serving maps on the web, take a look at Christopher Schmidt's 5 minute [flash video](#). He used an older version of QGIS (version 0.8), but the demo applies equally well to newer versions.

19.14 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 data source, 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 synchronization 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.

19.14.1 Using the plugin

- Open some vector layers, e.g. from a PostGIS or WFS-T datasource
- Save it as a project
- Press the  icon and select the layers to save. The content of the layers is saved to SpatiaLite tables.
- Edit the layers offline.
- After being connected again, upload the changes with the  Synchronize button.

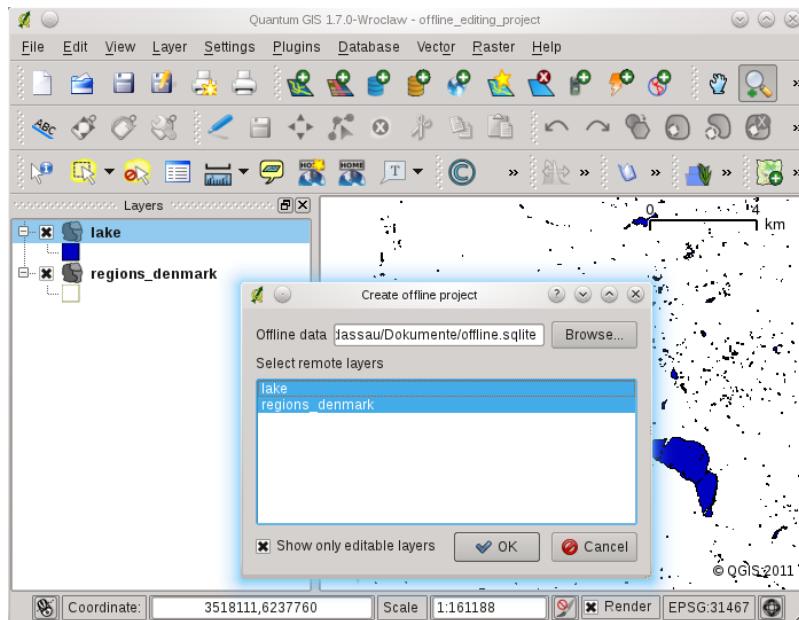


Figure 19.24: Create an offline project from PostGIS or WFS layers

19.15 Oracle GeoRaster Plugin

In Oracle databases, raster data can be stored in SDO_GEORASTER objects available with the Oracle Spatial extension. In QGIS, the  OracleGeoRasterPlugin 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.

19.15.1 Managing connections

Firstly, the Oracle GeoRaster Plugin must be enabled using the Plugin Manager (see Section [Loading a QGIS Core Plugin](#)). 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  Select GeoRaster toolbar button, it 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

- **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:** The password associated with your username that is required to access the database

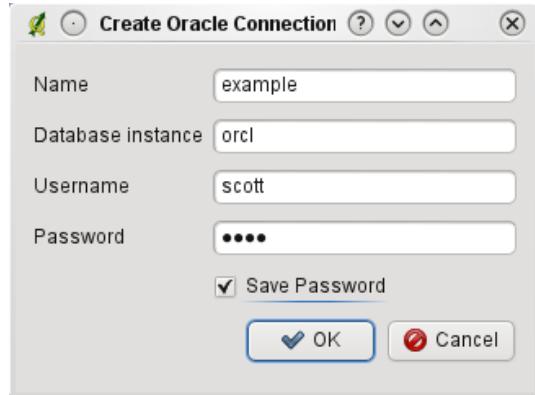


Figure 19.25: Create Oracle connection dialog

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.

19.15.2 Selecting a GeoRaster

Once a connection has been established, the sub-datasets window will show the names of all the tables that contains 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 the table/column combination. The dialog will now show all the rows that contains GeoRaster objects. Note that the subdataset list will now show the Raster Data Table and Raster Id's pairs.

At anytime 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.

19.15.3 Displaying GeoRaster

Finally, by selecting a GeoRaster from the list of Raster Data Table and Raster Id's, the raster image will be loaded into QGIS.

The *Select Oracle Spatial GeoRaster* dialog can be closed now and next time it opens it will keep the same connection, and will show the same previous list of subdataset making it very easy to open up another image from the same context.

Note: GeoRasters that contains pyramids will display much faster but the pyramids need to be generated outside of QGIS using Oracle PL/SQL or gdaladdo.

The following is example using `gdaladdo`:

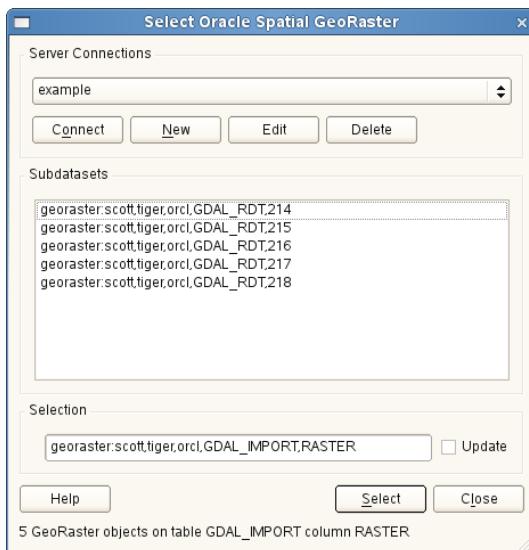


Figure 19.26: Select Oracle GeoRaster dialog

```
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;
```

19.16 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 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:** Create shaded map using light and shadow to provide a more three-dimensional appearance for a shaded relief map.
- **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 3x3 pixel grid.
- **Relief:** Creating a shaded relief map from digital elevation data. Implemented is a method to choose the elevation colors analysing the frequency distribution.

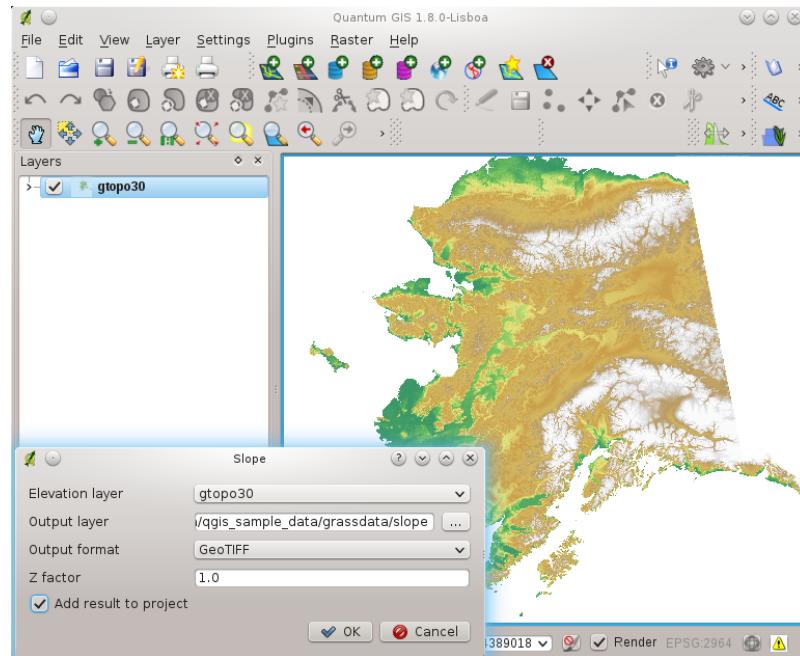


Figure 19.27: Raster Terrain Modelling Plugin (slope calculation)

19.16.1 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 Section [Loading a QGIS Core Plugin](#))
3. Select an analysis method from menu (e.g. *Raster → Terrain Analysis → 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].

19.17 Heatmap Plugin

The  **Heatmap** plugin allows to create a heatmap from a point vector map. A heatmap is a raster map showing the density or magnitude of point related information. From the result “hotspots” can easily be identified.

19.17.1 Activate the Heatmap plugin

First this core plugin needs to be activated using the Plugin Manager (see Section [Loading a QGIS Core Plugin](#)).

After activation the heatmap icon  can be found in the Raster Toolbar.

Select from menu *View → Toolbars → Raster* to activate the Raster Toolbar when it is not yet activated.

19.17.2 Using the Heatmap plugin

The  **Heatmap** toolbutton starts the dialog of the Heatmap plugin (see [figure_heatmap_2](#)).

The dialog has the following options:

- **Input Point Vector** dialog: Provides a selection of loaded point vector maps.

- **Output Raster:** Using the  button you select the folder and the name of the output raster the Heatmap plugin will generate. It is not necessary to give a file extension
- **Output Format:** Selection of the output format. Although all formats supported by GDAL can be chosen, GeoTIFF is most in cases the best format to choose.
- **Radius:** can be used to give the radius in meters or mapunit. When the radius is chosen too small you will not get a nice heatmap. In places where more circles around points overlap each other the brighter hotspots will occur!
- **Decay Ratio:** is used to show with which ratio the heat dies out from the center.
 - When 0 is given (=minimum) the heat will be concentrated in the centre of given radius and be completely extinguished at the edge.
 - When 10 is given (=maximum) the heat is concentrated at the edge and in the centre it is completely extinguished. Higher given values are allowed but have no effect.
 - When 1 is given the heat is spread evenly over the whole circle.
 - When a negative Decay Ratio is given you will create a Coolmap instead of a Heatmap!

When the  *Advanced* checkbox is checked it will give access to additional advanced options.

- **Row** and **Column**, can be used to change the pixel size of the output raster. More rows and columns means a smaller pixel size and the size of the output file will become bigger and processing a bit slower. When doubling the number of rows this will automatically double the size of Columns and the cell sizes will also be halved. The area of the output raster will remain the same!
- **Cell Size X** and **Cell Size Y** influence the pixel size of the output raster and will also change the rows and columns.

The point vector layer may have attribute fields that can be used to create a heatmap:

- **Use Radius from Field:** the radius set from an attribute field.
- **Use Weight from field:** the weight factor set from an attribute field.

When the output raster is given, the **[OK]** button can be used to create a heatmap. The first result is a grey surface that still needs to be given additional treatment to make it a heatmap.

Warning: Changing the raster size properties

When changing the raster size properties, this also changes the resulting output. The hotspot areas will become bigger.

19.17.3 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 on <http://qgis.spatialthoughts.com>.

In Figure_Heatmap_1 the airports of Alaska are shown.

1. Select the  **Heatmap** toolbutton. The heatmap dialog starts (see Figure_Heatmap_2).
2. In field *Input Point Vector*  select `airpoirt` from the list of point layers loaded in current project.
3. In field *Output Raster* give the name and location using the  button of the output raster. Give the output raster file the name `heatmap_airports` to give an file extension is not necessary.
4. In field *Output Format* choose `GeoTIFF`.
5. In the field *Radius* give `1000000` meters.
6. The original *Decay Ratio* of `0.1` is fine.

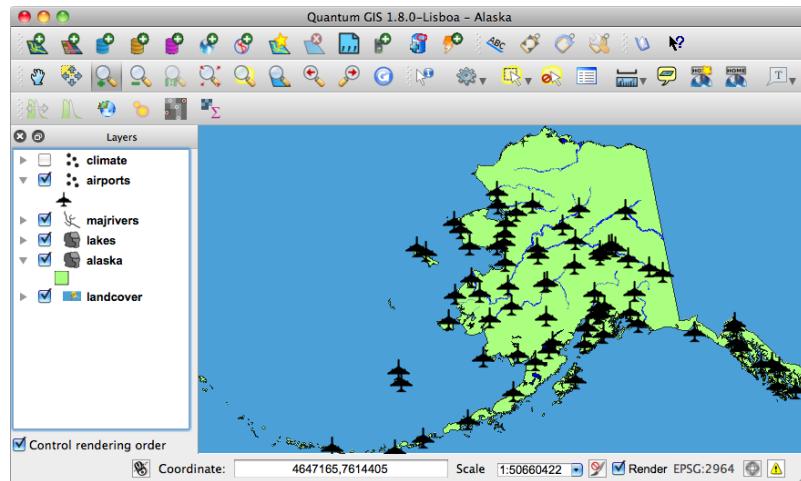


Figure 19.28: Airports of Alaska X

7. Click on [OK] to create and load the new raster map (see Figure_Hotmap_3).

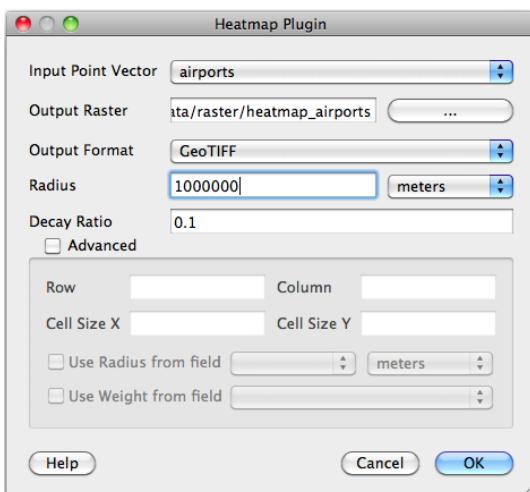


Figure 19.29: The Heatmap Dialog X

The result after loading the heatmap is probably not the result which was expected. It is still a grey even surface not showing any variation. First some additional configuration of this layer needs to be done to make the heatmap present itself.

1. Open the properties dialog of layer `heatmap_airports` (select the layer `heatmap_airports`, open context menu with right mouse button and select *Properties*).
2. Select the *Symbology* tab.
3. Change *Color map* from 'Grayscale' to 'Pseudocolor'.
4. Press the [Apply] button.
5. Switch to the *Transparency* tab and set *Global transparency* to 40%.
6. Select [OK]

The final result is shown in Figure_Hotmap_4.

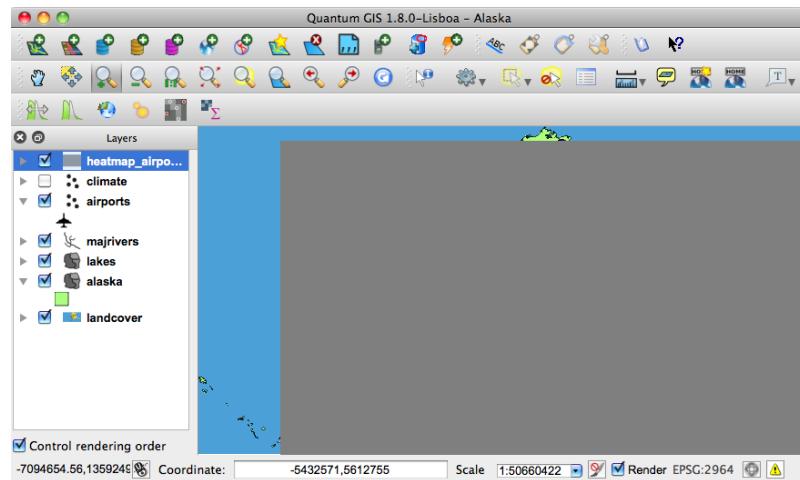


Figure 19.30: The heatmap after loading looks like a grey surface X

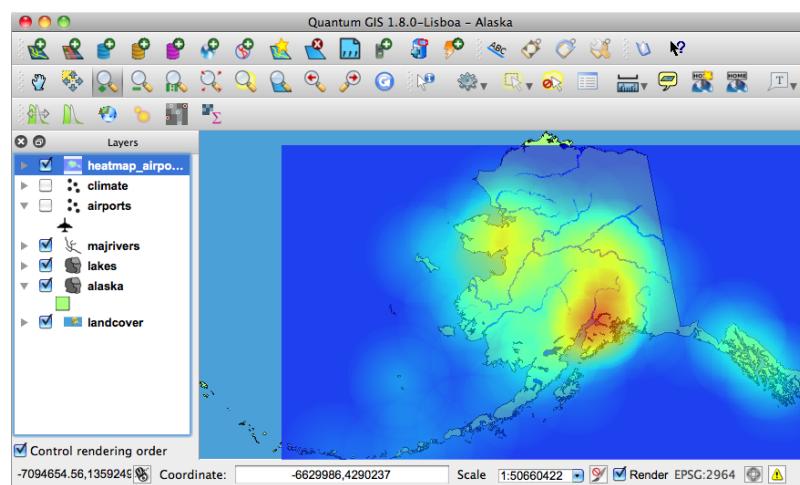


Figure 19.31: Final result of heatmap created of airports of Alaska X

19.18 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.

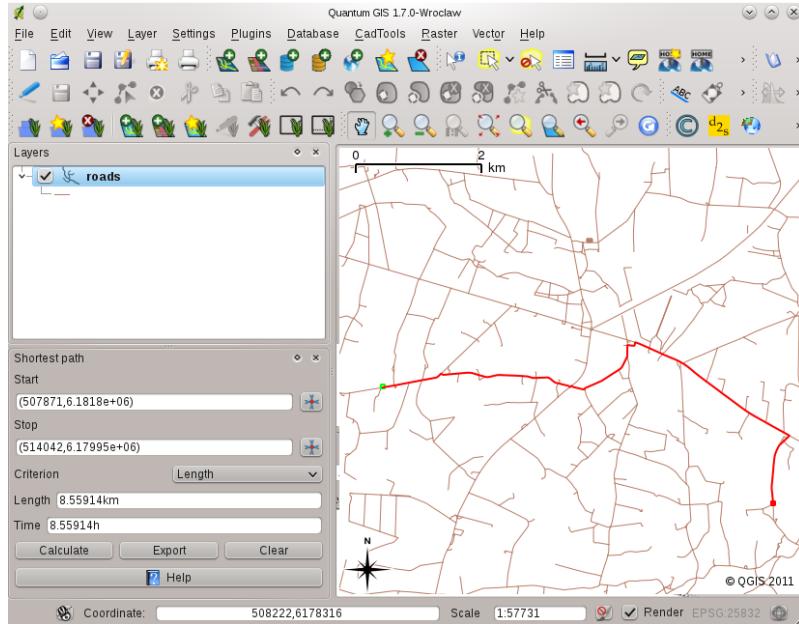


Figure 19.32: Road Graph Plugin 🐧

Main features:

- calculate path, it's length and travel time
- optimize by length or by travel time
- export path to a vector layer
- highlight 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 roads layer. This is due to the fact that recalculation of the coordinates between different CRS introduce 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 casted to string. Forward and reverse directions are correspond to the one-way road, both directions — 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 plugin settings dialog.

19.18.1 Using the plugin

After plugin activation you will see an additional panel on the left side of the main QGIS window. Now make some definitions to the *Road graph plugin settings* dialog in the menu *Vector → Road Graph*.

Select a Start and a Stop point in the road network layer and click on [**Calculate**].

19.19 Spatial Query Plugin

The  Spatial Query plugin allows to make a spatial query (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
- Touches
- Within

19.19.1 Using the plugin

As an example we want to find regions in the Alaska dataset that contain airports. 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 Section [Loading a QGIS Core Plugin](#)) and click on the  Spatial Query icon which appears in the QGIS toolbar menu. The plugin dialog appears.
3. Select layer regions as source layer and airports as reference feature layer.
4. Select ‘Contains’ as 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 the  Create layer with list of items
- Select an ID from the list and click on  Create layer with selected
- Select the ‘Remove from current selection’ in the field *And use the result to* .
- Additionally you can *Zoom to item* or display *Log messages*.

19.20 SPIT Plugin

QGIS comes with a plugin named SPIT (Shapefile to PostGIS Import Tool). SPIT can be used to load multiple shapefiles at one time and includes support for schemas. To use SPIT, open the Plugin Manager from the *Plugins* menu, check the box next to the  *SPIT plugin* and click [**OK**]. The SPIT icon will be added to the plugin toolbar.

 To import a shapefile, click on the  SPIT tool in the toolbar to open the *SPIT - Shapefile to PostGIS Import Tool* dialog. Select the PostGIS database you want to connect to and click on [**Connect**]. If you want, you can define or change some import options. Now you can add one or more files to the queue by clicking on the [**Add**] button. To process the files, click on the [**OK**] button. The progress of the import as well as any errors/warnings will be displayed as each shapefile is processed.

Tip: Importing Shapefiles Containing PostgreSQL Reserved Words

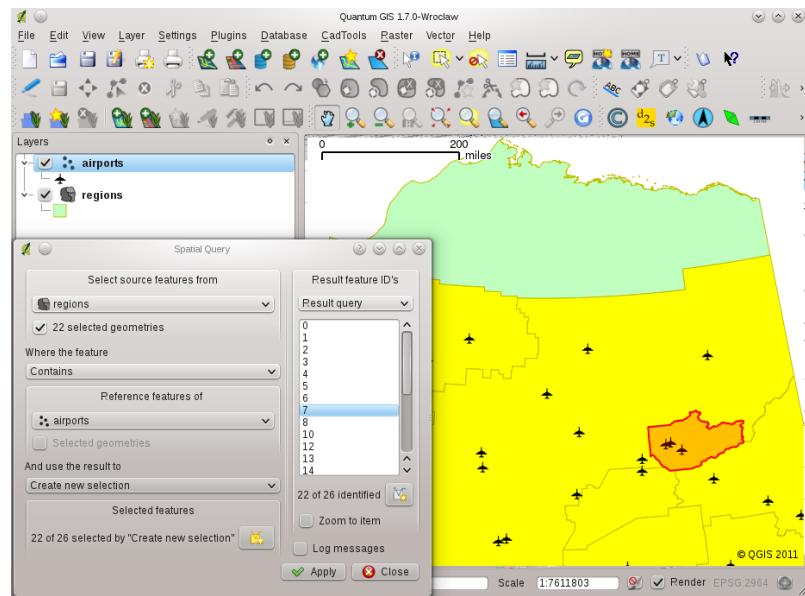


Figure 19.33: Spatial Query analysis - regions contain airports 

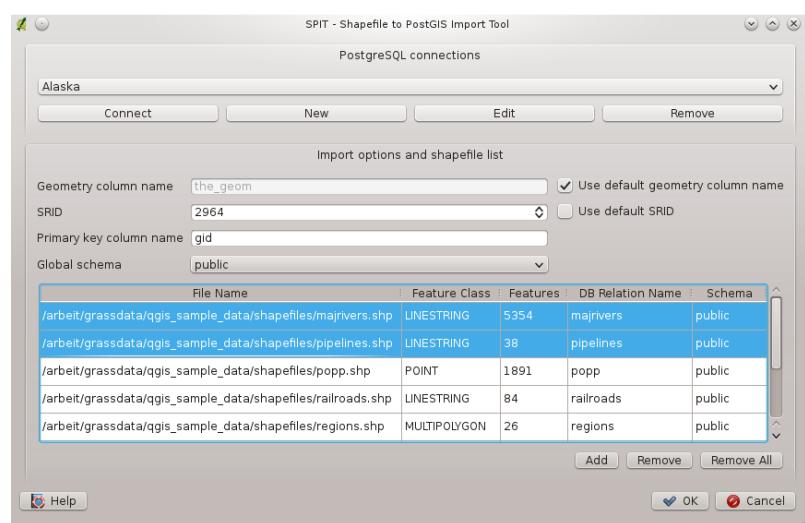


Figure 19.34: Using SPIT Plugin to import Shape files to PostGIS 

If a shapefile is added to the queue containing fields that are reserved words in the PostgreSQL database a dialog will popup showing the status of each field. You can edit the field names prior to import and change any that are reserved words (or change any other field names as desired). Attempting to import a shapefile with reserved words as field names will likely fail.

19.21 SQL Anywhere Plugin

SQL Anywhere is a proprietary relational database management system (RDBMS) from Sybase. SQL Anywhere includes spatial support including OGC, shape files etc. and built in functions to export to KML, GML and SVG formats.

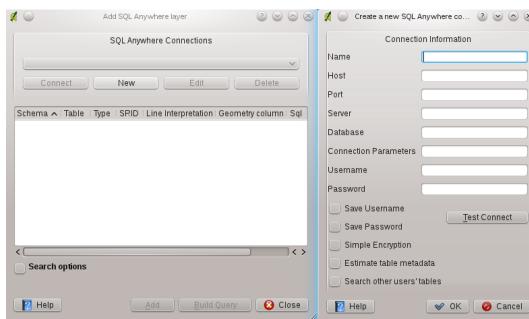


Figure 19.35: SQL Anywhere dialog (KDE) 🐧

The  SQL Anywhere allows to connect to spatially enabled SQL Anywhere databases. The *Add SQL Anywhere layer* dialog is similar in functionality to the dialogs for PostGIS and SpatiaLite.

19.22 Zonal Statistics Plugin

With the  Zonal Statistics Plugin you can analyze the results of a thematic classification. It allows to calculate several values of the pixels of a raster layer with the help of a polygonal vector layer (see [figure_zonal_statistics](#)). You can calculate the sum, the mean value and the total count of the pixels that are within a polygon. The plugin generates output columns in the vector layer with a user-defined prefix.

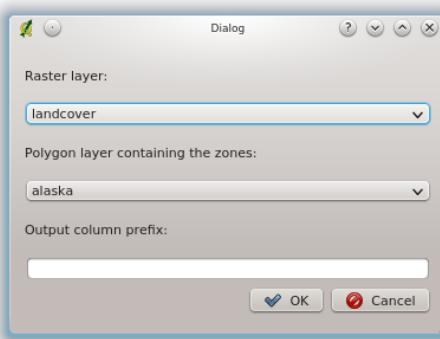


Figure 19.36: Zonal statistics dialog (KDE) 🐧

Help and Support

20.1 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.

20.1.1 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>

20.1.2 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>

20.1.3 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>

20.1.4 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>

20.1.5 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>

20.1.6 qgis-community-team

This list deals with topics like documentation, context help, user-guide, online experience including web sites, blog, mailing lists, forums, and translation efforts. If you 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>

20.1.7 qgis-release-team

This list deals with topics like the release process, packaging binaries for various OS 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>

20.1.8 qgis-tr

This list deals with the translation efforts. If you like to work on the translation of the 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>

20.1.9 qgis-edu

This list deals with QGIS education efforts. If you 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>

20.1.10 qgis-psc

This list is used to discuss Steering Committee issues related to overall management and direction of Quantum GIS. 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 are designed for notification only and not meant for user postings.

20.2 IRC

We also maintain a presence on IRC - visit us by joining the #qgis channel on irc.freenode.net. Please wait around 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. Commercial support for QGIS is also available. Check the website <http://qgis.org/en/commercial-support.html> for more information.

If you missed a discussion on IRC, not a problem! We log all discussion so you can easily catch up. Just go to <http://logs.qgis.org> and read the IRC-logs.

20.3 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 <http://hub.qgis.org/projects/quantum-gis/issues>. When creating a new ticket for a bug, please provide an email address where we can request 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 this patch also. Again, the lovely redmine ticket system at <http://hub.qgis.org/projects/quantum-gis/issues> has this type as well. Check **Patch supplied** checkbox and attach your patch before submitting bug. Someone 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.

20.4 Blog

The QGIS-community also runs a weblog at <http://www.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!

20.5 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'.

20.6 Wiki

Lastly, we maintain a WIKI web site at <http://hub.qgis.org/projects/quantum-gis/wiki> where you can find a variety of useful information relating to QGIS development, release plans, links to download sites, message translation-hints and so on. Check it out, there are some goodies inside!

Appendix

21.1 GNU General Public License

Version 2, June 1991

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Literature and Web References

GDAL-SOFTWARE-SUITE. Geospatial data abstraction library. <http://www.gdal.org>, 2012.

GRASS-PROJECT. Geographic ressource analysis support system. <http://grass.osgeo.org> , 2012.

MITCHELL, T. Web mapping illustrated, 2005.

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> , 2012.

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/> , 2012.

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