

PlanetGIS User Guide

2021.1



Table of Contents

Introduction to GIS.....	5
What is a Geographic Information System?.....	6
Summary of Concepts.....	7
How to use this guide.....	8
Installation and Licensing.....	10
Installing PlanetGIS.....	11
Software licensing.....	12
Software registration.....	13
Software updates.....	14
Getting Started with PlanetGIS.....	16
Introduction.....	17
Opening a GIS Project.....	17
The User Interface.....	18
Views.....	21
Displays.....	22
Styles.....	24
Locating features.....	27
Saved Locations.....	29
Design Mode.....	30
Map Production.....	32
Introduction.....	33
Displaying a Map Grid.....	33
Floating Objects.....	33
Callouts.....	36
Printing & Reporting.....	36
Print Frames.....	37
Creating your own projects.....	41
Starting a New Project.....	42
Multi-map Projects.....	42
Using Design Mode to set up your Views.....	45
Coordinate Systems.....	48
World Geodetic System 1984.....	49
Coordinate systems and projections.....	49
Local coordinate systems.....	50
Changing coordinate systems.....	52
Other projections.....	52
Secondary (projected) coordinate system.....	53
Map coordinate display.....	53
Mixing coordinate systems.....	53
Considerations when importing or exporting features.....	54
Capturing Features.....	55
Creating a New Feature Class.....	56
Capturing Points.....	56
Capturing Lines.....	59
Capturing Polygons.....	61
Capturing Raster Images.....	61

Labelling Features.....	62
Google Earth.....	66
Introduction.....	67
Interacting with Google Earth.....	68
Using Images from Google Earth.....	70
Attributes.....	74
Introduction.....	75
The Info tab.....	75
Popup Info.....	80
Multi-media content.....	80
Detail tables.....	84
Importing and Exporting Information.....	90
Introduction.....	91
ESRI™ shapefiles.....	91
Google Earth™ KML/KMZ.....	93
AutoCAD™ DXF.....	93
GPS Exchange files (GPX).....	94
Geotagged photographs (JPG).....	94
Spreadsheet information (CSV).....	94
Geo-databases.....	95
Thematic Mapping.....	97
Introduction.....	98
Select queries.....	99
Group queries.....	99
Range queries.....	99
Pie and Bar charts.....	99

Chapter 1

INTRODUCTION TO GIS

What is a Geographic Information System?

“A GIS connects *where* with *what*”

A *Geographic Information System* collects, stores and manages the location and geometry of features (the “where”) along with the attributes of those features (the “what”). By utilizing computer technology, this connection between *where* and *what* allows for powerful analysis and decision-making support.

The basic building block of a GIS is a “feature”

A *feature* is a computer model of a real world object (e.g. a river) or a concept (e.g. a boundary). The computer model consists of one or more coordinates (x, y, z or latitude, longitude, altitude).

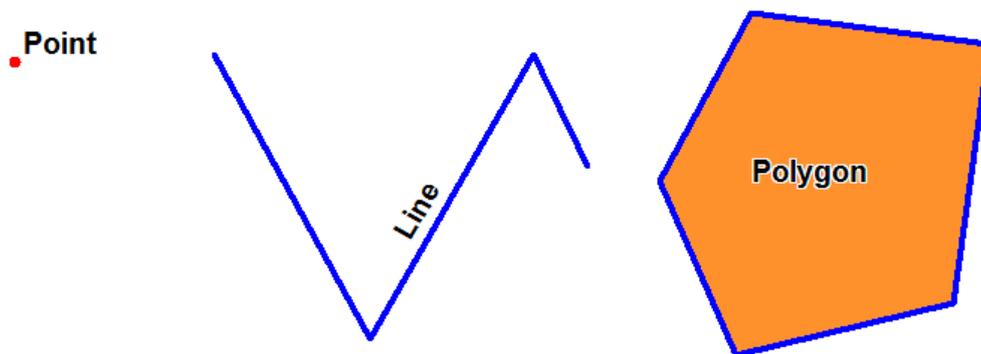


Figure 1: Three types of features

A feature¹ may be a single point in space or an ordered list of points (line²). A line may be closed to form a surface (polygon³). There is also fourth type of feature used to display images (e.g. satellite photographs) called “raster images” in combination with the above “vector” features⁴.

Features can be more complicated in that a single feature can consist of multiple *parts*. Lines may have breaks and polygons may have additional disjoint parts (separated surfaces that are identified as the same object). Polygons may also have any number of holes (called *islands*)⁵.

1 The term *feature* is unfortunately used a lot in software and technology to describe a specific benefit of a product, i.e. central locking in a car is a “feature” of the car. In GIS, *feature* is the term for an identifiable object on a map (more accurately defined above). When describing the software itself, alternative words like “function” must be used in the GIS world.

2 A “line” is technically a connection between two points, but in GIS “line” is short for “polyline” (multiple connected points).

3 A “polygon” in GIS is a closed polyline, but it is usually the surface area enclosed by the polygon which is being modelled. With polygons, a GIS more often answers the question: “is a point inside or outside of the polygon?” than the question “what is the surface area’s boundary?”

4 “Raster” means a rectangular grid of pixels (cells), where each pixel is a colour or other (e.g. elevation) value. “Vector” here means a mathematical model of a shape (feature). Raster images are actually positioned with vector rectangles.

5 And islands can have internal surfaces, which may again have islands...

Attributes

Each feature has a unique number (called a *FeatureId*). Each feature may have a label (text to display on a map) and a measurement. Point features may have an orientation, line features have lengths and polygons have perimeters as well as surface areas. Areas and perimeters/lengths are automatically calculated and updated by PlanetGIS.

Any piece of information connected to a feature is called an *attribute*. Some attributes may be unique identifiers (called *keys*) that can be used to retrieve information from a database or spreadsheet or to be used to locate the feature. A user-defined identifier or code is an example for a key, and PlanetGIS has an attribute defined by default, named “Key1” that can be used for this purpose. (Additional attributes can be defined by the user and used as keys).

Photographs, sketches, documents, multi-media & web links are other forms of attributes.

Feature classes

Features are classified into *feature classes* (e.g. rivers or roads) which may be further classified into subclasses (e.g. paved roads or dirt roads). All features of a feature class have the same attributes and subclasses may add more attributes to those of their parent class. For example, features in a feature class “Rivers” might have an attribute specifying whether it is perennial or not.

Features are also grouped into feature classes to use the same appearance on the map (colour, thickness, etc.) but through the use of *thematic mapping*, classifications may be done based on attributes (e.g. perennial [solid line] or non-perennial [dotted line]).

Map composition

A GIS map is built from a set of layers (called *displays*). Each display references either a feature class or a thematic layer. The user can control drawing order, visibility and the minimum and maximum scale at which each display is visible.

Displays use *styles* to define their visual appearance. Styles are collections of symbols, pens, fills & fonts.

Finally, views are different sets of displays that may be set up for different mapping purposes or themes for the same geographical area (e.g. water services are normally displayed separate from electrical services).

Advantages of using a GIS

Among many other things, a GIS enables you to:

- **Capture** & store spatial entities & their attributes.
- **Visualize** spatial data to reveal relationships, patterns & trends.
- **Share** information in a form that is easily understood.
- **Manage** updates to your database over time.
- **Integrate** with existing systems.

Summary of Concepts

Feature

A computer model of a real world physical object (river) or invisible concept (border).

Feature types

Features can be points (single coordinate), lines (multiple connected coordinates) or polygons (closed lines, possibly with holes/islands).

FeatureId

A unique number that identifies a feature within a database.

Attribute

Information attached to a feature. Can be a number, text, photograph, etc.

Key

An attribute that is indexed (and usually unique) which can be used to identify or locate a feature.

Feature class

Features of similar type belong to the same feature class. Specifically, all features of a feature class have the same attribute fields. (Not the same attributes, which are data items, but attribute fields, which are spaces for entering & storing data items).

Thematic classification

Features can be classified between different thematic layers, based on the values of their attributes. In PlanetGIS these are usually called “thematic queries” due to the similarity to a database query which can be a filter (sub-selection), grouping (classify by value) or ranges (classify by range).

View

A special “theme” or collection of map layers which has been set up for a specific purpose.

Display

Displays are references to feature classes or thematic layers and an associated style. A view is a collection of displays.

Style

A style defines the visual appearance of a display. A style is simply a named collection of drawing elements that can be used and reused for other displays. Drawing elements are pens, fills, fonts and symbols.

How to use this guide

This user guide was designed to be read in sequence, skipping any sections that you deem unnecessary at the time. Recent versions of this document is nearly identical to the PlanetGIS Training Manual. The content was developed during three years of presenting hands-on training courses by the author. Over time the PlanetGIS training course was developed to be suitable to both beginners and expert users. Because of this, parts of this guide will go into more detail than is required for introductory purposes.

This guide therefore aims to be both structured training *and* a reference manual. The beginner user should keep this in mind and skim over parts that are not immediately applicable to the user’s work. Wherever this guide goes into seemingly too much detail, the reader is reminded to take note for future reference. Content and index pages can be used to locate sections for future reference.

Chapter 2

INSTALLATION AND LICENSING

Installing PlanetGIS

Requirements

PlanetGIS requires the Microsoft Windows operating system (NT/2000/XP/2003/Vista/7/8/10), a minimum of 512MB of available RAM and 30MB of hard disc space for installation. For installation to the Program Files folder, you will also need administrator's privileges.

PlanetGIS can be run on Apple and Linux computers with the use of *Wine*, other emulator or a virtual machine¹.

Downloading the installers

The latest versions of PlanetGIS can always be found on the download page:

<https://planetgis.org/download.php>. If you have software licenses, download links will also appear on your profile page (<https://planetgis.org/profile.php>).

For downloads other than PlanetGIS Explorer (see *licensing* below), you need a user account on the PlanetGIS website. Creating an account is free and can be cancelled at any time.

When you download any version other than Explorer, you will be sent a license key via email. This should arrive before your download completes. If not, you will see it on your profile page (link above).

Updating an existing installation

It is not necessary to uninstall an existing installation of PlanetGIS. Simply install the latest version to replace a previous version. Some people like to keep older versions in which case you can simply rename the "Planet?nn.exe" to include a more complete version number. When there is a switch to a new "major" version number, e.g. 5.0 to 5.1, the names of the executables will be different and you will have both versions installed. (See next paragraph). You can simply delete an older .EXE and the shortcuts you may have to it on your desktop, start menu, or task bar.

Multiple versions

Each successive version of PlanetGIS either fixes defects, improve functions or add functionality. (Often all of the above). New functions can often be negatively affected by opening (and saving) a project with an older version. This is because older versions cannot save any options and settings you specify, of something the older version doesn't know about. For example, some new "widget" that can float on top of a map, will be lost when saved with a version of PlanetGIS that doesn't know about the new "widget". In reality, this is rarely a problem if you have multiple versions starting with the same whole number. (E.g. mixing 5.0 and 5.1 will in most cases not be a problem, but avoid opening a project that has been modified in 5.1, with, e.g. 4.3).

Installation procedure

Installation normally takes a handful of seconds and about as many clicks. Installation files will look like one of the following:

- Planet63Install.exe
- Planet63Trial.exe, or
- Planet63_64Install.exe

¹ See the FAQ on the PlanetGIS website for your options: <https://planetgis.org/faq.php?za&faqtype=1#25>

The numbers provide the major version number, and _64 means it is a 64-bit installer file. Unless you are using a 64 bit installer, make sure you choose the 32-bit location for program files. (Normally C:\Program Files (x86) on 64-bit systems).

For PlanetGIS Explorer (installer file starts with PlanetE...) you don't need to enter any further information, your installation should start and complete in a few seconds.

Other versions of PlanetGIS require you to enter a user name (any name of your choosing), an organization name and a license key. The latter two must be entered exactly as supplied (though capitalization and spacing is ignored).

Using PlanetGIS without an installers

If you do not have access to C:\Program Files (e.g. no administrator's privileges), you can install to any other location allowed by your operating system, e.g. D:\PlanetGIS. If you don't want to use an installer (or move/copy an installation from one computer to another), simply copy everything in the C:\Program Files (x86)\Planet GIS² folder to another computer. You can launch PlanetGIS by double-clicking on the .EXE file. Be sure to also copy IJL15.DLL and SQLITE3.DLL. Planet will work for most projects without any of the other files.

This is most useful when sending someone a GIS project on flash drive or external hard drive. Sometimes users do not want to install additional software, or do not have permission to do so. They can simply double-click on the Planet?nn.exe file to run PlanetGIS! You can also create a shortcut on the desktop (and elsewhere) to include the name of a project file (.db), so that the map will be automatically opened. (Be sure to enclose the whole path to the .db file in double-quotes if there are spaces in the path).

Software licensing

Free software

PlanetGIS Explorer is completely free and is suitable for students and casual users that do not require all the functionality available in the standard version.

With "Explorer" you can set up GIS projects, change the appearance of maps and even import information (e.g. from shape files). Starting with version 6, Explorer allows capturing and modification of features as long as the features belong to feature classes inside an "Annotations" main feature class and the user is limited to capturing 1000 features in total inside this group.

Explorer has enough functionality to be used as "trial software" for users that are considering purchasing a software license. Explorer can be used for all the exercises in this guide up to Chapter 10.

Licensed software

If the functionality provided by PlanetGIS Explorer is not sufficient for your work, you need to purchase a software license.

Software licenses can be purchased from our website: <https://planetgis.org/order.php> Please note that any data purchases do not include software licenses. (All data products can be used with Explorer).

A software license gives you access to priority email support and software updates for a year after purchase. This includes "major" updates, not just improvements to your current (main) version.

² Note "(x86)" might not be part of the path if your operating system is 32-bit.

Important: Licensed software does not expire. You will be able to use the software indefinitely. What does expire? *Web updates* (see below).

Educational or non-profit usage

In the majority of cases Explorer is sufficient for educational or private use.

Non-profit organizations may apply for software licenses at reduced or no cost.

Multiple users

The PlanetGIS licensing scheme is per user. (There is no “network license”). The license fee for additional users is steeply discounted. “Additional users” must be co-workers. This usually means that they are in regular contact with each other. Large organizations with groups in different locations must obtain a separate license key for each office.

Multiple installations by one user

Every user can install PlanetGIS on as many computers as required for use by that user. This includes e.g. additional laptops, tablets or home computers. While each installation must be registered (in order to update), there is no limit placed on registrations.

Ad-hoc users

Organizations may also install PlanetGIS for additional users that infrequently need access to the organization’s projects. Explorer is often sufficient for this, but other installations are allowed.

Software registration

PlanetGIS Explorer does not require any license key, registration or even a user account on planetgis.org.

Other versions of PlanetGIS require you to register the software before you can update it to a new version. This requires you to have a user account on planetgis.org. Some organizations use only one user account for everyone’s updates. This is quite acceptable, but it is easier to keep in touch with our users if every person creates their own account. The process of software registration combines user accounts with organizations’ license keys.

If you have not registered each installation, you will be prompted to do so before installing a new version. All you need to register an installation is the email address used to create a user account on planetgis.org and your 5-digit password. (Your password will be in an email sent by the system when you created an account. There is also a “Forgot password” link on the website to have it emailed to you again).

For quick, online registration, you need to have Internet access on the computer with the software, and the PlanetGIS software must be allowed by the firewall to send and receive information to planetgis.org or planetgis.co.za.

To register your PlanetGIS installation, click **Help**→**Register software**.

Software updates

Automatic checks

PlanetGIS will occasionally, on startup, attempt to contact the PlanetGIS website to see if a newer version is available. If your system’s firewall allows such check, PlanetGIS will notify you if any updates are available. You can also see the updates in a list, in order to decide if updating is necessary. You can manually check for updates by clicking **Help**→**Check for updates**.

Web updates

Web updates provide the latest versions of PlanetGIS to users with active update subscriptions. Updates are downloaded from the PlanetGIS website and then installed on client computers. Web updates are active:

- For one year after purchasing a software license
- For 6 months after obtaining a trial license
- For subsequent years upon purchasing web updates
- For one year after purchasing an *upgrade* (see below)

Additional years of web updates cost 25% of the cost of a new license. When web updates are renewed, the previous period's updates are extended by one year. When purchasing web updates after the expiration period, therefore, will extend the update period for one year since the last expiry date, not the date of purchase.

Ad-hoc upgrades

Web updates are optional. An alternative is to purchase an *upgrade* when the user is ready to move to a newer version of PlanetGIS. An upgrade of a license is always 33.3% less than the full price at the time of purchase.

Important: An *upgrade* does include one year of *web updates*.

Chapter 3

GETTING STARTED WITH PLANETGIS

Introduction

In this section you will be introduced to all the essential elements for using and customizing an existing PlanetGIS project and to produce output from it.

Opening a GIS Project

PlanetGIS project files have **.db** extensions. In this guide, the word “map” will sometimes be used as a short form for “PlanetGIS project”.

When launching PlanetGIS, you will be presented with a “Quick start” window which lists all your recently opened projects. Alternatively use the **File** menu which also maintains a list of recent projects. The following examples use the World map which is available here: <http://www.planetgis.co.za/browsemap.php?id=12>

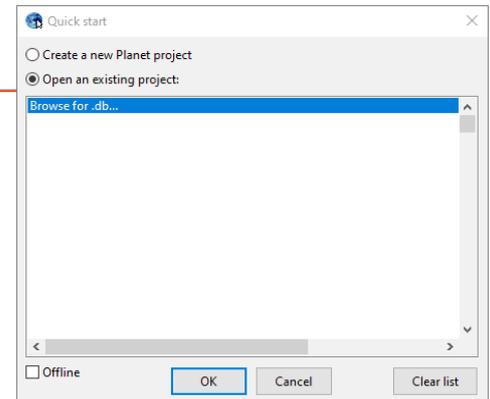


Figure 2: Quick start screen when opening PlanetGIS

Files used by a PlanetGIS project

PlanetGIS project (**.db**) files are databases that store the structure of the project, e.g. views, displays and styles, as well as spatial and attribute information.

Other files that will be created automatically if they are not present are:

- **.index** – Spatial index used for drawing the map. If not present it will be recreated from the geometry of features stored in the **.db** file.
- **.local** – Contains information relevant to a particular user that would typically not be shared with other users. Examples are the content of SQL tabs, filters on tables and the last location in a map when the project was closed.
- **.blobs** – Stores attachments (photographs, documents, etc). This file is separate from the main database for easier regular backups of the main database.
- **.shadow** – Stores all changes to the database, including by other users in a shared project.

Locations for PlanetGIS projects

PlanetGIS project files need to be together in a folder (directory) on your local hard drive, a network drive or external storage. PlanetGIS must be able to create files in this folder. It is therefore not a good idea to create folders for your projects anywhere under `C:\Program Files` or `(C:\Program Files (x86))` because Windows typically restricts software from creating their own files in this location. An easy location like `C:\PlanetMaps` works well.

Saving changes

Starting with version 6, PlanetGIS does not require changes to be saved and instead saves any changes immediately to the database. It is important to make regular backups in case you need to revert to a previous version.

The User Interface

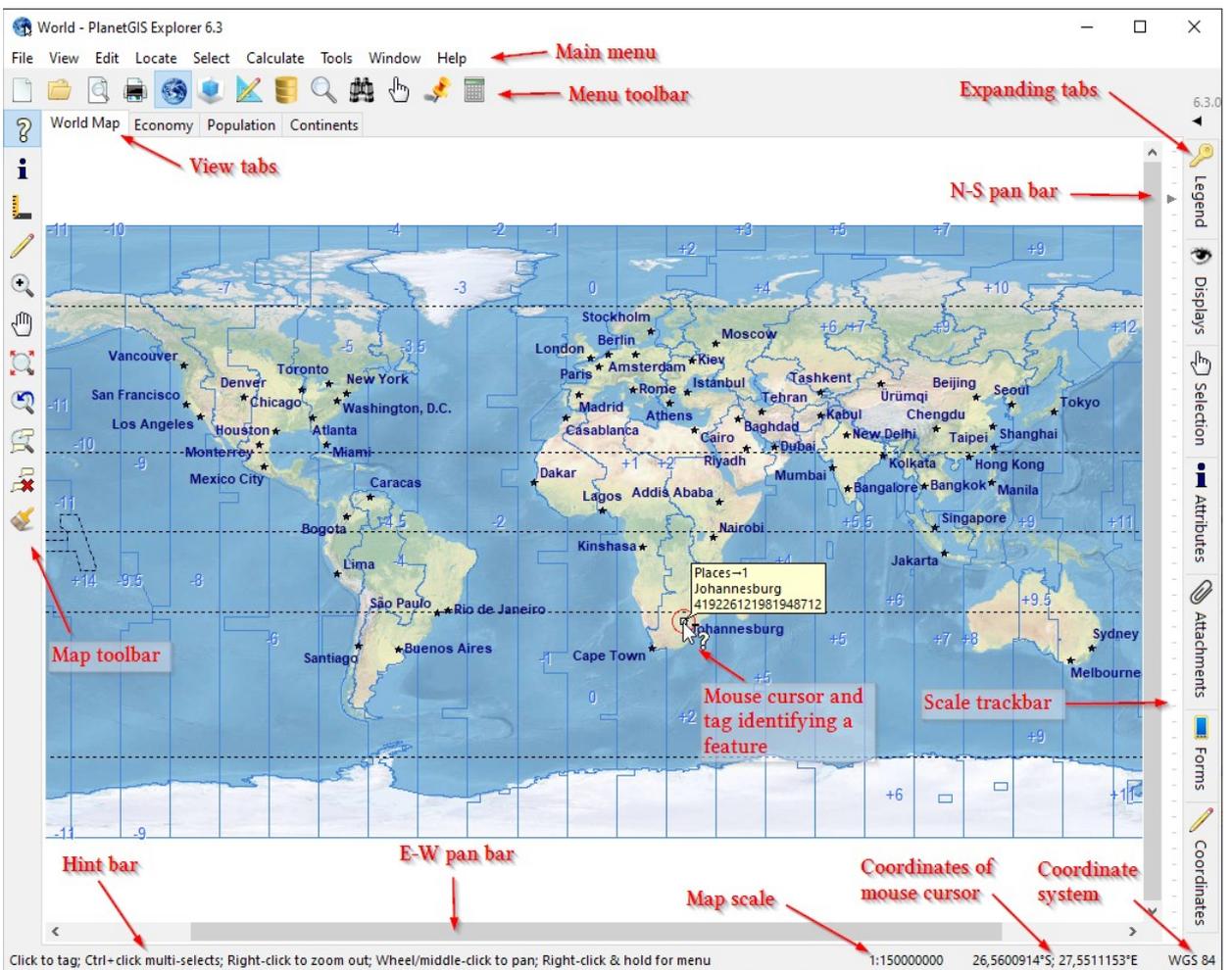


Figure 3: The PlanetGIS user interface

If you pause the mouse over most elements shown above, a small “tool tip” will appear that explains the element's function. A longer explanation will appear in the **hint bar** at the bottom. The first six buttons of the **map toolbar** are mutually exclusive “click modes”. Each changes the way that the mouse will interact with the map. When the mouse is over the map, notice how the **hint bar** tells you how you can use the mouse to interact with the map. A mouse with a wheel is recommended. Rolling the wheel will change the position on the scale bar, zooming in or out with the location at the mouse cursor remaining stationary. In **zoom mode** (🔍), clicking on the map will move the map so that it is centred around that location (and zoomed in). Right-click zooms out.

In all modes, right-click and hold the mouse button down for ½ second to see a menu with many useful items.

Map toolbar

? **Tag:** In this mode a map feature is selected while the existing selection is cleared. <Ctrl> changes the click mode into “**Tag multiple**” and <Alt> changes it to “**Untag**”. Alternate selection modes will appear to the right of this button when the mouse cursor is over the button.

i **Info:** This mode is the same as **Tag** mode except that the attribute information window pops up on top of the map every time you select a feature. Use **Tag** with the **Attributes tab** instead unless you have a large or multiple monitors.

 **Measure:** In this mode you can measure distance, direction and area. Click once on the map to indicate the starting position of a measurement and move the mouse in the direction of measurement. The distance from the start location, direction and bearing is displayed in the scale box. The total distance will be updated continually as you move the mouse. Click one or more times to fix a coordinate and create further line segments. If you keep the mouse button depressed, a path will be captured with many points as you move the mouse. To measure area, return to the starting point. Clicking at the starting point clears the measurement polygon. The <Esc> key cancels the current measurement.

 **Capture:** In this mode you can place your own points, lines or polygons on the map. Alternate capture or modify “click modes” will be shown to the right of this button when the mouse cursor is over the button.

 **Zoom:** In this mode you can click on the map to centre that position and reduce the scale by $\frac{1}{4}$, or alternatively click and draw a zoom rectangle by moving the mouse while keeping the the left mouse button down. Right-clicking – as with most other modes – will zoom out by doubling the scale.

 **Pan:** In this mode you can change the viewing location of the map without changing the scale. Click on the map and drag (move mouse while left button is held down) to “pan”.

The next 5 buttons do not change the click-mode selected above. They all perform a single action which usually do not need to be repeated.

 **Zoom all:** Display the map to its full extent or if the maximum extent is limited, zoom-all will go to that limit.

 **Zoom previous:** Revert to a prior location and scale. This is similar to “undo” for zooming and panning operations. All locations since opening the map is remembered.

 **Zoom tags:** Fit selected features onto the screen, zoomed in as close as possible.

 **Clear tags:** Clears all tags and empties the selection.

 **Redraw:** Re-renders the map on screen.

Menu toolbar

The buttons at the top are shortcuts for items in the main menu.

File & print

Buttons correspond to items in the **File** menu:

 **New:** Create a new PlanetGIS project.

 **Open:** Open a PlanetGIS project.

 **Print preview:** Changes the view mode to visualize the map as when printed on paper as per the currently selected printer and page size and orientation. (**File**→**Print setup** to change). Click again to change to normal map view.

 **Print:** Prints current view at current scale.

Application interface mode



Map: The map is visible (default mode).



3D: 3D viewer.



Design: Design mode exposes the entire structure of all open projects. Often operations are more efficient in this mode.



Database manager: Direct access to the internal as well as linked databases.

Map tools

Common mapping actions, e.g. locating features which will be demonstrated later in this guide.

Expanding tabs

The tabs on the right of the user interface expands once you click on them and can be collapsed by the small arrow at the top. Each tab serves a different purpose as explained below. The content of the tabs are determined by the currently active view and the current selection of features on the map.

If enough vertical space is available the names of each tab will be visible, alternatively only the icons are displayed and you have to move your mouse over each to see the tab's name.

The expanded area of the tabs can be resized by dragging a “splitter” between the tabs' content area and the map scale trackbar.



Legend: Legend display for the current view at current scale. Exactly the same content as the legend that could be displayed as a floating object on the map or inside a print frame.



Displays: The Display Manager controls what displays are added into a view, which displays are visible, the order of displays and more.



Selection: Shows exactly what has been selected on the map, and counts by feature class. Can be used to refine the selection.



Attributes: Displays all attribute information of selected features. Can also be used to change the selection on the map.



Attachments: Displays all attachments (photographs, documents, etc.) linked to selected features. Documents can be viewed, added and deleted.



Forms: A custom input area that can be defined for each feature class. The input fields correspond to the display on hand-held data collection devices.



Coordinates: Tools for making changes to the geometry of a selected feature.

Pan & scale trackbars

Use the East-West and North-South pan bar directly next to the map area below and to the right to “pan” the visible area of the map as desired.

The scale trackbar has levels of rounded and commonly used scales. The scale trackbar corresponds to each position of the mouse wheel when rolled forward or backward slowly. (The mouse wheel will skip scale levels when rolled continuously for speeding up zooming).



The status bar

The status bar at the bottom of the screen has four areas:

- Hint bar: Displays hints and descriptions based on the location of your mouse cursor. On the map the hint will describe commonly used actions that you can perform with your mouse, based on the current mode of operation. Outside of the map, the hint will describe the user interface element (button, tab or menu item).
- Scale: Current scale of the map. Click to change to a specified scale.
- Coordinate: The map coordinate of the mouse cursor. Click to change the format.
- Coordinate system: The name of the coordinate system of the active map. An asterisk at the end indicates a secondary coordinate system (not the actual coordinate system of the map).

Views

A PlanetGIS project has at least one view and by default this view will have the same name as the project. You can create any number of additional views of a map. Views are shown as tabs at the top of the map. When selecting a different view, the same geographic location is displayed but with a different set of displays (and usually a different appearance). There are two main reasons for creating multiple views:

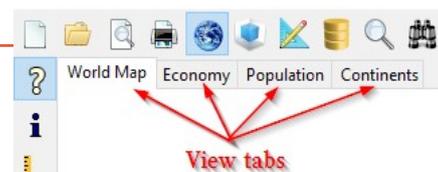


Figure 4: View tabs

1. To display different themes (e.g. displaying population instead of land cover or separating e.g. water utilities from electricity).
2. To set up views for specific purposes. You may want separate views used for printing and it is a good idea to have special views for capturing features.

To manipulate views, right-click on a view tab (Figure 5 shows how to add a view).

Views can also be created in a hierarchical structure where you have views within views. An ellipsis (...) will indicate that a view has sub-views. This is useful to reduce the number of top-level tabs, create a logical structure and reuse a group of displays. For example, you can have your background displays (e.g. country borders) in a parent view and different themes overlaid in sub- or “child” views¹. By default child views will first draw the displays of parent views. This can be switched off in the view's properties.

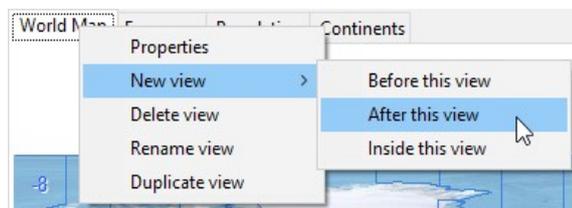


Figure 5: Adding a view

The “Select view” button in the menu bar (🔍) also lists the views and is mostly helpful only if there is a hierarchy of views.

Displays

Displays are similar to layers in Computer Aided Design (CAD) software. In PlanetGIS, a display is a reference to a feature class or a thematic layer (classification). A view is a collection of displays. A display acts as a link between a view and a feature class or a thematic layer².

- 1 The terms “parent” and “child” are from mathematical and computing “graph theory”, which is a system of organizing information into a “tree”. The tree starts with a “root” node which has sub-nodes (also called “child nodes”). The “parent node” is one level up in the hierarchy. You will find this concept almost everywhere in Planet, so you will soon be very familiar with parent-somethings and child-somethings.
- 2 We will use the word “layer” to refer to thematic classifications and sometimes feature classes. PlanetGIS doesn't have the concept of layers as does CAD software, but a display works similarly to a layer and for thematic queries, results are separated (classified) into layers.

The visual appearance of features is determined by the style that is selected. While feature classes and thematic layers have their own default styles, the display ultimately defines which style is to be used for a layer in a particular view. A display therefore also acts as a link between a layer and a style.

Displays have many properties that control when and how to display a layer and how features are labelled.

The visibility of layers is indicated by the eye icons and controlled by

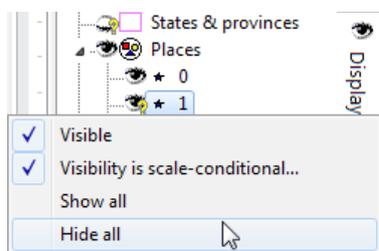


Figure 7: Switching off all displays in a group

clicking on the eye icons. The yellow question mark indicates that a display's visibility is dependent on scale. As you zoom in on the world map, you will see more "eyes opening" in the "Places" group.

Figure 7 shows a popup menu when right-clicking on an "eye". Here you can use "Show all" or "Hide all" for controlling the

visibility of all displays in a group.

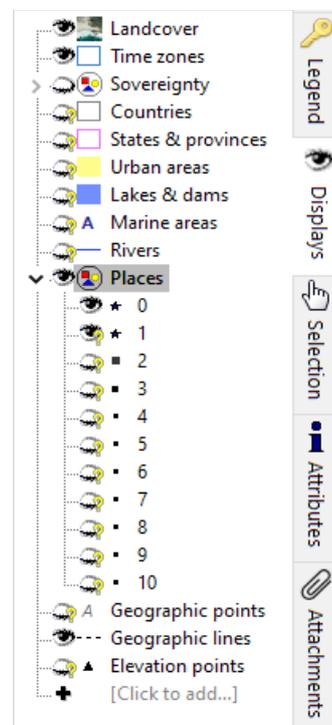
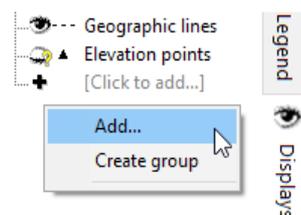


Figure 6: The Display Manager

Adding displays into a view

You can click anywhere on the white space in the Display Manager or right-click on a display to add displays. Figure 8 shows the selection of two feature classes to add to the display list. Multiple selection is done by holding in [Shift] or [Ctrl].



Ordering displays

Displays are listed in the order in which they are drawn. The topmost display is drawn first and so on. If you think of displays as layers, the topmost display is the bottommost layer. However, by default, Planet uses "smart draw ordering". Planet will first draw all raster images, then fills (of polygons) then lines/outlines, then symbols and lastly text (labels). Within each of these steps, displays are drawn in top-to-bottom order. As an example, if you drag the "Landcover" display to the bottom of the list, the map will look the same: the land cover raster image does not obscure anything. If you switch off smart draw ordering, the landcover will obscure everything else. It is therefore good practice to place raster displays at the top of the display list. ("Smart draw ordering" can be switched on and off in the view's properties [right-click on the view tab]).

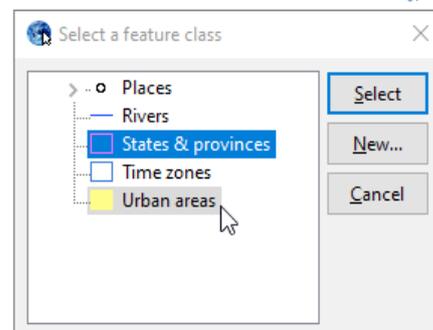


Figure 8: Adding a feature class as a display

With smart draw ordering switched on (the default), only the order of displays with similar style elements are important. For example, in the World map the "Sovereignty" display (switch it on if you want to test) must be before (above) the "Urban areas" and "Lakes & dams" displays, otherwise the latter will be obscured by it. Similarly, if you want one display's pen to be drawn on top of another's that display must be lower in the list.

To change the order of displays, simply by drag them to a new position. Care needs to be taken with grouped displays and this applies to many other places in Planet where items can be dragged to new positions: if you drag-and-drop a display onto another display that is a group of displays, the

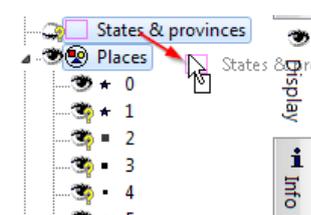


Figure 9: Avoiding dragging a display into a group

dropped display will go inside the group. Figure 9 shows dragging of a display to the right of a group display. This will place the “States & provinces” display after “Places” instead of inside.

Display properties³

Figure 10 shows the General tab of the display properties. On this tab you can change the display's name (if required to be different [perhaps more descriptive] than the name of the feature class), select a different feature class and select a different style.

There are many settings & options (properties) for displays. In this section we will only look at the visibility tab. Here you can make a display to be “scale conditional”. This is immensely useful to speed up map rendering and de-cluttering maps containing lots of features. Also, Figure 10 shows a second item in the menu (“Style properties...”) which is a shortcut to take you directly to the assigned style.

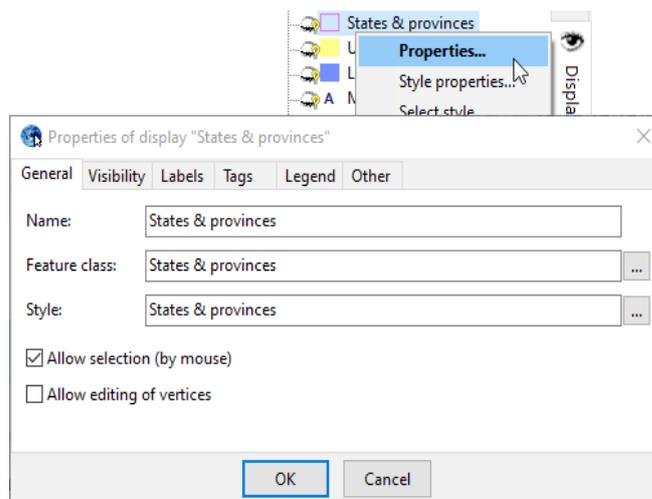


Figure 10: Display Properties window / dialog box

Styles

A style is simply a named collection of style elements. There are four types of style elements:

- Pens
- Fills
- Symbols
- Fonts

A style can have any number of these elements. In Figure 11 there are two pens: one is used for small scales (global, continental) and the thicker, coloured pen is used for larger scales (when only one or a few countries fit onto the map)⁴. You can also specify a style element specifically and exclusively for printing, on-screen or quick display. The effect of individual style elements is determined by a complex set of conditions.

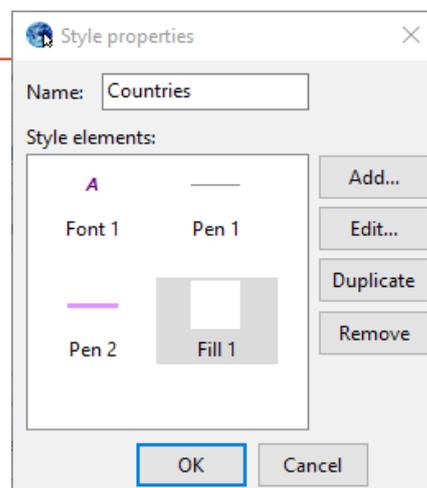


Figure 11: The Style Properties window

All feature types (points, lines, polygons) can display a label (using a font) and a symbol. A symbol will be used to display a line or polygon that hasn't any visible pens or fills. This is sometimes useful when you need to show lines and polygons at a small scale where they would be invisible otherwise.

In some cases it is useful to only see the label of a line or polygon feature (e.g. the name of a mountain range). To accomplish this, pens and fills need to be invisible at the current scale and the display properties need to have “label invisible features” set.

Only polygons will use fills and only polygons and lines will use pens.

3 Nearly everything in Planet has “properties”. Properties are settings or user options that are stored for each item. In this guide we will often use a phrase like “in the something properties” which will mean: “in the window (dialog box) that displays all the options and settings for this something”. You can almost always right-click on an item to see a popup-menu which nearly always will have “Properties...” as the first item.

4 The terminology “small scale” and “large scale” can be confusing because a small scale has a large number in the second part of the one-to-number ratio (1:n). A small scale (e.g. looking at a whole continent) could be 1:10 000 000 while a large scale (e.g. looking at a suburb) could be 1:10 000. Mathematically, it makes sense when you realise that scale is a fraction of 1, i.e. the fraction 1/n.

Common aspects of style elements

The Colour Picker

Planet has an extremely capable colour selector (/picker). The “colour wheel” provides the full range of colours at a particular “lightness” (/shade). Click anywhere on the wheel to select a colour. Slide/click on the “lightness” bar to select a shade (amount of black mixed in for the colour wheel). The centre of the colour wheel is achromatic (a shade of grey).

Alternatively, click on a coloured or grey-scale cell in the “quick pick” area. You can also build your own palette of often-used colours by clicking on “Custom palette”.

For precise colour selection, you can enter either Red-Green-Blue values between 0 and 255 or Hue-Saturation-Value values. Sliding any of the 6 black triangles to the left or right is an efficient method to adjust a colour to your liking. R-G-B corresponds to how colour is mixed on a computer screen and H-S-V corresponds to how colour is mixed by a printer.

Hue is a value between 0 and 359 which corresponds to the degrees of arc around the circle that is the outer edge of the colour wheel. Red is at 0 degrees, green at 120°, etc.

Saturation is a measure of how much white is mixed in (tint). A fully saturated (pure) colour is on the outer edge of the colour wheel, while the centre of the wheel has no colour. Changing saturation changes the distance of the selected colour between the centre and the outside of the colour wheel. For printing, you would typically reduce Saturation if a colour is too bright (and to save ink).

Value is a measure of how much black is mixed in (shade). Changing Value (or lightness / shade), changes the entire colour wheel, similar to how all available colours will appear darker in low light conditions. Text and lines that need more contrast to stand out will typically need a reduction in Value, while solid fills will typically need a reduction in Saturation.

The “Dropper” sampler

The “dropper” is a very convenient tool to select a colour from something else already displayed on your screen. It is a good alternative to building your own custom colours (palette) if you want to restrict the colours that you are using to a finite set.

Click on the dropper button and then anywhere on the map or any area that is part of Planet to select the same colour. To pick a colour from another application you need to have both Planet and the other application visible on the same screen (or on multiple screens). Planet needs to keep the focus to sample the colour, so the procedure is slightly different: click on the dropper button and keep the left mouse button down; move the mouse to the colour you want sampled; only release the left mouse button once you have the desired colour under your mouse cursor.

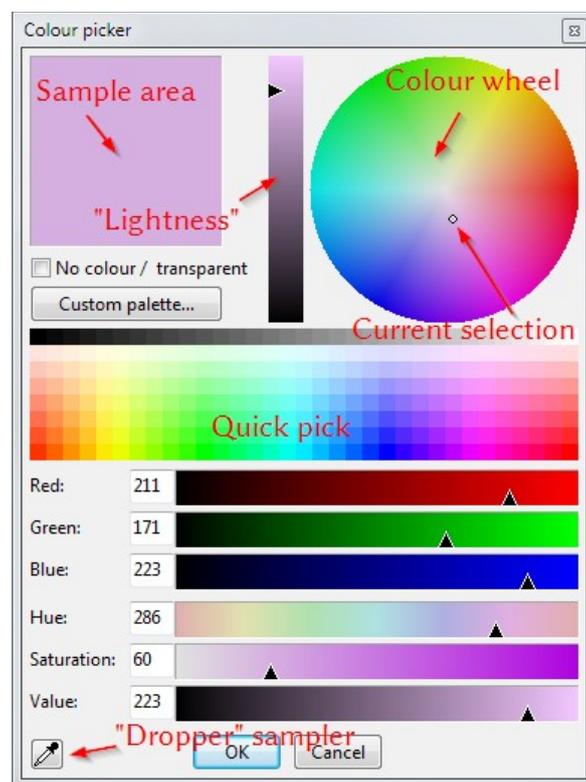


Figure 12: Advanced colour picker

Visibility

Every style element has the option for displaying either for on-screen, printing or quick display. In addition every element can be selected to display for a range of scales. For styles that have child styles (for use with groups of feature classes or thematic queries with sub-groups of either groups or ranges) a parent style can be made to be applicable or not.

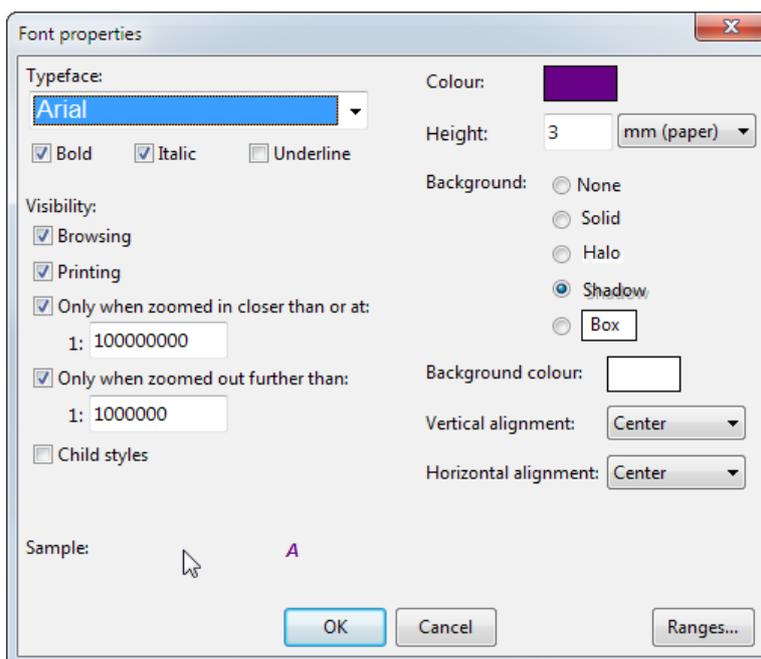
Units of measurement⁵

The width and height of pens, fonts, symbols, etc. can be specified in either “paper units” or “real units”. Paper units are fixed, while real units are real-world dimensions. For example, if you set the font for street names to “8m (real)” the street names will always have the height equal to roughly the width of a residential street. This can be useful at large scales, but the street names will soon become invisible as you zoom out to smaller scales.

Never use px (pixels) if you intend to print your map. On a typical screen, one pixel is about 0.25mm but on a typical 600dpi printer only about 0.04mm.

Font properties

Fonts are a combination of a typeface, a style, size, colour and effect. The Typeface is the name of the font given by the designer (e.g. “Times New Roman”, “Arial”, “Georgia”, “Helvetica”, etc). The style can be a combination of italic, bold and underlined.



Fonts can also have a background effect to make them more visible. You can specify a solid colour for a background, a “halo” of lighter colour can make text more visible as well as a shadow. There is also an option to draw a box with an outline and fill around the text.

Figure 13: The font properties window

Symbol properties

Symbols can be either vector shapes or bitmap images. Shapes have the advantage of producing symbols at the maximum quality allowed by the output device/printer. Bitmap images have the advantage of having unlimited colours. Planet includes about 300 shapes. Click on the shape button to select a shape. Expand the “Stock” tree node to see groups of shapes.

It is also possible to create your own shapes by capturing features and importing them as shapes.

⁵ If you are seeing inches selected by default and you are not in the U.S.A. it means that your computer's locale is set to U.S. or measurement units is set to “U.S.”. Change this in Control Panel, “Clock, Language, and Region” and set your location, or alternatively click on “Additional settings” in the Region and Language window and change the measurement system to “Metric”.

Pen properties

Pens can be either “hairline”, “solid”, “pattern” or “shapes”. Hairline implies a width of one pixel. Do not choose hairline if you will be printing your map. Hairline pens do have the advantage of being very fast. Since pens are typically used on a large amount of coordinates, thick pens can slow down the drawing of your map considerably. A possible solution to this is to have separate pens for “browsing” than for “printing” (set this in the “Visibility” section).

Pattern and shape pens can become quite complex as seen in Figure 14.

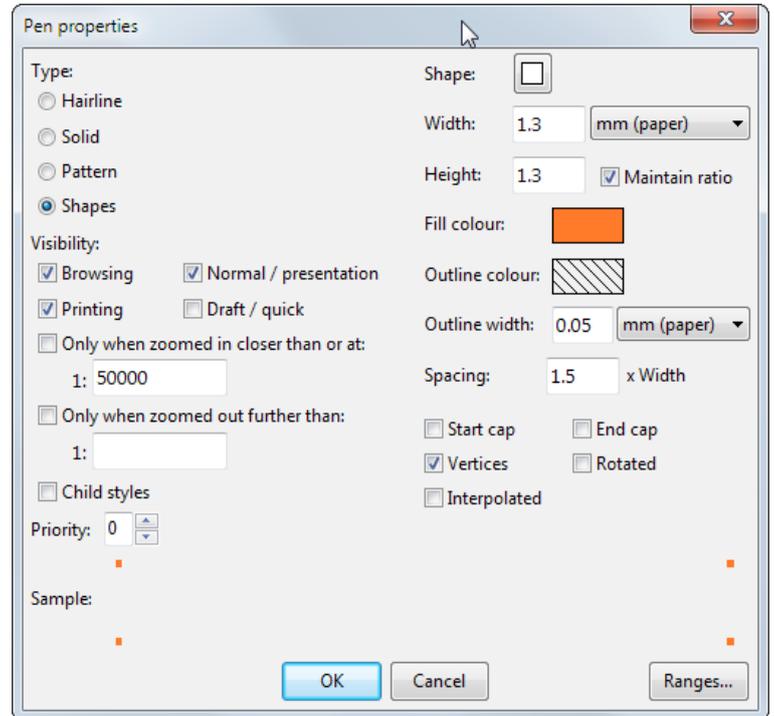


Figure 14: A complex pen using shapes on vertices

Fill properties

Fills can be either “solid”, “transparent”, “hatch” or “shape”. For transparent fills, you supply a value between 0 and 100% for “opacity”. 0 is completely transparent (invisible) and 100 is completely opaque (non-transparent). Good values for opacity are 25 and 50⁶. Please note that transparent fills do not work in PDF documents. They do work very well in XPS documents.

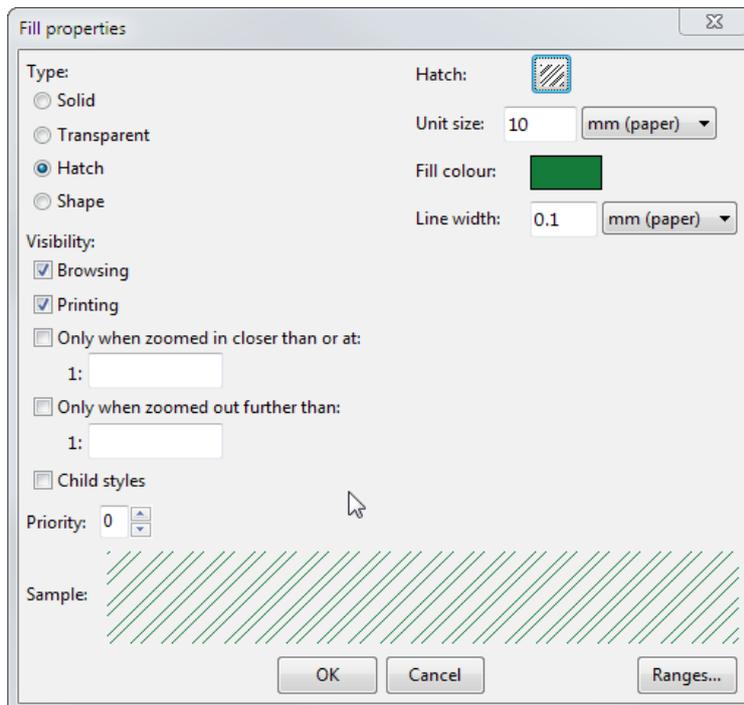


Figure 15: An example of a hatch fill

6 Planet uses a “dither pattern” to simulate transparency similar to how printers do it. True transparency requires pixels to be blended with the background which means the entire image must be created as a bitmap prior to printing which is not practical. This means that transparent fills do not look as good on screen as they do when printed.

There are a large number of hatch patterns to choose from. For a “hatch fill”, click on the hatch button to select a pattern. A shape fill uses shapes, normally used for point symbols, spaced out horizontally and vertically per user specification.

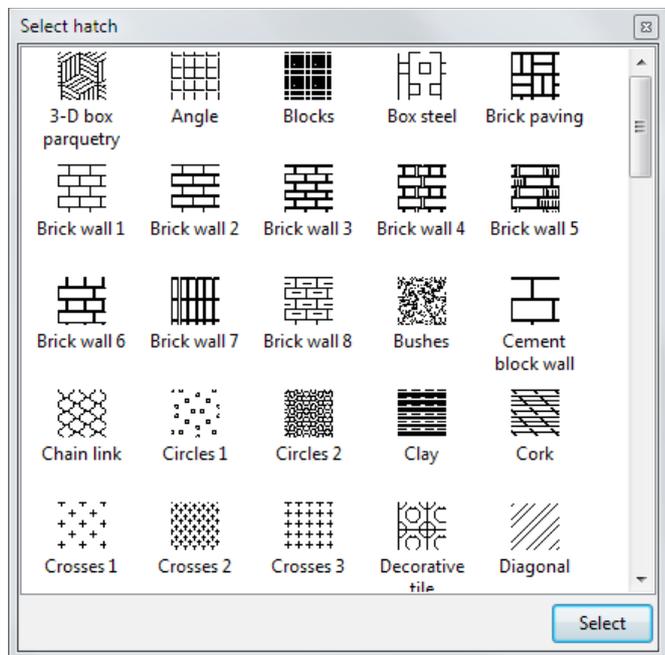


Figure 16: A few of many available hatches

Locating features

Click on the **Find** button (🔍) to locate a feature.

With the “Features” node selected, the first 1000 features of the map is displayed. Simply click on a row to select the feature in the background. Use [Ctrl] or [Shift] to select more than one feature.

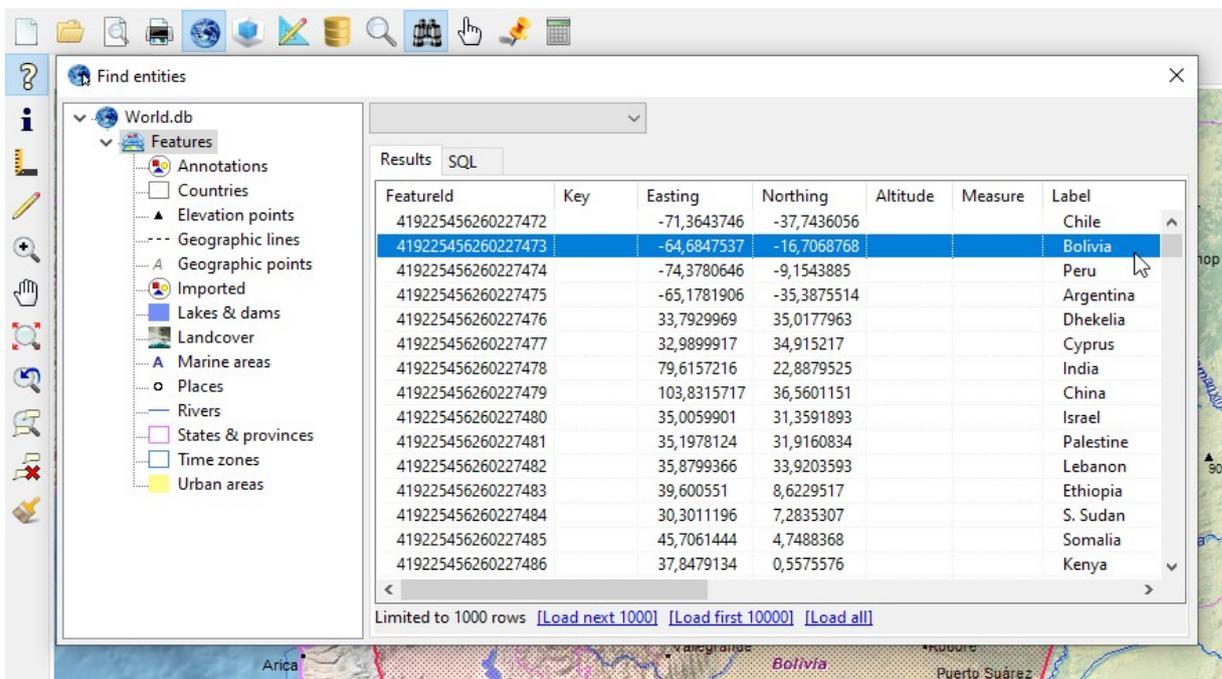


Figure 17: Locating a feature

To narrow down a search, first select a feature class on the right. As an exercise, select “Countries” and then locate “continent” in the long list of attributes (about 2/3rd down the list).

Select “Africa” to narrow down the list.

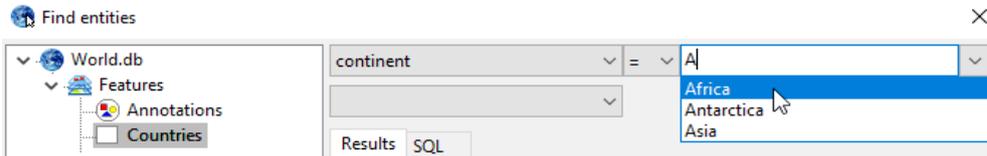


Figure 18: Type one or more letters to get a list of values found in the database

You can add additional criteria: In the second dropdown list, locate the field “gdp_md_est” (Gross Domestic Product in millions of dollars, estimated) and select greater than (>) instead of equals (=). Now type in a value of 100 000 to see a list of the top 12 economies in Africa (see Figure 19).

The SQL tab of the results shows the actual SQL query used to fetch the results from the database.

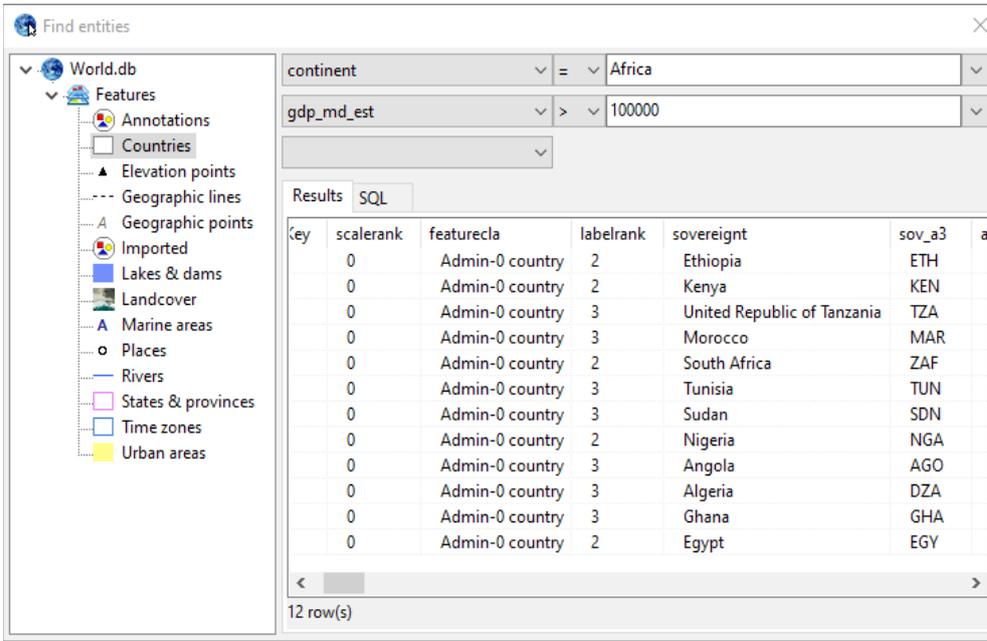


Figure 19: Top 12 African economies found by additional criterion

Saved Locations

Saved locations are like “bookmarks” for a map. You can use Saved locations to return to a specific place on your map and either at a specific scale or a rectangular area.

If you are at a location which you would like to return to, save it by clicking on the **Goto** button () in the menu toolbar. Notice that the Goto button has two regions: the down arrow on the right will display a list of previously saved locations, if there are any (if not it will do the same as a click on the left side). The left region of the button is therefore actually “save this location”, not “goto”.

Give the location a name that makes sense to you. Saved locations have the following properties:

Activate view

If checked, the saved location is also tied to a view. The selected view (or current view) will be activated each time that you “goto” the saved location.

Limit to this view

If checked the saved location is tied to the selected view in a different manner: It will only appear in the list if the selected view is active. This option allows you to have saved locations that are specific to views. If unchecked, the saved location is always visible.

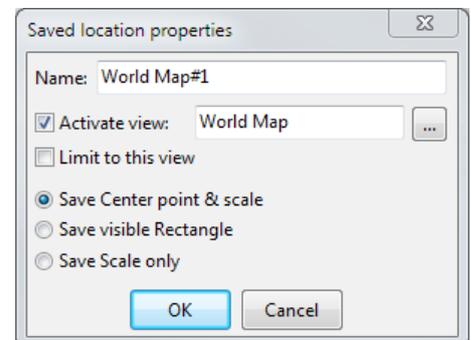


Figure 20: Saving a location

Options for how the location is stored

- “Save centre point & scale” - if the scale is more important than the extent.
- “Save visible rectangle” - regardless of screen or paper size the rectangular extent visible when saved will be fit such that (if the width/height ratio changes) either the width or the height will be exceeded but not both.
- “Save scale only” - a different kind of location which is not a location, but only a scale. This option is for when you are working at specific scales and need a quick way to zoom to these scales while keeping the part of the map in the middle of your screen in the same place.

Limiting your project area

Each view can be limited to the extent defined by a saved location. Right-click on a view tab and click **Properties**, then activate the “Activate/Limit” tab.

Check “Limit visible area” and select a saved location as shown in Figure 21. In most cases where you have separate views for distinct project areas, you would also want to check “Zoom when activated” so that the entire project area will be shown when you switch to the view.

A variation on this would be to zoom to a project area without limiting the visible area. This would add the convenience of zooming to the appropriate project area without restricting the visible area (i.e. you can still zoom out to other locations/scales).

Yet another variation is to use a (polygon) feature instead of a saved location. Figure 21 also shows the values for using the boundary feature of South Africa. Check “to feature” and enter those values to use the feature instead of a saved location.

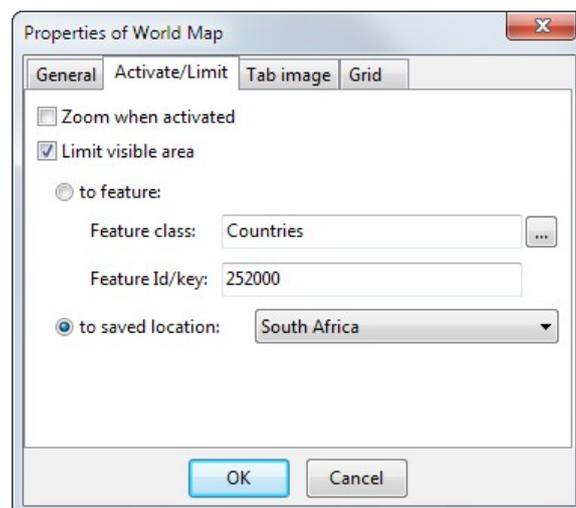


Figure 21: Limiting a view to a saved location

Design Mode

“Design mode” is an alternate view of your opened projects – a “look under the bonnet”, so to speak. Every single aspect of your project is accessible here. Design mode is analogous to looking at a database table’s structure instead of its content. Click on the **Design** button (🔧) in the menu toolbar to activate Design mode.

Design mode consists of two panels separated by a “splitter” which you can move to assign more space to either panel as required. On the left is a “tree” displaying the hierarchy of elements of your projects, starting with each project on highest level under the “root” which is simply called “Maps”. This tree is very similar to the folders view in Windows Explorer. Each item in the tree is called a “node” and an arrow⁷ to the immediate left of the node indicates that the node can be expanded to reveal more (“child”) nodes. In Figure 22 you can see that the “World.db” and “Feature classes” nodes have been expanded. The “Feature classes” node has also been selected.

⁷ On some systems this is a block enclosing a plus.

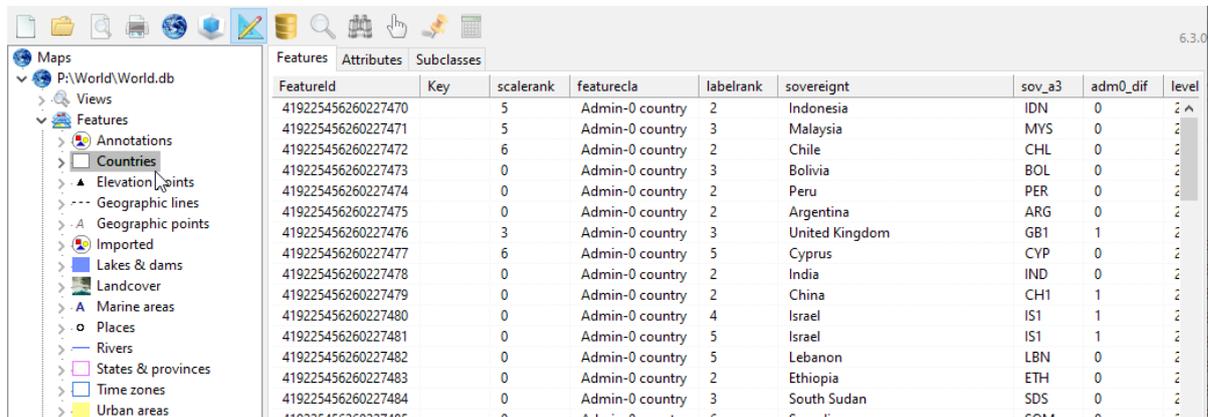


Figure 22: Design mode with "Feature classes" node selected

Once a node is selected, you will see that the right panel contains either a list of data items or child nodes which are also in the tree view on the next level down. (Feature subclasses are shown in the "Subclasses" tab).

In general, Design mode has several very useful functions:

- Right-click on any node to see a menu of possible tasks for that node.
- Right-click on any node and click **Properties** to see all settings for that element.
- Create new elements or delete elements.
- Re-order elements and move elements into other elements.
- Create duplicate copies of elements.
- Copy any element to another project (simply drag-and-drop).

Other than displaying database information for feature classes, the right panel (or content panel) is useful for performing actions on more than one element at the same time. For example, you can select many elements and delete them all in one action, or copy them all to another element by dragging them onto a node in the tree on the left. There are several ways to select more than one element:

- Select an element, then press <Shift> and select another element to include all elements between (from left to right, then top to bottom).
- Select an element, then press <Ctrl> to add individual elements.
- Position the mouse onto white-space (to avoid selecting something), then drag a rectangle touching all elements you require to be selected.
- To unselect individual elements that have been selected, press <Ctrl> and click on each.
- You can also use the drag rectangle method to unselect elements by pressing <Ctrl> when completing the rectangle-drag.

To return to mapping mode, click **Map** (🌐) on the menu bar or double-click on the project node ("M:\World\World.db" in the example above). This will also activate the project if you have multiple projects open.

Chapter 4

MAP PRODUCTION

Introduction

In this chapter you will learn how to set up existing projects for producing maps. This includes embedding maps into your documents, producing electronic (paperless) maps and paper maps.

All tasks in this chapter can be achieved with the free PlanetGIS Explorer.

Displaying a Map Grid

To display a grid (or “graticule” for a geographic projection map), right-click on the view tab as in the previous section and click **Properties**. Activate the “Grid” tab.

To display an automatic grid with text for the values, select the items as in Figure 23. A fixed grid can be specified, but will only be useful at a narrow range of scales. The grid interval can be specified in degrees, minutes or seconds (and fractions thereof) or in the case of a projected coordinate system (usually) metres. On a World map, it is typical to have a 15 degree grid (graticule). (15 degrees is one hour of the Earth’s rotation). If you forget to change from seconds to degrees, Planet will not display a grid because there would be too many grid lines.

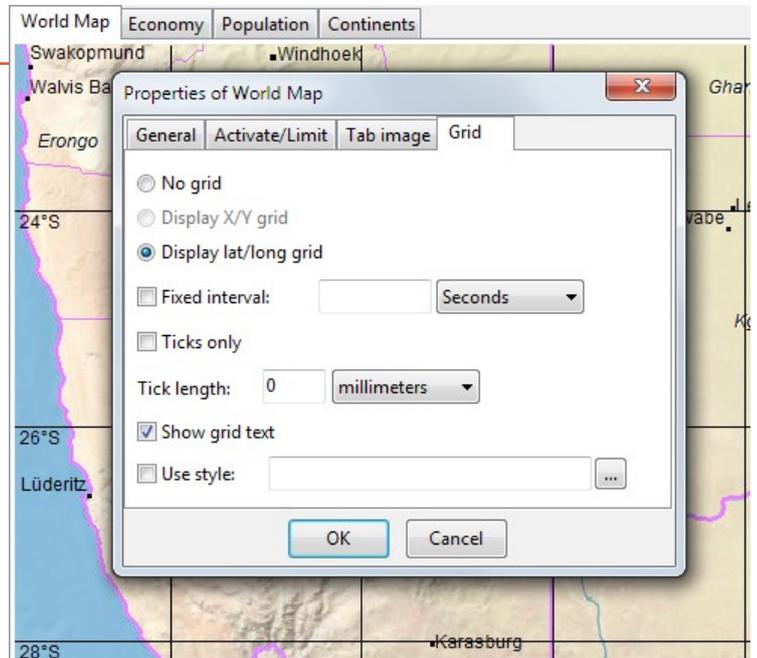


Figure 23: Setting up a latitude/longitude grid

If grid lines are too intrusive, select “Ticks only” which will draw short lines of the specified length around the edges of the map and crosses where grid lines intersect.

Floating Objects

Floating objects are elements added to a map that remain in one place on the screen (or printed page), regardless of changes to location or scale of the map. To add a floating object, you need to open the map popup menu with a long-right-click (i.e. keep the right mouse button down for ½ second). Figure 24 shows how to add a “floating” legend.

Typical types of content for floating objects are:

- Text (e.g. a title)
- Image (e.g. a logo)
- Legend
- North arrow
- Scale bar
- Locality map
- Page references

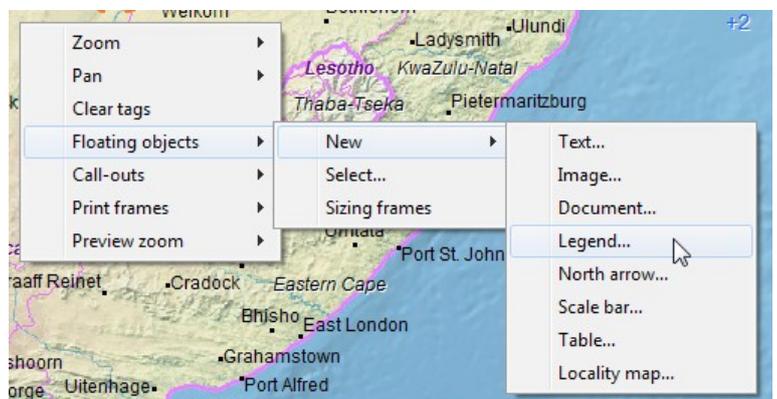


Figure 24: Adding a “floating” legend

Once you have selected the type of floating object, a “Floating object properties” window will appear. For this example, simply click OK.

Sizing frames

As soon as you create a floating object, “sizing frames” will be automatically switched on. You can click in the interior of a floating object and drag it to an appropriate location, or drag the edges to adjust the size.

When you close your project and re-open it, sizing frames will not be visible. This is the default mode of operation so that you can interact with the map without floating objects interfering. The only interaction available without sizing frames is right-clicking inside the floating object. To switch sizing frames on or off, right click on a floating object and check/uncheck **Sizing frames**.

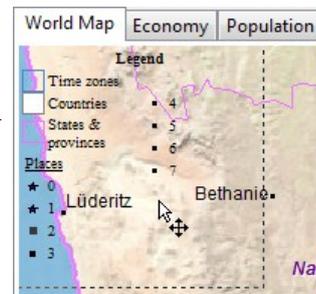


Figure 25: Dragging a legend

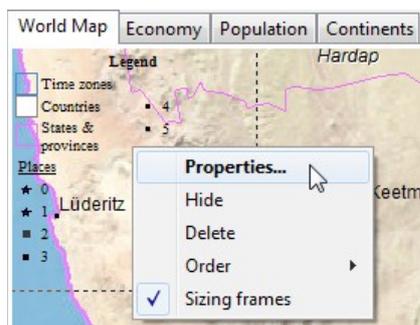


Figure 26: Floating object menu

Right-clicking on a floating object also allows you to change its properties and hide or delete it.

Common properties of floating objects

Every type of floating object has the same properties window for common properties which are divided into tabs for:

- **General.** The name (only for reference) and type of content as well as access to the specific properties of the content (see next section).
- **Position.** For specifying exact distances from edges of the page.
- **Size.** For specifying exact or relative sizes.
- **Visibility.** Choose which views to display the floating object in as well as whether it should be used for printing, on-screen or both.
- **Border.** For specifying a frame to use around the floating object and also what colour to use for its background (if any).

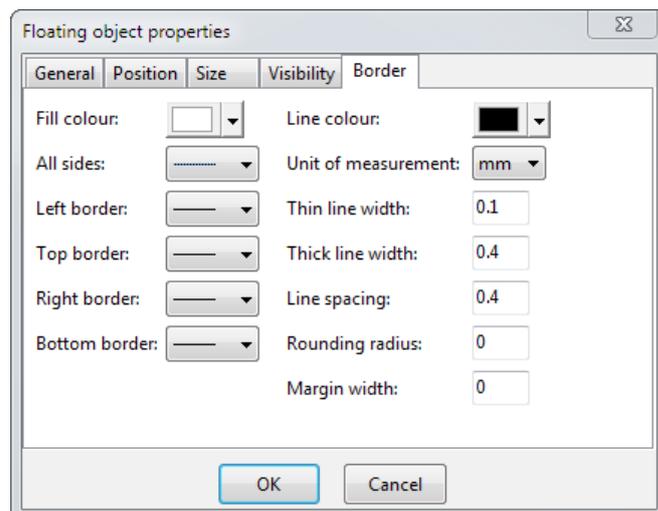


Figure 27: Floating object properties; Border tab

Specific properties of the content of floating objects

You can access specific properties for the type of floating object you have chosen in the **General** tab of the floating object's properties window.

Use the button with the down-arrow to change the type of content or click on the content button to open specific properties.

Floating text

Floating text is normally used as a title for the map. When you create floating text, it will appear in the default location for a title. Move it to an appropriate location for other uses.

For a title, your text size should be “auto” and alignment “centre” to size it to fit according to the extent of the floating object. For other uses you may prefer a fixed size and left-aligned text.

As part of the text you can use the following “macros” for automatic/variable information: (all lower case, no spaces, preceded by \$)

\$viewname
\$longdate **\$shortdate** **\$time**
\$coordsys **\$projection** **\$coordinate**
\$scale
\$filename **\$fullpath**

\$viewname is handy to use the name of your views as titles on the map. The date format (as elsewhere in PlanetGIS) is determined by your operating system settings (Control Panel→Clock, Language & Region). \$coordinate corresponds to the centre point of your map.

Floating legend

A floating legend is a common addition to a map. The font size should be “auto” for most cases and use the “multi-column” option together with options in the “Legend” tab of the properties of displays (Displays tab→Right-click→Properties→Legend) to control the layout and visibility of items in the legend.

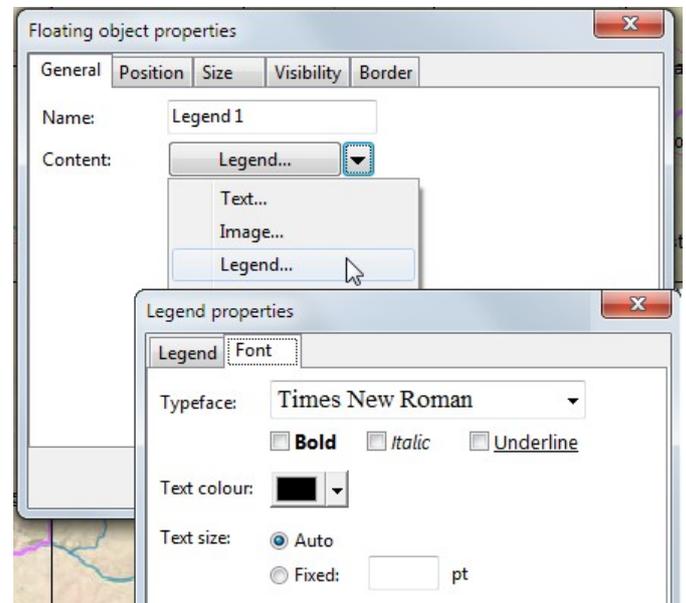


Figure 28: Specific properties for a legend

Floating locality map

A locality map provides locational context. The default location is top-left and offset by 5mm. No frame is used by default.



Figure 29: A locality map

Options for a locality map are:

- Scale factor: scale of locality map = scale of map x factor
- Choose another view: locality maps must be less complex as in this example of the World map that uses the Economy view for the locality map.
- Use a saved location for user-specified locality.
- Whether and how much to darken the area outside of the visible map area.

Callouts

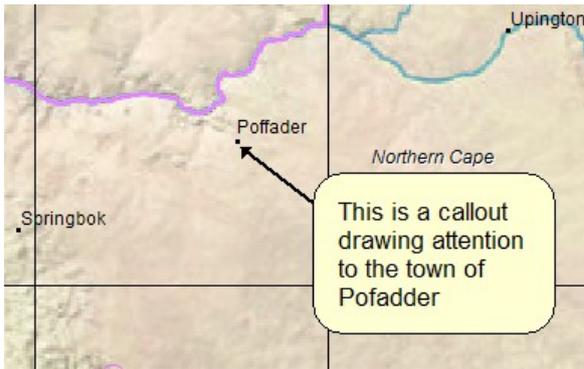


Figure 30: An "arrow tethered" callout

will be maintained and the callout will only be displayed if the anchor point is visible on the map.

Callouts are elements added to a map that are “tethered” to a coordinate. Callouts are used to draw attention to a location or feature and attach content to it. The most common type of callout is a “speech bubble” containing text. Callouts can have most of the content types as floating objects. Only the properties for positioning are different.

When sizing frames are enabled you can move the anchor point and the callout independently. The relative distance between the callout and anchor

Printing & Reporting

Printing

To print the map displayed on your screen, it is advisable to first activate **Print preview** in the menu toolbar (). If you skip this step Planet will do it for you, but the print job will also start. Print preview shows you what the printed map would look like for the paper size currently selected for your printer at the same scale as on your screen when not in Print preview. The “page” is scaled to fit onto your screen, so will probably look smaller than the hard copy that will be produced¹. In Print preview mode, the scale displayed at the bottom of the screen is not the displayed scale but the hard-copy scale, so you have to keep in mind that the map is (probably) smaller due to additional scaling to fit the page onto the screen.

Print preview shows the selected paper orientation and the printable area. Printers report to the operating system exactly how many millimetres from each of the four edges of the paper they are able to print². You can drag each margin to increase the size of the edge, or specify exact values if you create a “page frame” (see below).

To select a printer and to change the page size, click **File**→**Print setup**.

Paperless printing (eg. PDF)

It is a common task to create PDF (Adobe Acrobat Portable Document Format) files of maps. Planet cannot create PDFs directly, but there are many “PDF creators” that can be installed. Bullzip is a popular example (<http://www.bullzip.com/products/pdf/info.php>). These, when installed, look like a regular printer and when you print, a PDF file is produced. PDF has one drawback in that it doesn't support transparency (Planet's transparent fills appear black).

A little known alternative to PDF that works well for anyone using Windows, is Microsoft's XPS Document Writer. (XPS stands for XML Paper Specification). Apparently meant to be an open and popular alternative to PDF, it is unclear if this format will ever become as widespread in use. You can create an XPS document on any version of Windows since Vista (unless you uninstalled the XPS printer) and any other user of Windows can view and print it³. XPS integrates better with printer drivers (on Windows) and handles Planet's transparent fills very well. If you have a map in an XPS

1 These days, with large screens and high resolutions, what you see on screen is very similar to what you will see on an A4 page. Try a larger format like A2 or A0 to see a marked difference.

2 PDF & XPS (among a few physical printers) can print right up to each edge.

3 Of course, for users of Mac and Linux systems, PDF is still preferred.

document, you can still produce a PDF from the XPS viewer which is included in your Windows installation by printing it to a PDF creator.

Reporting

The easiest way to include maps into your own documents is to copy the contents of the screen to the clipboard and paste it into your word processor (or other software). The copy-to-clipboard function is not under the **Edit** menu, as is traditional, but rather under **File**, then

Clipboard→**Copy bitmap**. Depending on the software and the content of your map, **Copy metafile** *might* work better because it is a vector format that should yield better quality when printing. You need to experiment with it to see which works better for you.

When copying a bitmap or metafile to the clipboard, a settings window appears, allowing you to specify the image resolution (see Figure 31).

You have the option to change the physical size in pixels or the resolution (as density in pixels per inch or dpi). While you can change the actual size to influence the resolution, it is not as useful. For example, a typical computer screen has a dpi of around 100. An image of 100 dpi, however, will not look as sharp when printed because a typical printer can produce images at 300, 600 or higher dpi. To create an image for including in a document that will be printed, the easiest is to change the resolution to 300 dpi⁴.

It is also important to note the difference in initial settings when you are in print preview mode as opposed to normal viewing. In print preview, you will get the size and resolution for the currently selected printer which will produce an image that will take a lot of storage space inside your document.

Finally, you can also save images to file from where you can manipulate them with image editing software and include into documents at a later stage. **File**→**Save image...** This option gives you more control over the file format. For lossless compression (image remains exactly like the original), PNG is the best option. If a slight reduction in image quality is acceptable, JPEG is a good option⁵. After selecting the image file format and entering a file name, a settings window similar to Figure 31 will appear with additional options related to the file format.

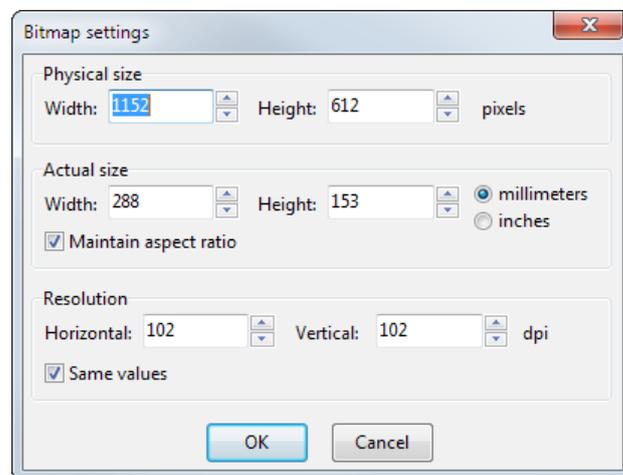


Figure 31: Bitmap resolution settings

Print Frames

The finishing touch for printed maps often include a frame (border) around the map. This can be set up and selected similar to floating objects. Frames can also be created inside frames, so you can create a hierarchy of frames in order to add a title block, for example. The possible types of content of each frame (other than more frames) are similar to floating objects.

4 Even on a 600dpi or higher printer, 300 tends to be enough and also saves 75% in storage space as compared to 600dpi.

5 You can control how much the image quality is degraded: 90 would be almost imperceptible, while 60 will yield excellent compression.

Creating & selecting a print frame

To work with print frames, you need to activate **Print preview** in the menu toolbar (). To select and edit print frames, use the “map popup menu” (long-right-click, i.e. keep the right mouse button down for ½ second on your map. In print preview mode, unless your click mode is “Zoom”, a regular quick right-click does the same). Now follow the following steps:

1. Click **Print frames** and **Select...**
2. Click **New** if creating a new print frame, otherwise **Select**.
3. Give the print frame a name for easy reference. Typically the paper size and orientation is used as part of the name.
4. Click **Edit** to start setting up the frame.

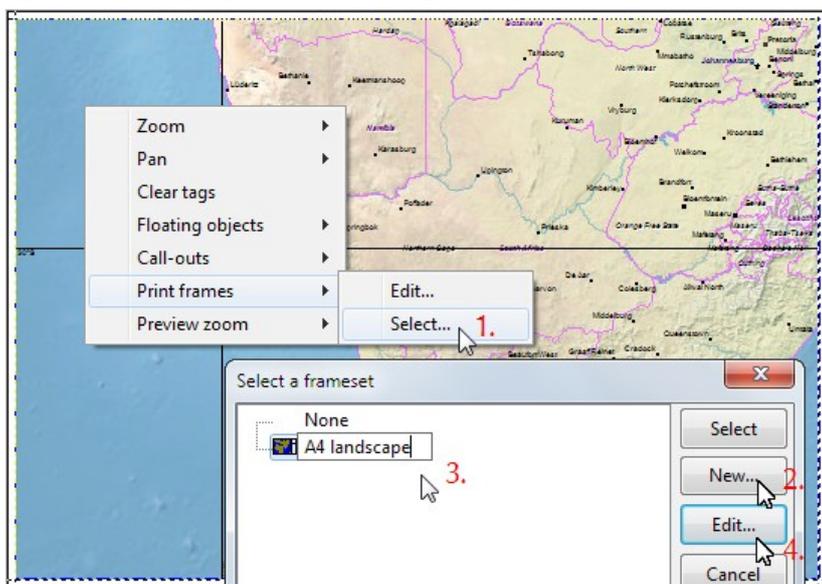


Figure 32: Creating a print frame

Setting up a simple page frame

A page frame often consists of more frames inside it. The default content for a page frame is therefore “Frames”. The simplest type of page frame, however, contains the map at the top level. The content of such a frame must therefore be set to “Primary map”. When setting up print frames, one frame must have a primary map, or no map will be displayed.

Alignment

Frames can be aligned to an edge of the page. An alignment of “All” means to use all space available to the frame. An alignment of “None” allows exact placement of a frame. Care must be taken with a “None” alignment as such a frame can overlap and obscure other frames. An aligned frame (other than “All”) requires a size to be specified in the “Outer spacing” tab. All measurements use the same units as specified in the “General” tab.

Border

For a typical page (outermost) frame, a thin-and-thick border is typically used. Use “All sides” to select the same line style for all edges. The exact widths of lines, spacing and colour can also be changed in this tab.

Spacing

Inner spacing is the margin between the content of a frame and its innermost border. In most cases this should be 0 for frames containing more frames and at least 1mm for frames containing actual content, e.g. text.

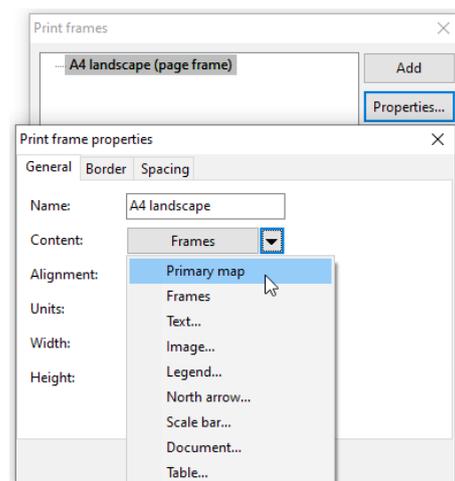


Figure 33: Creating a simple page frame

Outer spacing defines the outermost measurement of a frame. For left/right aligned frames a width is required (but height is ignored, if specified). For top/bottom aligned frames a height is required (but width is ignored, if specified). For a page frame (outermost frame) the offsets are the distances to the edges of the page. Offsets should be used with care for any inner frame as inner spacing normally provides better control.

To create a simple page frame for your map, you only need to specify “Primary map” as the content and choose a line style in the “Border” tab. Then click **OK** and **Close**. If you have created the frame earlier you also need to click **Select**.

Setting up more complex frames

Editing and expanding on your print frames will require a series of **Map menu** → **Print frames** → **Edit...** (don't click select unless you want to pick another print frame for your map, although you can simply click the **Edit** button there to work with the selected frame).

More complex frames require frames-within-frames. In order to create frames inside your page frame, you will have to change the content from “Primary map” to “Frames” (See Figure 34).

Click **Properties**, change the content to “Frames” and click **OK**. (You will notice your map disappear in the background).

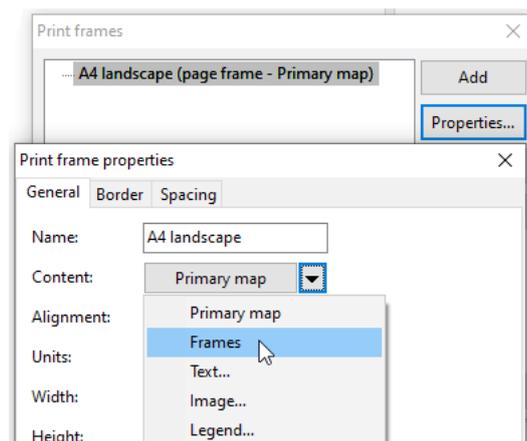


Figure 34: Changing the page frame to allow inside frames

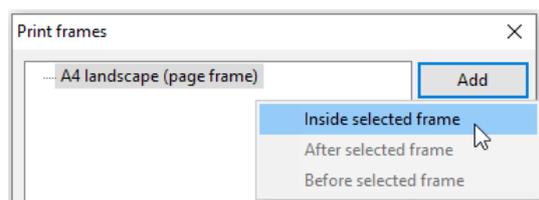


Figure 35: Adding frames inside frames

Now, instead of Edit, click **Add** and then **Inside selected frame**. (See Figure 35).

On this level you will need at least two frames: one for frame content and one for your map. Figure 36 shows a print frame with an empty title block (Name: “Title block”, Content: “Text”, Alignment: “Right”, Width: 50mm wide and in the Border tab, single line border on left). Be sure to create another frame for the map with Content: “Primary map” and Alignment: “All”. Click **OK** to see your map frames in action.

From here you can add multiple top- and bottom-aligned frames inside the title block for a legend, title, project description, scale bar and company logo. Choose one frame to be All-aligned, so that it would make use of remaining space left over from the other frames. When multiple frames have the same alignment (eg. Top), the creation order determines the actual layout order. You can change the order in Design Mode (see next section).

Setting up print frames requires a lot of work and careful planning. You cannot use the mouse to resize the frames and must instead supply exact widths, heights and margins. This pays off in the long run as you can always reuse your frames in other projects and you have full control over the layout. You can also create a duplicate set of frames from an existing set in order to

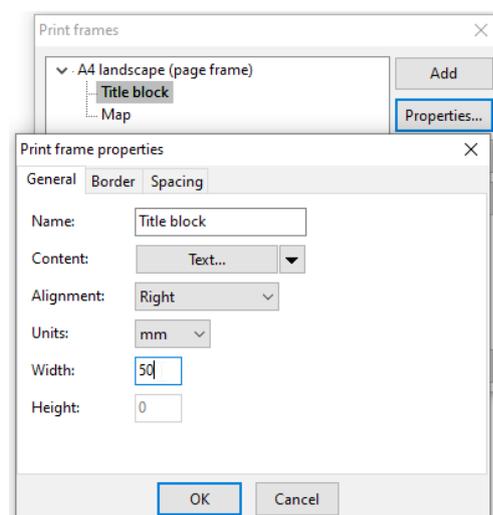


Figure 36: Print frames with the beginnings of a title block

Chapter 5

CREATING YOUR OWN PROJECTS

Starting a New Project

To start a new PlanetGIS project, select “Create a new Planet project” in the Quick start window or select **File**→**New...**

After you have specified a location and name for your project, Planet needs a coordinate system to be specified.

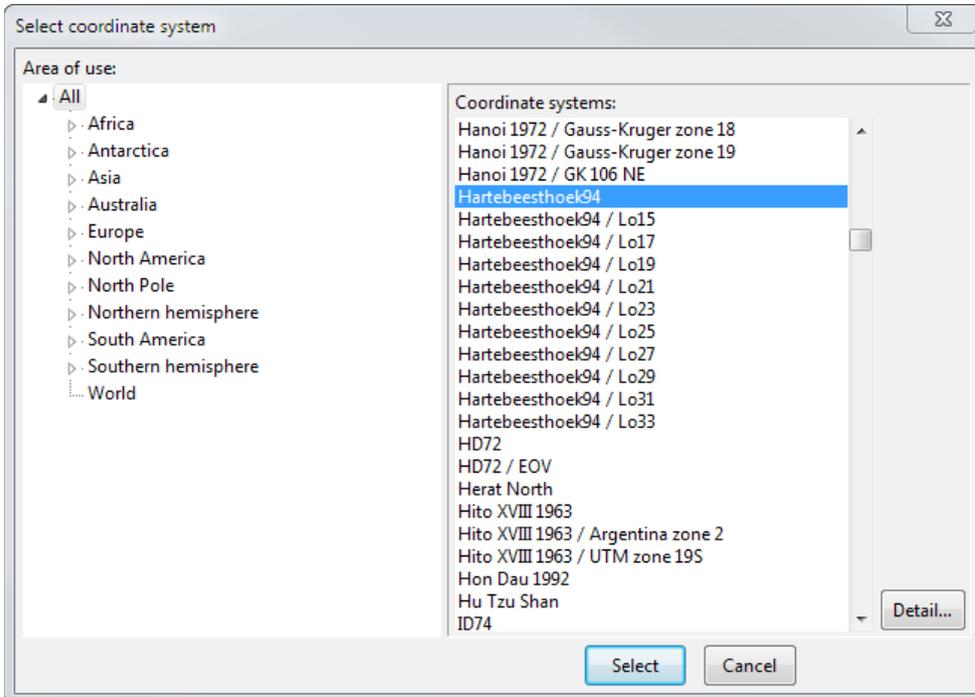


Figure 37: Selecting a coordinate system for a new project

The most common coordinate system in use today is **WGS84**, a geographic projection using spherical latitude and longitude coordinates. This is also the default coordinate system used by all GPS devices. In South Africa, we use **Hartebeesthoek94** which is equivalent to WGS84 for most purposes. You can select either of these for projects in South Africa that will not be using a local coordinate system.

If “All” is selected under “Area of use” you can click on the list of coordinate systems and type “har” or you can select “World” as the area of use which will produce a short list containing WGS84. You can also explore by expanding “Africa” and selecting “South Africa”.

If you do not select a coordinate system (press Cancel), your project will use a “non-earth” projection which is a simple, flat, Cartesian coordinate system. Transformation to/from (data exchange with) any other “earth” coordinate system will not be possible.

Multi-map Projects

PlanetGIS can combine data from multiple maps (projects). This is very useful for adding “backdrop” information to your new project. For example, most projects could benefit from displaying administrative boundaries to provide context. You can open any number of additional maps without closing any. You can then use the **Window** menu item to switch between them. **Design mode** will show all the maps that are open including secondary maps which will not be displayed in the **Window** menu. To view secondary maps, you have to activate them in **Design mode** (double-click on the project node or right-click and click **Activate**).

In addition to the **Window** menu, the **Map popup menu** (right-click for 0.5s - a so-called “long-right-click” - on the map) provides a function to go to the same location on another map. See Figure 38.

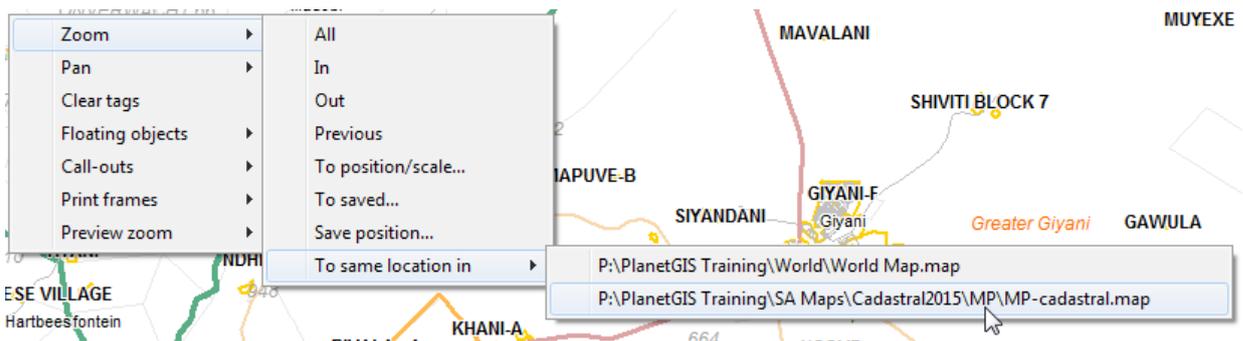


Figure 38: Zoom to same location in another map

In multi-map projects, we will use the terms “external maps/projects” or “secondary maps/projects”. An external project is simply another project that is opened at the same time as the project which is the focus of your current task. External projects are available to add as displays into your main project (i.e. your current focus). A secondary project is a project that has become a dependency of another project. In other words, some other project included one or more feature classes as a display and is now dependant on it. Secondary projects are opened automatically by the projects that require them. If a secondary project cannot be found, Planet will ask you to locate it. You can choose to ignore (click “No”) and the main project will open without it, ignoring displays that reference feature classes from it.

If you have multi-map projects which also need to be portable (i.e. able to be run from an external storage device) it is important to keep them all in a directory structure where relative paths can be maintained between them. Projects on different drives are not portable if they are part of a multi-map setup.

You can use the “SA administrative boundaries” map (available here: <http://www.planetgis.co.za/browsemap.php?id=13>) for the examples below.

Adding external feature classes in the Display Manager

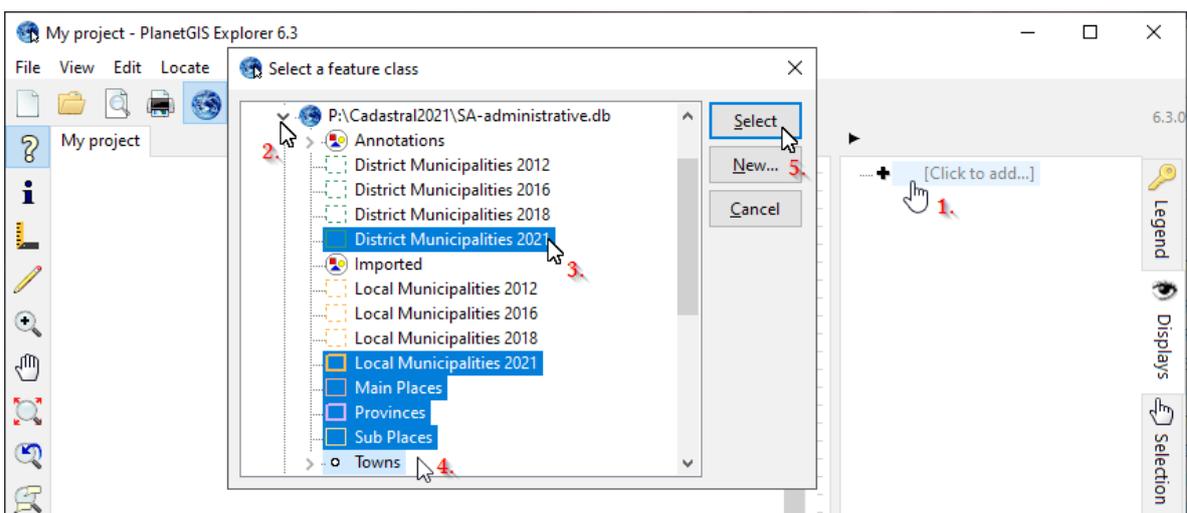


Figure 39: Adding external feature classes

1. Activate the Display tab and click on “Click to add” or anywhere in the white-space below existing displays.
2. Locate and expand the external project “SA-administrative.db”.

3. Click on the first feature class you would like to add.
4. Press <Shift> and click on the last feature class (alternatively select [or unselect] individual feature classes by pressing <Ctrl> while clicking).
5. Press <Enter> to select (or click the “Select” button).

Feature classes with thematic queries

You will notice that the “Towns” feature class that you've selected is not ideal for mapping purposes. A feature class like this needs to be classified into a hierarchy and set up such that only the more important features are displayed at smaller scales (zoomed out more).

Figure 40 shows that you can expand the node for the feature class “Towns” and select a thematic query named “Towns (levels)”. You could have done this in the previous step: selecting multiple feature classes with <Ctrl> allows you to expand nodes without clearing the selection. The steps for selecting a thematic classification for towns instead are as follows:

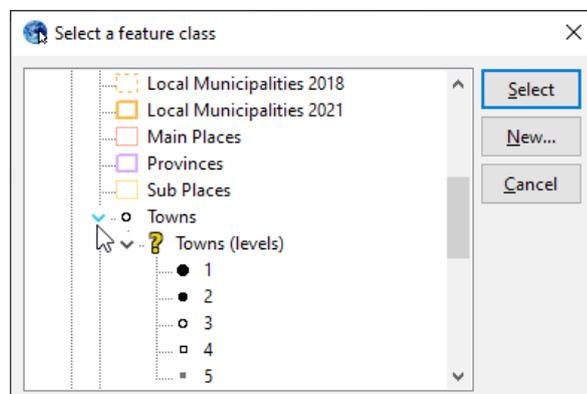


Figure 40: Selecting a thematic query

1. Hide the “Towns” display by clicking on the eye icon, or delete it by choosing the delete option from the popup menu (right-click on the display).
2. Click on “Click to add” or right-click anywhere in the Display manager and select “Add...”.
3. Expand the SA-administrative project and then expand “Towns” by clicking on the arrow icon.
4. Select “Towns (levels)”.

Renaming displays

Displays are automatically assigned the names of the feature classes (or thematic queries) they are referencing. Within the context of a view, it often makes sense to rename a display to something more appropriate. A single click on the name of a display will place the node into edit mode, allowing you to rename it. Alternatively right-click and choose “Properties...” where you can change the name among many other properties.

In this particular case, you might want to rename “Towns (levels)” to simply “Towns” or even “Places”.

Grouping displays

The Display Manager can very quickly become hard to manage due to too many displays. When layers can be logically grouped together (and especially with “backdrop” type information), it is always a good idea to create a group display first.

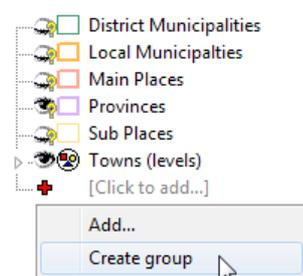


Figure 41: Creating a display group

1. Right-click in the Display manager and click “Create group”.
2. Type in a name for the group, e.g. “Boundaries”

3. Drag-and-drop each display into the group, making sure you drop on top of the text, i.e. “Boundaries”. Start with the topmost display (“District Municipalities”) if you want to keep the order.

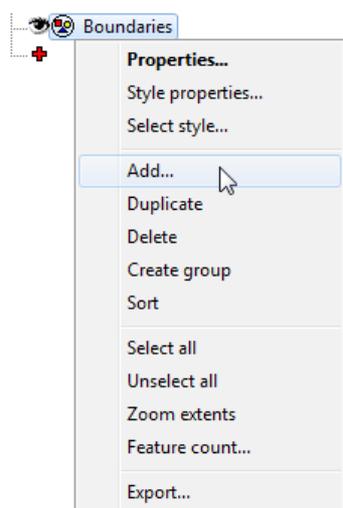


Figure 42: Adding feature classes into a group

A more efficient procedure would be to create the group before adding the feature classes. You can right-click on the group display and then click “Add...” to create displays for the selected feature classes inside the group. (See Figure 42).

Now that you have a group of related displays you can easily switch off the displaying of the whole group by clicking on the group's eye icon. The whole group can also be dragged to a different position in the list.

The above examples are the most typical uses of the Display manager. There is, however, a more efficient way to set up the displays of a view from multiple secondary maps: *Design Mode*.

Using Design Mode to set up your Views

A more efficient method of adding displays into a view, is to copy the displays from another project to your main project. Displays are references to feature classes and contain many options and settings. By copying a display, you will retain all those settings. By adding a feature class into a view, you create a new display which references the feature class and also the feature class' default style. Therefore, if you are setting up your own projects to utilize displays from external sources, (and assuming you want to preserve the general appearance and behaviour) you would save time by copying displays from the source project to your main project.

For the following examples you can use one or more of the provincial cadastral maps as well as the OpenStreetMap, or one of the projects that combine these. All the South African maps can be downloaded from this page:

<http://www.planetgis.co.za/browse.php?id=11>

1. Activate Design Mode.
2. Expand the nodes of your project so that the displays of the first view are visible (Figure 43).
3. Right-click on the view node (“My project”, if that is what you named your project).
4. Click “New”, then “Group” (Figure 44).
5. Enter “Cadastral” as the name for the group.
6. Now expand a cadastral map and click on its first view. You must be able to see the displays of the view on the right-hand side.
7. Click on the first display on the right-hand pane (“Parent farms”), then press <Shift> and click on the last display you want to use (“Parks” is a good choice). (Figure 45).

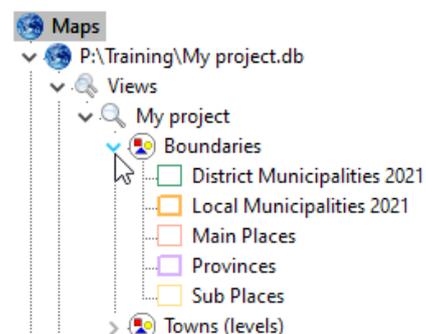


Figure 43: Expanding a view to see its displays

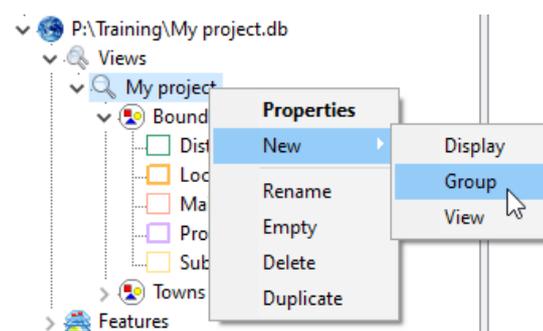


Figure 44: Creating a display group in Design mode

8. Use the scrollbar to make your target visible in the left-hand pane. Your target is the group display you have created (“Cadastral”). (Figure 45).
9. Now drag your selected displays from the right and drop it exactly onto the text of your target node (i.e. “Cadastral”). Also shown on Figure 45.

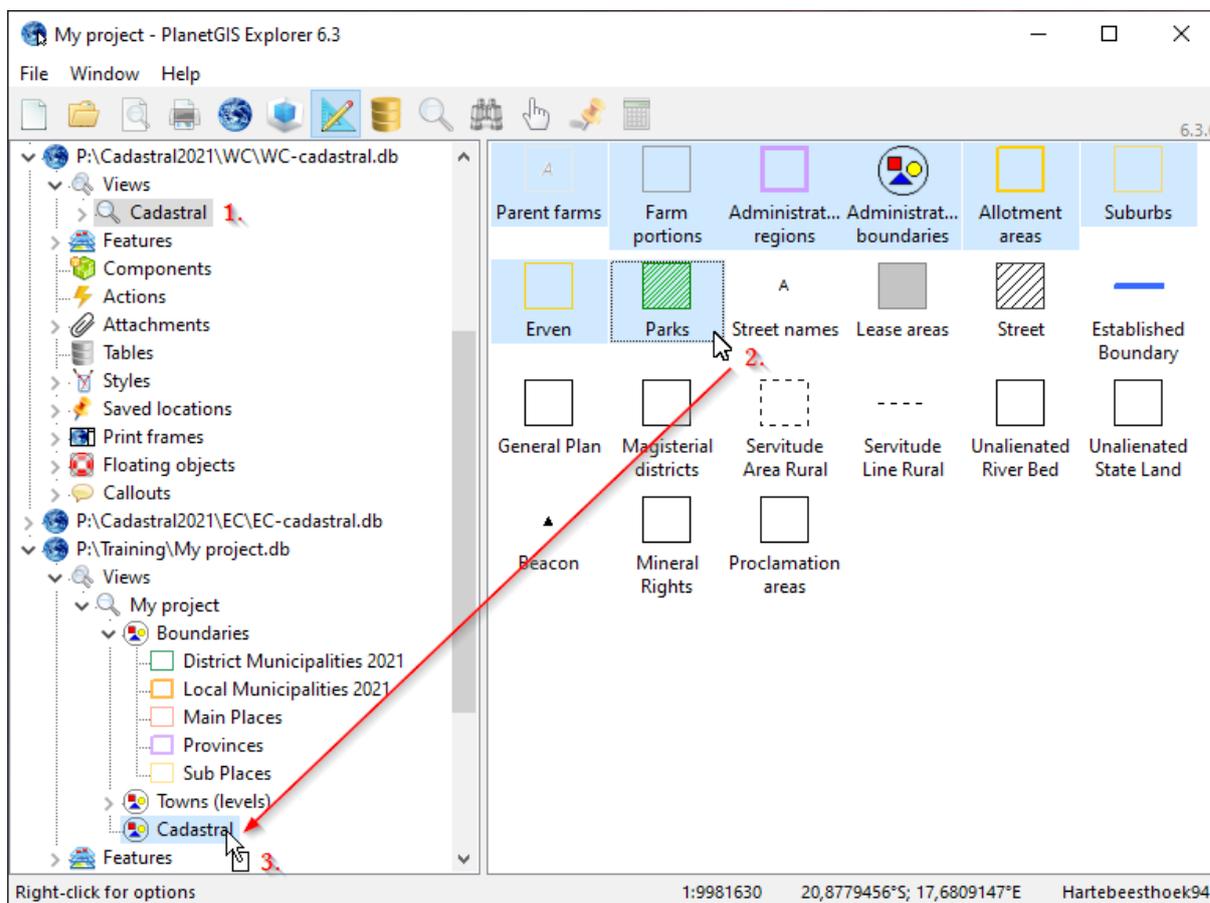


Figure 45: Dragging displays from one project to another

You can also use Design mode to copy displays from one view to another in the same project, delete multiple views, move displays into a group, reorder displays, etc.

Copying displays vs. copying feature classes

It is important to be aware whether your source and target is a display or a feature class, since they may look the same (same styles). A display is a reference to a feature class. If the source is a **display** and you are copying into a target **view**, you copy a reference along with all the settings of the source display.

You can drag a feature class (or selection of feature classes) into a view of the same or another map. This will simply create a display referencing the source feature class. (The display will not have any custom settings, since it is new).

If you drag a feature class to the “Feature classes” node of another map (or into a feature class group), a copy of the feature class with all its features and attributes will be made. In this case you will have created a duplicate of the database and you will still need to create displays (drag them to a view) to see them in the destination map.

Styles (and everything else)

Styles will usually be copied across automatically, but you can always drag a style to another project's "Styles" node. You can also drop a style onto a feature class or a display to assign the style to the feature class or display. If the style is from a different project, a copy will automatically be made in the destination map and the reference will be to the new copy.

You can also copy style elements (e.g. a pen) to other styles.

Print frames, floating objects and saved locations can also be copied between projects in this way. It will serve you well to have a project containing templates of your styles and print frames that you can call up and copy anything you need to a new project.

Chapter 6

COORDINATE SYSTEMS

World Geodetic System 1984

WGS84 is the coordinate system used most commonly on Earth. It defines an “ellipsoidal” model that closely approximates the shape of the earth¹. The origin point of this system is the centre of Earth’s mass, determined by observations from outer space to an accuracy believed to be less than 2cm.

WGS84 is a spherical coordinate system which uses angular units, latitude and longitude. It is important to realise that the distance between two points on the surface of the Earth is expressed as an angle between the two points and the centre of the Earth. The actual radius of the Earth determines the exact distance between the points and will change if a different ellipsoidal model is used. A latitude or longitude is simply the angle of some point on the surface, the middle of the Earth and the zero line of latitude (the Equator) or the zero line of longitude (the Greenwich Meridian).

The WGS84 ellipsoidal model has a major (equatorial) radius of 6 378 137m and a minor (polar) radius of 6 356 752m. An ellipsoidal model does not take into account mountains or even mean sea level at any particular location. The model is a smooth surface which is the mean sea level for the whole planet. Mean sea level at specific locations can be up to 105m below the ellipsoid (South-East India) and up to 87m above (eastern Indonesia). This is due to gravitational changes which is due to irregularities in the composition of the inner Earth.

Coordinate systems and projections

Maps on computer screens and paper are flat representations of a surface which is not flat. The transformation from a spherical surface to a flat surface is called a “projection”. If you look at the World map, it is obvious that the closer to the poles you get, the more the shapes and sizes of land masses are distorted. This is because the projection used keeps lines of longitude straight and parallel. It is common for a world map to use a different projection where lines of longitude are curved, but not so much on computers.

If you zoom in a bit you will see that Planet adjusts the distance between lines of longitude (meridians) so that shapes of landmasses (or borders of countries and other features) in the middle of the screen correspond better with reality. Only a thin pixel-wide horizontal line running through the centre of the map is exactly correct. Everything North and South of this line must necessarily be distorted to keep meridians parallel to each other. The more you zoom in, the more accurate features will be reflected, similar to how the Earth seem flatter the closer you are to the surface.

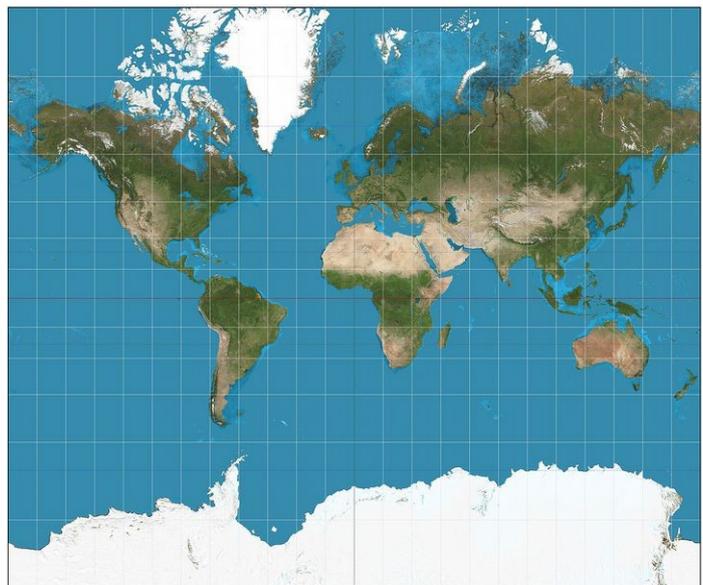


Figure 46: The famous Mercator projection

In 1569, Gerardus Mercator, a Flemish cartographer, presented a projection to solve this problem for nautical navigation.

His solution was to stretch out the distances between lines of latitude (parallels) the closer they get

¹ The shape of the earth is an “oblate spheroid” - a sphere with a slight bulge at the equator due to the centrifugal force due to rotation.

to the poles. The shapes of landmasses are distorted similarly, but this projection became the standard for nautical navigation because lines of constant course become straight lines.

Other methods of projection are also used, especially when working with smaller areas than the World map. The most common projection is to use a cylinder that touches the surface of the sphere along a line of longitude (meridian). This is then flattened into a system with X and Y coordinates. The flattening of the cylinder creates a distortion which only becomes noticeable about a degree away from the central meridian. This type of projection is called **Transverse Mercator**² and is appropriate for areas no wider than 6 degrees (preferably less than 3 degrees). Projections like this are used in **local coordinate systems**.

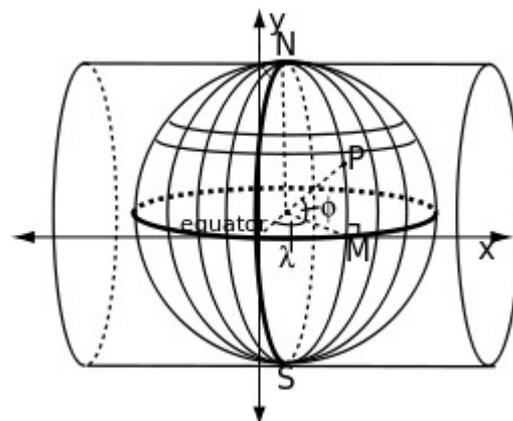


Figure 47: Cylindrical projection of the sphere

The projection onto screen of spherical coordinates is a simple on-the-fly transformation. The coordinate system remains spherical, so it is called a “geographic coordinate system”.

When the coordinate system is a projection onto a flat surface with X and Y values (usually in metres) it is called a “projected coordinate system”. Since the coordinate system is on a flat surface, there is no transformation needed when displaying on a screen or paper. The X and Y values in a projected coordinate system are typically the distances from the equator and a chosen central meridian.

Local coordinate systems

In South Africa there is a Transverse Mercator coordinate system centred around every odd-numbered meridian. They are called “Lo” (el-oh) systems. You can see in Figure 37 (previous chapter) that the “Hartebeesthoek94 / Lo” systems range from 15 degrees longitude to 33 degrees, spanning the breadth of SA. A shorter form of the name “Hartebeesthoek94 / Lo XX” (where XX denotes the longitude value of the central meridian) is simply “WGXX”.

It is becoming more common to simply use a geographic coordinate system, but if your project requires the use of an Lo system, you need to choose the system with the central meridian (the number after “Lo”) that runs through your area. If there are two, choose the one closest to the centre of your area. Sometimes it is impossible to “spill over” into a neighbouring zone. This is OK, it will be nearly impossible to notice the distortion until you get into the next neighbouring zone.

Features can also be copied between zones with no loss of information (see below).

Outside of South Africa – especially in other African countries – the coordinate system used is **Universal Transverse Mercator (UTM)**. This is a system developed by the United States Army Corps of Engineers that divides the earth up into zones that are 6 degrees wide. Distortion is balanced out by using a scale factor which creates two lines of “true scale” parallel to the central meridian. The South African Lo systems do not use a scale factor (actually it is simply 1) and therefore the only line of true scale is the central meridian and that is also the reason why Lo “bands” are only two degrees wide.

² Other names in use are Gauss-Krüger or Gauss conformal projection.

South facing coordinate systems

Rather unique in the world, South Africa has “south facing” local coordinate systems. Lesotho, Swaziland, Namibia and Zimbabwe shares this oddity, while Botswana uses UTM like most other African countries.

Contrary to what a mathematician would expect, the convention in Lo systems is that X is the distance from the Equator toward the South Pole and Y is the distance **west** of the chosen central meridian³. Even more confusing is that the convention is to write Y first, which make the coordinates appear like X,Y except that the signs are wrong. It is easy enough to convert Lo Y,X to Cartesian coordinates:

$$X' = -Y$$

$$Y' = -X$$

Also important to know is that *directions* are south facing: 0 degrees is **South**; 90 degrees is **West**.

All software that hasn't been specifically designed for South Africa will store coordinates in Cartesian format internally. Some (like Planet) will display the coordinates in the expected convention. Shapefiles always come in Cartesian X,Y. DXF can be either. If you receive Lo coordinates in a text file (typically from a survey diagram) it is most likely Lo Y,X. If you receive coordinates in a database table it can be either.

Fortunately, since South Africa is far from the equator, the X value is always larger than 2 000 000 which helps identifying which is which, however, it is not uncommon – especially in CAD drawings – for the 2 000 000 to be subtracted to reduce the length of the numbers. This is called a “false northing”.

Datums in South Africa

In the simplest sense, a “geodetic datum” defines the location of the centre of the earth and the size (major and minor radius) of an ellipsoidal model of the earth. Geodetic datums usually have a fixed point defined somewhere on the surface of the earth to account for continental drift.

Hartebeesthoek94 is the official South African datum and uses the same centre point and dimensions as WGS84, so a coordinate in a system based on either datum will be the same⁴.

Before WGS84, a different estimation of the size and centre of the Earth was used. The South African coordinate systems were initially set up based on the size of the Earth as described in a book named “Geodesy” written by Col. Alexander Ross Clarke and published in 1880. He described the “figure of the Earth” with a major radius of 6 378 249m, only 112m more than our current model for which we needed to get into space! This model of the Earth is called the “Clarke 1880 ellipsoid”⁵. The original South African datum was called the “Cape Datum” and has its fixed point at Buffelsfontein, near Port Elizabeth.

Gravity measurements from space allowed us to accurately determine the centre of Earth's mass to within 2cm. The difference between the centre points of WGS84 and Cape (Clarke 1880 ellipsoid) is surprisingly small too: 292m north, 110m east and 134m along the axis from the centre of the Earth to 0, 0 on the surface (a point at sea about 500km South of the coast of Ghana).

3 Every other system in the world using X,Y coordinates follow the Cartesian convention: X-axis points East and Y-axis points North.

4 Well, nearly. WGS84 actually gets recalculated periodically. At the moment Hartebeesthoek94 coordinates are between 20 and 30cm away from WGS84. Continental drift will also have an impact because the Hartebeesthoek94 datum has a fixed point at the Hartebeesthoek Radio Astronomy Observatory Telescope near Pretoria.

5 Often called “Modified Clarke 1880” since Clarke calculated a different figure in 1866 (~43m smaller).

Maps produced in South Africa before 1999 mostly used the Cape Datum and from 1999 onward maps were using Hartebeesthoek94 and older data converted to the new datum. It is becoming increasingly rare to find maps in the Cape Datum, but if you have such data, it is important to know the difference and the procedure for converting the data.

When data sources are mixed and you have features of both the Cape and Hartebeesthoek94 datums, there will be an offset of roughly 300m north-east in a projected coordinate system. In a geographic coordinate system the difference is much less because the angular (spherical) coordinates assume the same Earth radius (whichever datum is selected for your map). The difference varies slightly throughout South Africa from around 5m to 15m.

Changing coordinate systems

If you know that a map is in the Cape datum, either Cape geographic or Cape Lo projected, it is a simple action to tell Planet about it: Click **File**→**Project**→**Coordinate system** to open the coordinate system window.

To tell Planet what coordinate system a project is currently in click the **Select** button. To convert a project to a different coordinate system, first verify that the information about the current system is correct (and click **Select** if it isn't), then click the **Convert** button to select a new coordinate system and reproject all features in the project to the new system. For multi-map projects this need to be done for each individual map. An alternative to the **File**→**Project**→**Coordinate system** menu is to right-click on the project in Design mode and then click **Coordinate system**.

If you are copying features between two maps with different coordinate systems, the features will be automatically reprojected **provided** the coordinate systems have been correctly defined in **both** maps.

When working with different coordinate systems, you may want to maintain a Planet project for each system and periodically copy features between them (typically from the older to the newer system). That way it is easy to update features in the old system from sources that remain in the old system. (See Importing below).

Other projections

There are many other projections designed for small scale mapping (continents / subcontinents). These are primarily conical projections which model the curvature of the earth by a conic volume that bisects the sphere at two lines (usually) of latitude (also called “standard parallels”).

The two most common projections are “Albers Equal Area” and “Lambert Conformal”. The former preserves area but distorts direction and distance, while the latter preserves direction and angles but distorts area and distance. If you encounter source data in either of these projections, you will need to supply all the parameters for the projection exactly as the source of the data has determined them.

Secondary (projected) coordinate system

For projects in a geographic coordinate system, Planet can also be set up with a second, projected coordinate system.

Figure 48 shows a geographic coordinate system set up with an additional projected coordinate system. This is very useful for importing or exporting features and for coordinate display on your map.

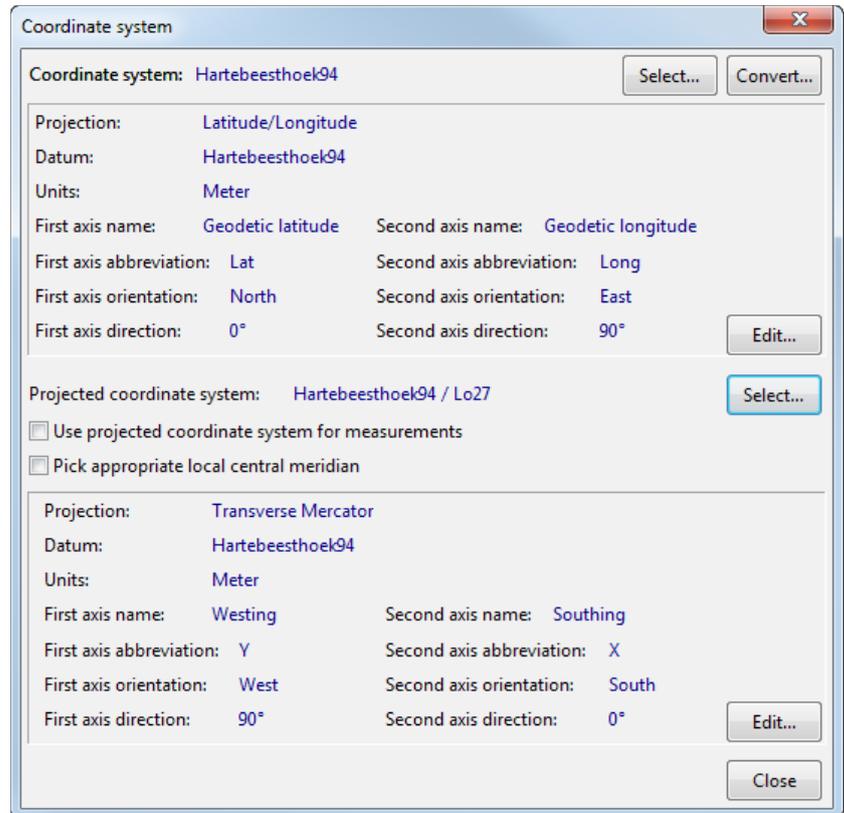


Figure 48: Coordinate system window with secondary coordinate system selected

Map coordinate display

The coordinate system for the active project is shown next to the scale and mouse cursor coordinates (Figure 49).

To change the coordinate display format, click directly on the coordinate text. Along with other formats for spherical coordinates, you will also see an option to display projected coordinates (if a project system was set up as in the previous section).

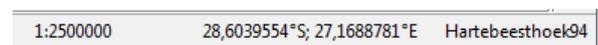


Figure 49: Scale, mouse coordinates and coordinate system display

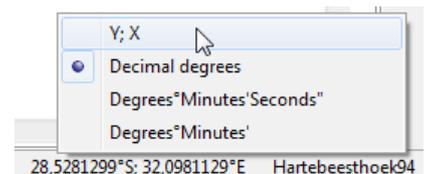


Figure 50: Select coordinate display format

If you select “Y; X” as in Figure 50, you will see that the coordinate system text changes to “Hartebeesthoek94 / Lo27*”. The asterisk at the end indicates that it is not the actual coordinate system of your project.

Mixing coordinate systems

Planet will allow you to create a multi-map project containing different coordinate systems. The coordinate system that Planet will use is the one set up for the active map. Features from secondary maps will not be reprojected on-the-fly and features from secondary maps will not be in the correct position⁶.

⁶ In future, on-the-fly reprojection may be implemented.

Considerations when importing or exporting features

Importing

Before importing data that has projected (X,Y) coordinates, you need to set up the coordinate system to match the source exactly. Shapefiles normally come with a *.prj file which describes the source coordinate system. You can open this file with Notepad. It is a bit hard to decipher since all the information is in one line, but it is possible.

If you have a project already in a projected (X,Y) system but are importing geographic (/spherical lat & long) coordinates, you don't need to do anything. Every projected coordinate system knows how to convert spherical coordinates to local coordinates and back. **Except**, if the datums are different, e.g. if the spherical coordinates are from a Cape datum but your project is in Hartebeesthoek94 or WGS84. For this scenario follow the same steps for reprojecting explained above.

Exporting

The issue of producing X,Y coordinates from lat,long coordinates comes up most often when exporting to DXF. This is because DXF is used to get GIS data into CAD applications, which nearly always need a flat, projected coordinate system. PlanetGIS therefore provides this reprojection as an option in the DXF export options window (which simply sets up a secondary coordinate system as shown above).

In all other cases you need to reproject your data before exporting. The procedure is as follows:

1. Create a new project with the desired coordinate system
2. Copy the data from the source project to the new project
3. Export the data from the new project.

The copy process will automatically reproject coordinates. There are two ways to copy data between projects:

1. For a selection of features on the map, use Edit→Copy
2. Drag-and-drop feature classes between projects in Design Mode

Chapter 7

CAPTURING FEATURES

Creating a New Feature Class

Although called “feature classes” new feature classes are actually “feature subclasses”. At the top level, a feature class is a subclass of the root feature class. The root feature class contains all attributes that are applicable to all features in any feature class, including the feature's location and geometry.

When creating many feature classes, consider whether a feature class is better defined as a subclass of another feature class already in your project. For example, an asset management system for a municipality may have at the highest level “Electricity”, “Water”, “Sewer”, “Stormwater”, “Roads”, etc.

When adding attributes, consider at which level an attribute will be most appropriate. Which feature subclasses will share the attribute?

Allowed feature types

When creating a new feature class, you must specify which feature types will be allowed. In the vast majority of cases, it is best to choose only one type to avoid future confusion and complications with styles and capturing. It can be very useful, though, to allow multiple types as can be seen in the OpenStreetMap project.

You can also specify no types to force features to be captured into subclasses instead. The feature class will act as a “group” in this case.

Although possible, it is not recommended to mix raster with any other type.

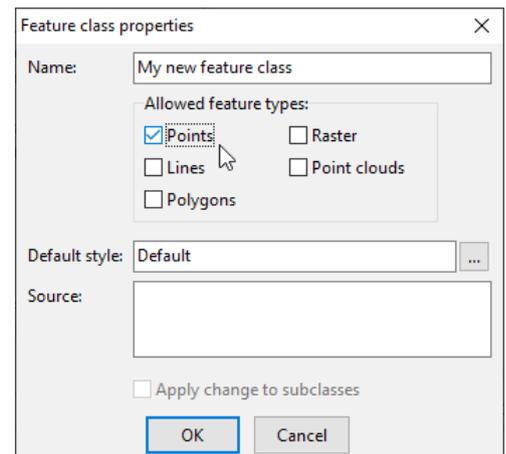


Figure 51: Allowed feature types

Capturing Points

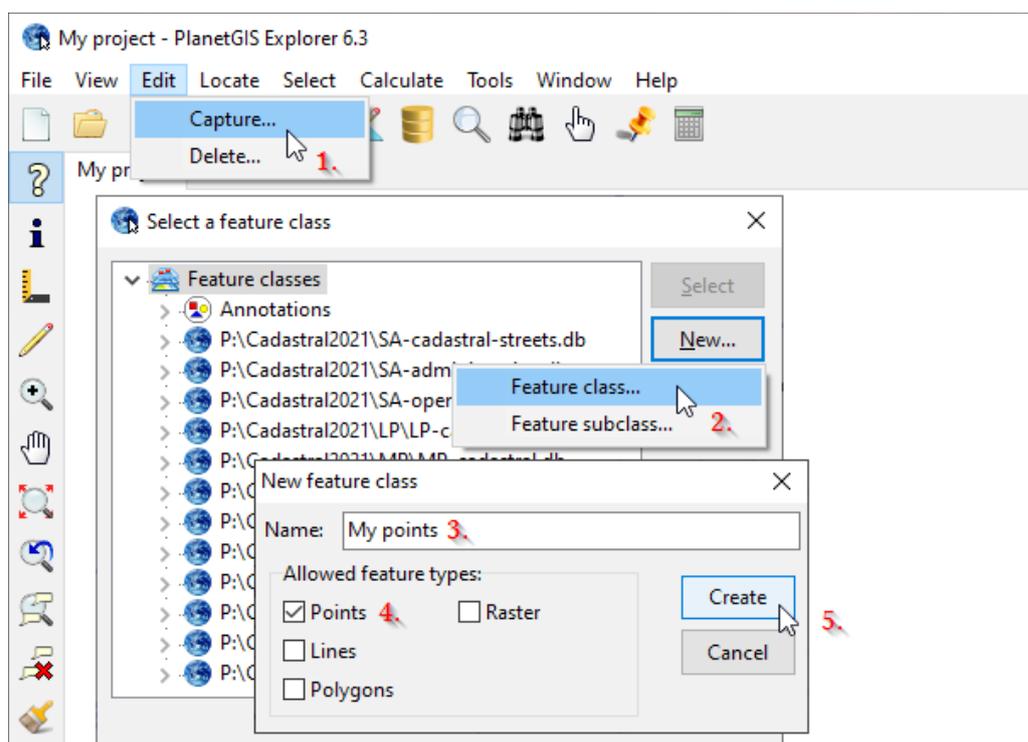


Figure 52: Capturing a point into a new feature class

To capture a point on your map, into a new feature class, follow these steps:

1. Click **Edit**→**Capture** (or <Ctrl+N>)
2. Click **New**, then **Feature class...** (or select a feature class in the tree and click **New**, then **Feature subclass...**)
3. Enter a unique name (unique among other subclasses of the same parent class, if any)
4. Check **Points** in the “Allowed feature types”
5. Click **Create**. If using PlanetGIS Explorer, your new feature class will be placed in a group called “Annotations”.
6. Click **Select**
7. Click on the map to capture a point.

You will notice that the “click mode” has automatically changed to “Capture point”.

If you know the coordinate for the point that you want to capture, right-click instead of left-clicking on the map to enter the coordinate by hand.

Planet understands coordinates in various formats:

- Degrees:minutes:seconds (27:30:00.0)
- Degrees° minutes' seconds" (27° 30' 0.0")
- Degrees:minutes (27:30.0)
- Degrees° minutes' (27° 30.0')
- Decimal degrees (27.5)

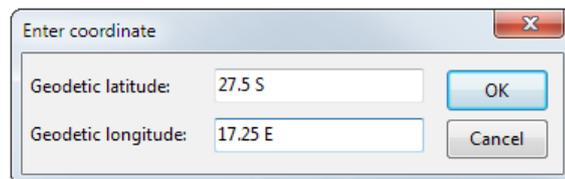
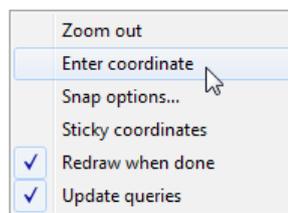


Figure 53: Entering a coordinate by hand

“S” at the end is a substitute for negative latitude (don't do -27.5 S) and similarly “W” at the end is a substitute for negative longitude. “E” and “N” are entirely optional.

To capture multiple points, keep clicking on the map. Each new point will be a separate feature with a new FeatureId.

Moving points

To move a point, you have to change the capture mode. Click on the “Capture point” button (📍) and hold the left mouse button down for ½ second (long click). Then click the “Edit vertex” button (🔧). When moving points, you have to be extra careful not to inadvertently move a coordinate of a feature (eg. an administrative boundary or orthophoto). It is best to click on the point (letting go of the mouse button) and then to verify that you have the desired point selected. The Attributes, Selection and Coordinate tabs on the right can be used to monitor your selection.

You will now see a small black square on top of the point feature. Now click, hold and drag the point to the desired location and let go of the mouse button.

Deleting points

To delete any feature that is not desired, verify you have that particular feature selected (Info, Select or Edit tab on the right) and only that feature selected (unless you are deleting multiple features), then click **Edit**→**Delete** in the main menu.

At this point you would probably want to select a new style for the points which currently have the default small white dot (if you haven't changed your default style). Follow these steps:

1. Activate the Displays tab.
2. Select the “Points” display and right-click on it to see the popup menu.
3. Click **Select style...**
4. Click **New...**, then **Style...**
5. Enter a name for the style.
6. Click **Add...**, then **Symbol...**
7. Click on the Shape button.
8. Expand the “Stock” node if necessary.
9. Select “Industrial” (feel free to deviate here)
10. Select a shape.
11. Click **OK**
12. Change the width to 10mm and click **OK**.
13. Now click on **Add...** and **Font...**
14. Change the font settings, e.g. check “Bold” or leave as is.
15. Click **OK** and again **OK** and finally **Select**.

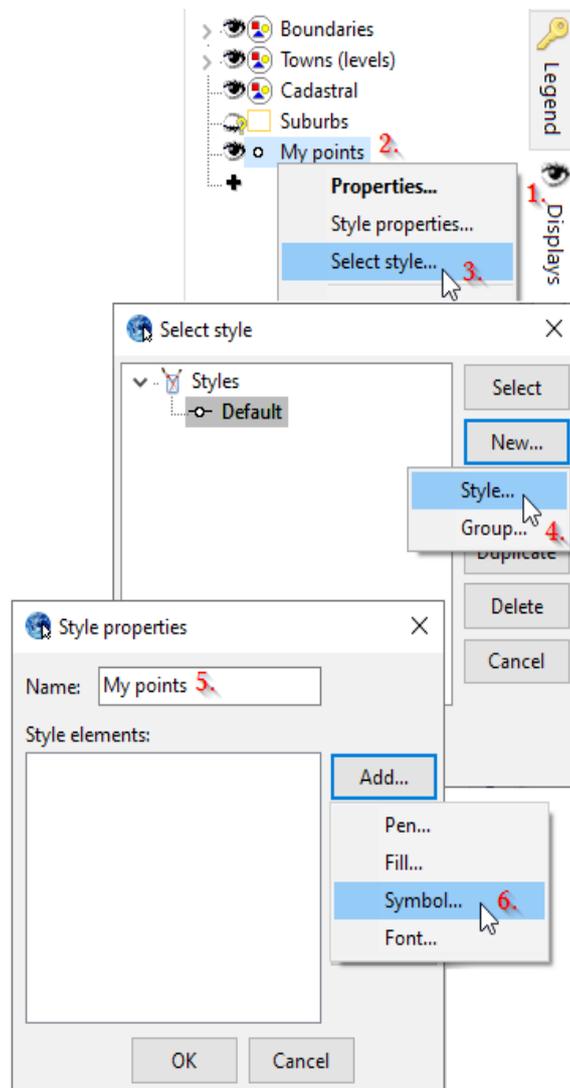


Figure 54: Creating and selecting a new style

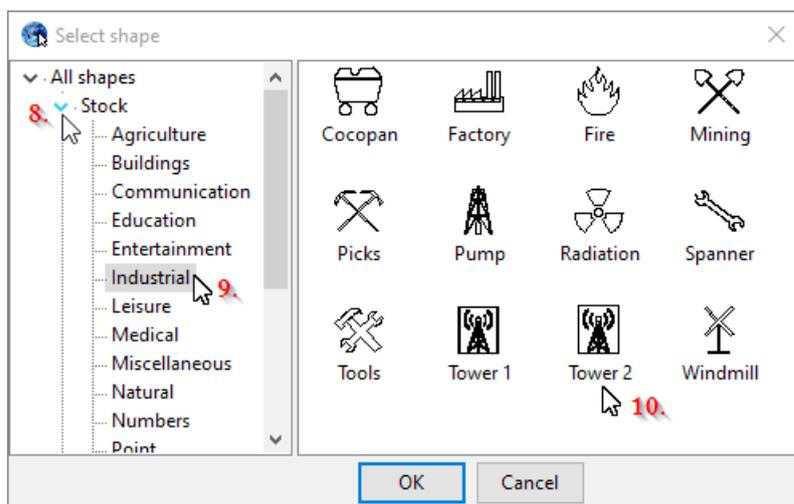


Figure 55: Selecting a shape for a symbol

To conclude this exercise, we will label the captured points.

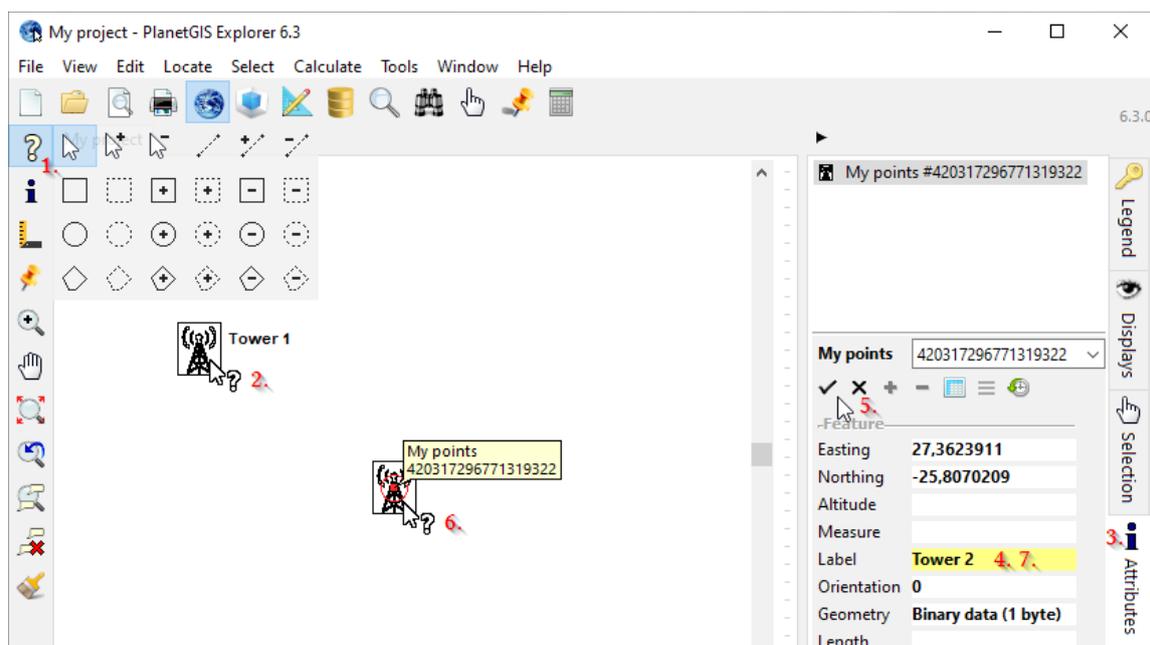


Figure 56: Labelling points

1. Change the click mode to **Tag**.
2. Select a point by clicking on it.
3. Activate the **Attributes** tab.
4. Enter a label for the point, e.g. “Tower 1”.
5. Save the change by clicking on the **Save** button or pressing <Enter>.
6. Select the next point.
7. Enter another label and press <Enter> to save.

Capturing Lines

Repeat the steps above to capture and create a new feature class which allows lines¹ instead of points (**Edit**→**Capture**→**New**→**Feature class...**). Call the new feature class something like “My lines” and make sure to check the “Lines” check box. Click the “Create” and “Select” buttons to start capturing. Notice that the click mode has changed to “Capture” automatically. You can activate the **Coordinates** tab on the right to see your captured coordinates.

Now follow these steps:

1. Click somewhere away from the points to capture the first coordinate of a line.
2. Move the mouse cursor close to the centre of one of the points. Notice how the location “snaps” to the point when the mouse is close enough. Move the mouse around a bit to see the “snapping” at work similar to a sticky spot.
3. Click to capture the second coordinate exactly at the centre of the point.
4. Repeat for second point. In a GIS it is very important to capture coordinates that are supposed to be coincident with other coordinates carefully so that are “snapped” to be coincident.
5. Move the mouse away and right-click.

¹ Strictly speaking, a line could be a line segment (exactly two vertices/coordinates) or a polyline (many vertices/coordinates). In PlanetGIS we use the term “line” as a shortening for “polyline”.

6. Select **End**. (A quicker way if you don't want to see the menu is to press <Enter>).

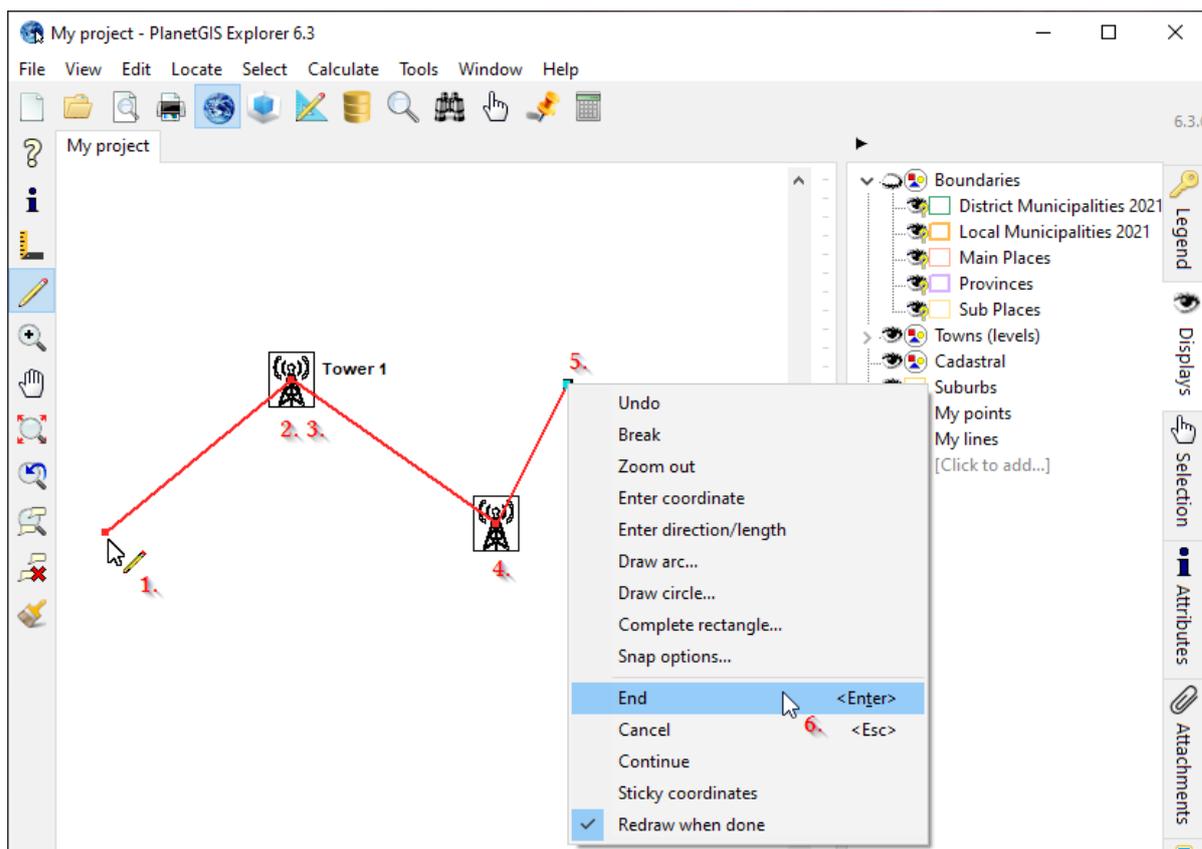


Figure 57: Capturing a line

Note that if you wanted to retain the coordinate at (5) you would have to have first left-clicked to capture the coordinate.

To remove the last captured coordinate, right-click and click **Undo**. To cancel capturing the feature, right-click and click **Cancel** or press <Esc>.

Lines with breaks

Lines may have multiple parts, i.e. lines can have “gaps”. To end a line part, right-click and click **Break**. Click again to start the next part of the line.

Using distance and direction to determine subsequent coordinates

Quite often, the relative distance and direction between coordinates is known instead of the coordinates themselves. Right-click while capturing and click **Enter direction/length**.

It is sometimes useful to move the mouse in the general direction of the anticipated next coordinate. The current distance and direction will be displayed in the window, which can then be rounded or made accurate.

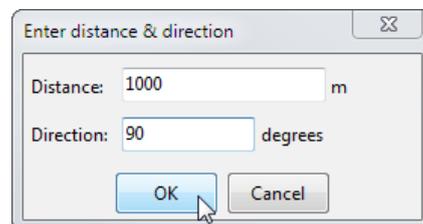


Figure 58: Capturing by specifying distance and direction

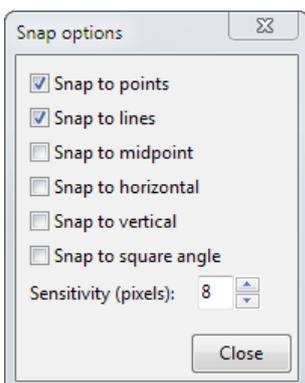


Figure 59: Snap options

Snap options

Snap options control the exact position of a captured coordinate which may be up to a certain amount of pixels away from the mouse cursor location. This is called “Snap sensitivity”.

When capturing features by tracing them on an underlying orthophoto, one often doesn't want to have other features interfere with the capturing, i.e. you might want to turn snapping off. In other instances you may want to snap to points (vertices/coordinates) but not the line segments connecting them.

Capturing Polygons

Polygons are similar to lines except that they are always closed. Polygons can have multiple “outer rings” and each outer ring may have any number of “interior rings” which form holes or islands. Click **Break** in the capture menu to start a new ring. If you are capturing a hole, be sure to reverse the direction, i.e. if the outer ring was captured clockwise, capture all holes/islands counter-clockwise.

Polygon orientation

PlanetGIS allows polygons in any orientation, but the standard in GIS is to have outer rings in counter-clockwise order and inner rings in clockwise order. An observer walking around a polygon in the same order of the coordinates will have “surface” / fill on the left hand side and either nothing or hole / island on the right hand side. It is a good habit to be consistent with this convention.

Capturing rectangles or shapes with right angles

Planet is often used to capture the footprint of buildings (or “rooftops”). To speed up the process Planet has two very useful functions.

1. **Complete rectangle.** Capture one side and position the mouse over the next corner, then right-click and select “Complete rectangle”. Don't left-click on the third corner because the angle will not be guaranteed to be 90 degrees unless you use the following. The mouse position tells Planet the length of the second edge and Planet will place the third corner so that interior angles are 90 degrees.
2. **Snap to right angle.** This snap option will steer a captured coordinate to a location which will form a right angle with the previous segment. You may want to increase the snap sensitivity for this.

Capturing circles

To capture a circle, start by indicating the centre point and move the mouse to the edge of the circle, but don't left-click. Now right-click and click “Draw circle...”. The radius as indicated by the mouse and central coordinate will be displayed in the **Draw circle** window. You can supply an exact radius and change the central coordinate. The circle will be approximated by many line segments. The default number of segments (“steps”) is 32. Click OK to finish capturing a circle.

Capturing Raster Images

“Raster” means a matrix or grid of values or colours. Raster images in GIS are typically satellite or aerial photographs, but could also be scanned drawings or maps. Most raster images will already be “georeferenced” meaning the location on earth is known, but they need to be captured in Planet similar to other types of features.

Planet supports the following types of images directly:

- MrSID (*.sid)
- Enhanced Compressed Wavelets (*.ecw)

and will create compressed and indexed images (*.ijp) from:

- Windows Bitmaps (*.bmp)
- JPEGs (*.jpg, *.jpeg)
- TIFF and GeoTIFF (*.tif, *.tiff)
- Portable Network Graphics (*.png)

MrSID, ECW and GeoTIFF images have their geo-location encoded within the image file. Most images are accompanied by an additional small text file, called a “world file”. Planet will recognise the world file, but if location information is embedded in the image file, the world file option will not be selected automatically.

To capture a raster image, click **Edit** → **Capture**. Create a new feature class and select only “Raster” for the allowed types. Then click **Select**.

In the “Insert image” window, click Browse and select one or more images. (Please note that you can insert all your images in one step. Ctrl+A is an easy way to select all images in a folder or use the search function to list all images in all subfolders).

World files

World files describe the position, orientation and pixel size of images so that they can be accurately placed on a map. These files have the same name as the image file that they describe, but the extension is formed by taking the first and last letter from the image file's extension and adding a “w”. The world file for Image001.JPG will therefore be Image001.JGW.

Planet will automatically place an image in its correct location based on an accompanying world file or encoded location information. In the absence of this information, you have the option to indicate a diagonal line on the map or enter coordinates.

Specifying coordinates or indicating corners on your map

If you have coordinates for a diagonal (two corners separated diagonally), you can enter them manually by selecting “Specify coordinates”. If there is no geo-location information available, your only option is to indicate a diagonal line on the map. This will normally be a rough estimation, but you will be able to improve the location afterwards.

Once your image is captured and appears on your map, you may want to improve locational accuracy by indicating a shift (translation) as well as a stretch (scale). These functions are under the **Edit** menu: **Translate** and **Scale**. Planet cannot yet do rotations and other transformations on raster images.

Labelling Features

We labelled a feature during the exercise on page 61. Every feature has a special attribute called “Label” which you can edit in the Attributes tab. As soon as you enter a value for this attribute and save the change, you will see the feature labelled on the map. If you don't see a label the style used for rendering the feature does not include a font, or the label may have been dropped due to congestion on the map.

It is often useful to limit the scales at which features are labelled, and sometimes at different scales than other drawing elements. You might want to show the outlines (pen) of an administrative boundary to switch on at a certain scale, but only display the label (font) at a bigger scale (zoomed in closer) to reduce clutter of text on your map. Another example would be to switch off the labels when zoomed in too much, e.g. you don't necessarily need to see the name of a country at a scale of 1:5000. Figure 13 on page 25 shows a font with limits on both minimum and maximum scale.

Fixed vs automatic labelling

The default labelling method of PlanetGIS is to distribute labels as evenly as possible while maintaining an obvious association between a feature and its label and omitting labels that will appear ambiguous. In some cases this is not ideal. Property boundaries, for example, are better labelled at their centroid.

Figure 60 shows “Erven” set to display labels at the centroid of each polygon. Lines will be labelled at a point **on** the line that is exactly in the middle, measure **along** the line.

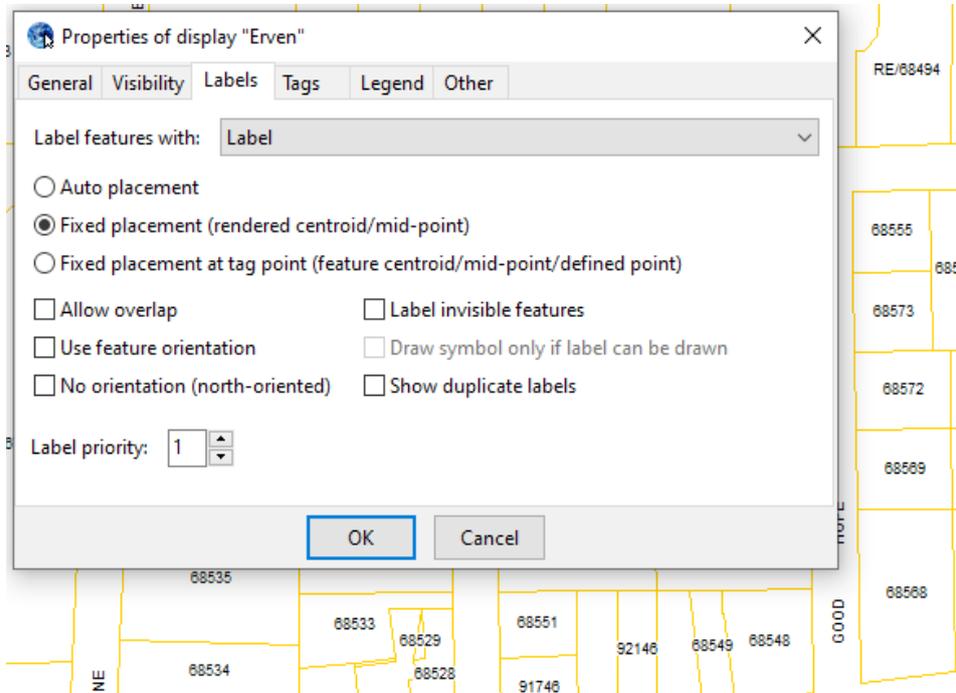


Figure 60: Label options for a display

Placing static text on the map

Text is not a GIS “primitive” element (or in other words, a feature type). Some systems allow text, calling them “annotations”. In PlanetGIS², static text can be placed on a map by labelling a point, but providing the display a style without a symbol and setting the “fixed placement” option. The alignment of the font in use by the style will determine the relative position of the text to the (invisible) point.

The “Orientation” attribute (an attribute immediately following “Label”) is used to determine the rotation of the text. 0° means “upright” text, or in other words the vertical axis of a letter points North. An orientation of 90° will have the vertical axis of a letter point East. The degrees used for label orientation are geographic (compass) degrees, regardless of the coordinate system settings, and refer to the vertical axis of the letters.

Purely static text will also have the “Allow overlap” option set. This way you will be guaranteed to see the text. This is obviously not what you want, in most cases, when producing output maps.

Labelling from a database

Text from another attribute or detail table can also be used to label features. Select the source in the drop-down box in the Label tab of Display properties. (See Figure 60). The disadvantages to this approach is that it can be slow to display a map for the first time. Planet needs to load all the labels into memory (and keep it there) before the rendering of a map can be completed.

² In PlanetGIS 3 and earlier, there was a feature type for text. Since version 4 the type of such feature classes is automatically changed to point.

Another disadvantage is that when changes occur in the database, Planet may not be aware of it, so labels need to be reloaded from the database. Re-opening the map will accomplish this, or pressing <Ctrl+F5> or holding <Ctrl> while clicking on the Redraw button.

Chapter 8

GOOGLE EARTH

Introduction

Google Earth is a very popular application that allows one to view satellite and orthophoto images from anywhere in the World. The ability to capture ones own points, lines and polygons with Google Earth makes it an ideal tool to do GIS-like work with it. Google Earth is very “consumer oriented” and uses different terms for certain things than what a GIS professional will use. A point, for example is called a “place mark” and a line/polyline a “path” in GE.

To download Google Earth, go to this page: <http://www.google.com/earth/download/gep/agree.html> and use “GEPFREE” as the license key when installing. This link is for Google Earth Pro, which has some advanced features over regular Google Earth.¹

The KML / KMZ standard

Google introduced a new text-based (XML) format for exchanging geographic information. The file format is large (being human readable), cumbersome and somewhat un-GIS-like. However it has become very popular and works well with Google Earth as long as feature count is limited to at most a few thousand. Depending on your industry, you may be encountering KML files more often than shapefiles.

KML files are used to exchange features between Google Earth and Planet GIS. KMZ files are simply zipped versions of KML files. To view the content of a KMZ file, rename it to a .ZIP and unzip. (The zip will contain a file called “doc.kml” which can be opened with Notepad).

Troubleshooting Google Earth

All interaction with GE is through KML files. There is no intra-program communication. To launch GE with a KML file, Planet simply asks Windows to open the KML file with the appropriate program. This means two things:

1. Google Earth must be installed correctly.
2. KML files must be associated with Google Earth.

Sometimes the Windows association between KML files are broken by other applications or manually. A re-installation of GE should fix the problem, alternatively you can check and repair the file association by right-clicking on a .KML/.KMZ file in Windows' File Explorer, then click **Open with...** (If you don't have a .KML/.KMZ, use Planet to create one by exporting a feature: see “Exporting KML” in next section).

If you need to browse for the executable, Google Earth Pro is at C:\Program Files (x86)\Google\Google Earth Pro\client\googleearth.exe

Make sure you check “Always use the selected program to open this kind of file”.

You may have to repeat this process with a .KMZ file after doing it with a .KML file.

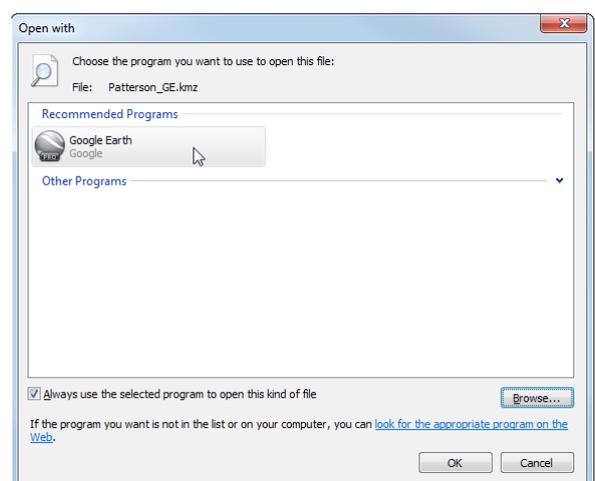


Figure 61: Checking and repairing KML file association

¹ Since January 2015, Google Earth Pro is free: <http://google-latlong.blogspot.com/2015/01/google-earth-pro-is-now-free.html>

Another form of troubleshooting is to inspect the KML files that Planet produces. When not explicitly exporting to a KML/KMZ file (i.e. View→In Google Earth→...), Planet creates .KML files in your system's %TEMP% folder. To see where your temporary folder is, simply type %temp% in the “address bar” of Windows' File Explorer. The files that Planet created will look like planetxxxx.kml. Sort by “Date modified” (descending) to easily spot them at the top of the list. If you now double-click on one of the .KML files, that is the same as what Planet does to launch GE. (Or right-click and Open with... to check the association).

Interacting with Google Earth

PlanetGIS has several useful ways to interact with Google Earth (“GE”). The following main menu commands will take you directly to GE:

- **View→In Google Earth→Current location**
Zoom to same location and approximate scale.
- **View→In Google Earth→Tags as placemarks**
Current tags on the map are created as place marks (points).
- **View→In Google Earth→Selected features**
Selected features are exported to GE and displayed as an overlay.

Exporting KML

- **File→Export...**
Create .KML or .KMZ files that can be used with GE.

As with other export formats, the File→Export menu item allows the creation of KML/KMZ files with an options window. This option can be used either with one or more features selected, or if none are selected, you will be prompted to select one or more feature classes. First you need to enter a name for the exported file and select “Google Earth KML (*.kml)” or “Google Earth compressed KMZ (*.kmz)” in the “Save as type” drop-down list. You will then be presented with the following options window:

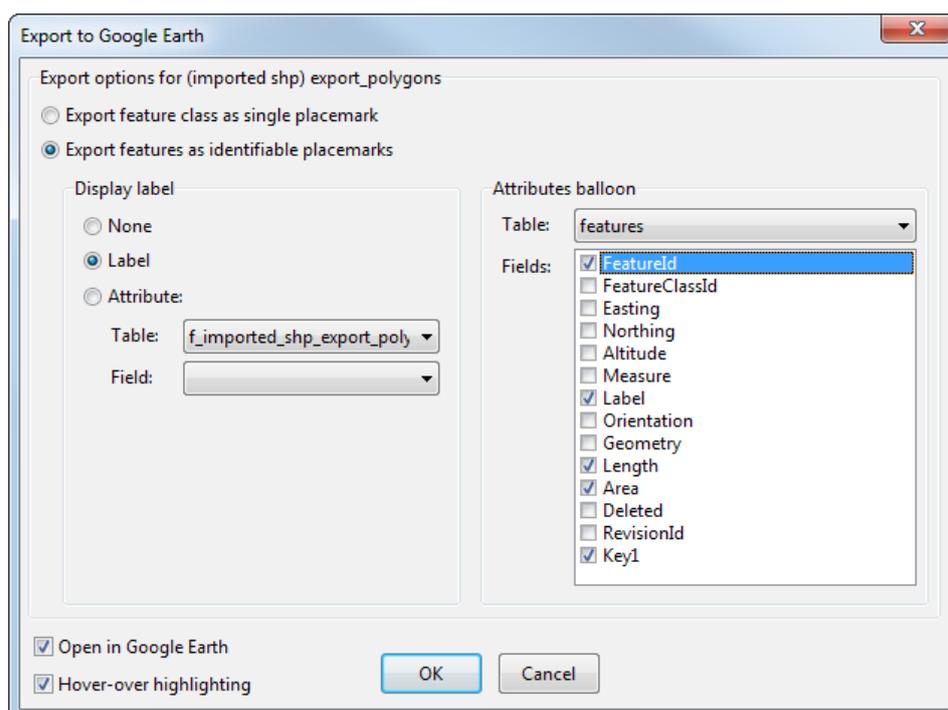


Figure 62: Google Earth export options

- **Export feature class as single placemark**

This is the best way to show lots of features (many hundreds or thousands) on Google Earth without slowing or crashing it. Features will not be individually identifiable (clickable). This is the first option but not the default option. The default option is second because it is related to the options further down, which are not available for the first option.

- **Export features as identifiable placemarks**

Each feature will have it's own label and if you click on one, information about that feature will be shown in an "attribute balloon".

- **Display label**

By default, the same label displayed in Planet will be displayed in GE. You can also choose "None" or a field from an attribute or detail table.

- **Attributes balloon**

Select one or more fields from an attribute or detail table to display in the attribute balloon. See Figure 63.

- **Open in Google Earth**

If checked, the KML file (GE) will be automatically launched.

- **Hover-over highlighting**

This creates a GE style that shows each feature with a slight fill when the mouse is over it. While useful it may be undesirable.

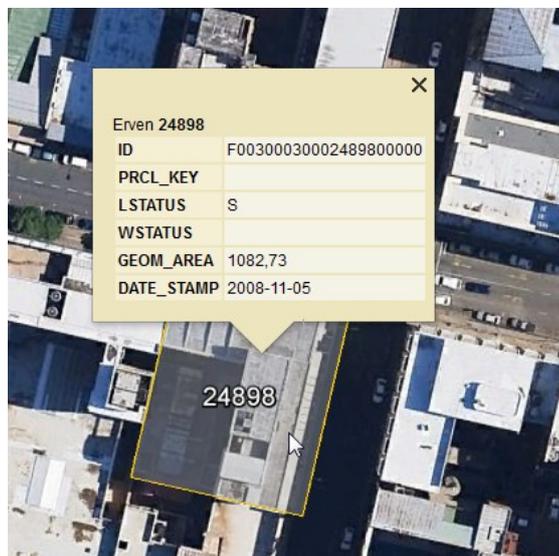


Figure 63: An attributes balloon in Google Earth

Importing KML

If you have features in Google Earth (vector objects as opposed to images; see next section for images), they can be exported to KML and then imported into PlanetGIS. Once you close Google Earth, everything inside "My Places" is saved on your computer but in a location not so easy to find². Since this is all in one file, and you have to close GE to save to that file, a better option is to right-click on the folder inside "My Places" (or "Temporary Places") in the "Places" tree and then click "Save place as" (Figure 64).

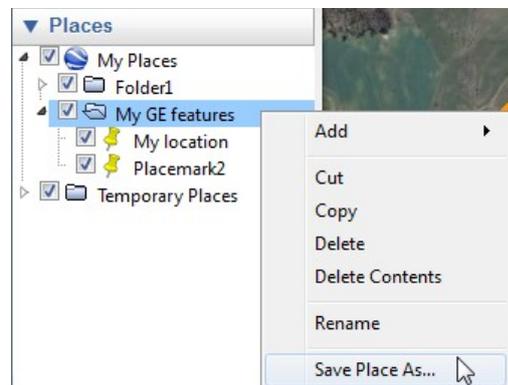


Figure 64: Saving a folder of features in Google Earth

Choose a location that is easy to find from PlanetGIS and then switch to PlanetGIS and click **File**→**Import** to import the KML/KMZ.

Capturing features in Google Earth

You capture features in Google Earth using the "Add Placemark", "Add Polygon" or "Add Path" buttons:



First it is a good idea to create your own "folder" for your features. Give it a name, for example, of "My GE features". If you want to capture features within feature classes, you need to create another level "folder" for each feature class.

² The file containing everything in "My Places" is usually C:\Users\yourname\AppData\LocalLow\Google\GoogleEarth\myplaces.kml

Then right-click on the new folder and click **Add**→**Placemark** (if you want to capture a point). Give the placemark/polygon/path a name and remember to move the placemark or finish capturing the polygon/path before closing the properties window.

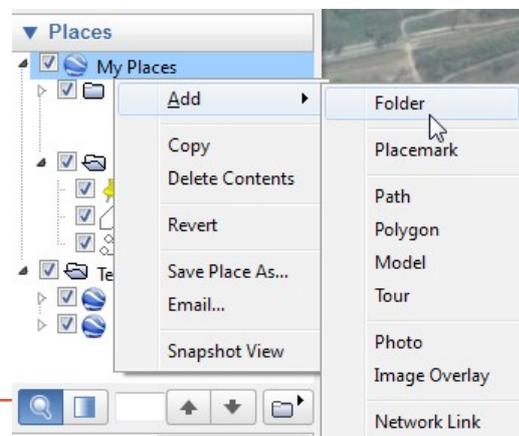


Figure 65: Create a folder under My Places in Google Earth

Using Images from Google Earth

Google Earth Pro allows for images to be saved at resolutions up to about 4800x3600. These images can then be captured in PlanetGIS. If your accuracy requirements are high, you should use georeferenced orthorectified images instead.

Setting up Google Earth Pro for saving images

1. Click **File** → **Save** → **Save Image** (or Ctrl+Alt+S). This will only activate the user interface that allows you to save images.
2. Uncheck everything in the “Map Options” drop-down list.
3. Choose the highest or preferred resolution in the “Resolution” drop-down list.
4. Navigating on Google Earth with the mouse will cause GE to tilt the image so that the focus of your view is not vertical. This can be disabled by clicking **Tools** → **Options...** and in the “Navigation” tab, choose “Do not automatically tilt while zooming”. Also increase the zoom speed in this tab.
5. Press “R” to reset the tilt (if any) and make sure North is up.
6. Switch off all layers (bottom-left, under “Places”). You can uncheck everything by unchecking “Primary Database”. It is especially important to have “Terrain” unchecked since the shape of the surface will affect the polygons you will be capturing in the steps below.

Steps to perform a “Google Grab”

Google Earth does not produce georeferenced images. You therefore have to position the images saved from GE yourself. Experience has shown the following steps to be the most efficient:

1. In PlanetGIS, choose a viewing area for which a single image from Google Earth will be appropriate.
2. Click **View** → In **Google Earth** → **Current location**.
3. (Optional) It is advisable to maximize the GE window and keep the map area the same from this point on.
4. Capture a polygon to indicate the extents of the visible image:
 1. Click the “Add Polygon” button (next to “Add Placemark”).
 2. Do not close the “New polygon” window as that will end the capture process. Position it so that it will be in the middle of your screen (all corners of the map visible). It is not necessary to give the polygon a name, but it is best to give it the name of the files you will be saving in the next steps, eg. “GE1”.
 3. Click once in each corner of the screen. Don't try to get too close to the corner, the accuracy of the polygon will be increased in the next step.

4. Click on each of the 4 vertices and drag them into the corners. If something goes wrong with this process, cancel the polygon and start over.
 5. Click OK in the “New polygon” window.
 6. You will see the polygon appear in “Places” on the left. Right-click on it and click **Save Place As...**
 7. Save the polygon as a KMZ or KML in your working folder. Give it a name that you can easily identify, eg. GE1.kmz
 8. Uncheck the polygon in Places so that it disappears from the map.
5. Click the “Save Image...” button at the top of the map and save the image with the same name as the polygon (eg. GE1.jpg) in your working folder. This will take a short while.
 6. Switch to PlanetGIS.
 7. Import the .kmz/.kml file of the polygon you saved from GE: **File** → **Import** and select the .kml/.kmz you saved. You will now see something approximating a rectangle on your map. Because of coordinate system transformations and the 3D surface shape in GE, one diagonal (e.g. top-left to bottom-right) may be more accurate than the other (e.g. bottom-left to top-right). If you are inserting multiple images, trial-and-error will provide the answer.
 8. Capture the .jpg image saved from GE: **Edit** → **Capture** and create a feature class for your GE images if you don't have one already, otherwise select it. This feature class must have only “Raster” selected for the allowed types.
 9. Browse to your GE image (e.g. GE1.jpg) and choose “Indicate on map”. Click OK.
 10. Now indicate a diagonal line by clicking on one corner of the imported polygon and then a diagonally opposite corner. Redraw or zoom out if you don't see the image.

Additional steps to improve positional accuracy

1. Find a location on the Google Earth image where a (required) shift is apparent compared to other existing features (e.g. cadastral boundaries not aligning with visible roads/fences). This should be either an obvious point feature or a bend (vertex) on a line/polygon.
2. Make sure the GE image is selected (and nothing else). Click on it and select the GE feature class in the Attributes tab if necessary.
3. Click **Edit** → **Translate** and keep the default “Capture translation vector” option.
4. Click on a point on the GE image that needs to be moved to an existing feature, then click on the point to which it should be moved.
5. This specific point will now be considered accurate (repeat from step 1 if not). Further steps will investigate whether a stretch (scale) will be necessary. You will have to come back to this point to indicate it as “fixed” if that is the case.
6. To determine if the image also needs to be stretched (scaled), find a location as far away as possible from the point you have been focusing on where a (required) shift is apparent. This location needs to be diagonally separated, i.e. both along the North-South axis and the East-West axis. Failing this, small errors may result in large errors overall. If you don't see any obvious discrepancies, skip the following steps.

7. If you have identified a location, diagonally separated as far as possible from the initial location, that can be improved by an obvious shift to an existing feature, take careful note of it so that you can locate it after going back to the initial point. Tip: use saved locations if these locations are hard to recognise visually.
8. Again make sure only the GE image is selected and then click **Edit** → **Scale**. Keep the default “Indicate” options for both the fixed point and the scale factor.
9. Navigate to the initial point and click on it to capture the fixed point.
10. Navigate to the second point and click once on the location that needs to be relocated, then on the target location.
11. Review the overall quality of positional accuracy and repeat from either step 1 or step 6 if necessary. Do not expect a high degree of accuracy with this method, though.

Chapter 9

CLASSES & ATTRIBUTES

Introduction

“Attribute” is a GIS term for an item of information about a feature or a value describing some characteristic of a feature. In a relational database, information is stored in “tables”. Each table consists of rows and columns also sometimes called records and fields¹. Each row (or record) contains information for a specific feature. The row must contain a FeatureId or other key field that identifies the row as information for a specific feature.

Each database table typically has a different set of columns (with different names and data types). This is also called the “structure” of the table. One of the main reasons for having different feature classes is to have different tables with different structures assigned to the feature classes, in order to store information that is appropriate to each feature class.

Classes

PlanetGIS uses a much broader system of “classes” which is similar to the concept of classes from Object Oriented Programming (OOP). OOP is the dominant style of modern programming languages (examples include C++, C#, Java and many others). The concept of a “class” here, in addition to simple classification of data objects, includes “inheritance” where a “sub-class” *inherits* (also often known as *extends*) the data definitions (attributes) from higher level classes.

In addition to *Feature classes*, PlanetGIS also has *Component classes*, *Action classes*, *Table classes* and *Attachment classes*. These can be considered “root classes” which all other classes *extend* by adding attributes that are appropriate for entities that are classified into those classes. In Planet, these are referred to as “class types” since the actual root of all classes is a class called “Entities”.

An “object” in OOP is the instance of a class, or in other words a set of data values describing some identifiable entity according to the specification of the class. An object, or rather the values describing the object is stored as a row in a table or multiple tables. Recall that we are using computer models to describe real-world objects or concepts (Chapter 1). The computer model or “data object” is called an “entity” in PlanetGIS.

Entities

An *entity* is a data object that can be identified by a unique number (EntityId) and is classified into a *sub-class* of one of the 5 “root classes” (class types):

- **Feature.** An entity with a location or *geometry*.
- **Component.** An entity without location (or perhaps its location is deemed to not be worthwhile to be determined or stored in the context of the project).
- **Action.** An entity that describes an event, for example an inspection.
- **Attachment.** Data objects used to describe or document other entities, for example photographs.
- **Row.** Additional data objects in tabular format, such that each “row” is an entity.

All entities have the following information stored in the database:

- **EntityId.** A number that uniquely identifies an entity.
- **ClassId.** A number specifying the class of an entity.

¹ A “field”, more accurately, is the space provided to display or enter a value, for example in a form.

- **ParentId.** The EntityId of another entity that encapsulates or owns an entity, at least for purposes of data organization.
- **Key.** An additional means of identifying an entity.
- **Track.** An additional means of partitioning entities of the same class, mostly used to indicate deleted entities, or private or work-in-progress entities.
- **UserId.** Identifies the last user to make changes to an entity.
- **Timestamp.** The date and time of the last change made to an entity.
- **Attributes.** All other values needed to describe an entity, as specified by its class.

Every object (set of values, each describing a different characteristic/property) in PlanetGIS is an entity. Classes are also entities and so are styles, displays, views, etc. though these are referred to as “schema objects” with the main distinction that they belong to predetermined classes and have no user-definable attributes. Like any object, they do have values that describe characteristics (also called “members” in OOP) but since these values are fixed (hard-coded in the software) we will refer to them as properties, not attributes.

Attributes

The term “attribute” is used in two contexts:

1. First as described above, an item of information corresponding to a field in a form or a cell in a table/spreadsheet;
2. Second as the definition of data items that apply to all entities of a particular class – the names and types of data items that *can* be stored for entities belonging to a class.

When not referring to an actual piece of information, a value stored to describe some characteristic of an entity, “attribute” needs to be understood as a definition or description of the data item, not the data values. Put differently, an entity has a set of attributes (values stored in the database) and a class has a set of attributes (definitions of what *can* be stored in the database). In order to avoid ambiguity, this guide will use “attribute definition” to clearly indicate that the second context of the term applies.

Each class has a set of *attribute definitions* that are appropriate for entities placed/classified into such class **or any sub-class**. Care must be taken to define attributes at the appropriate level in the class hierarchy so that sub-classes do not contain the same attribute definitions as other sub-classes belonging to the same super-class, which in this guide will be called a *parent class*. An entity placed into a class will have the storage space (in the database) and input fields (on screen) as defined by the attributes of its assigned class and **all parent classes**, but not any sub-class (*child class*) of the class to which the entity has been assigned.

Attribute definitions

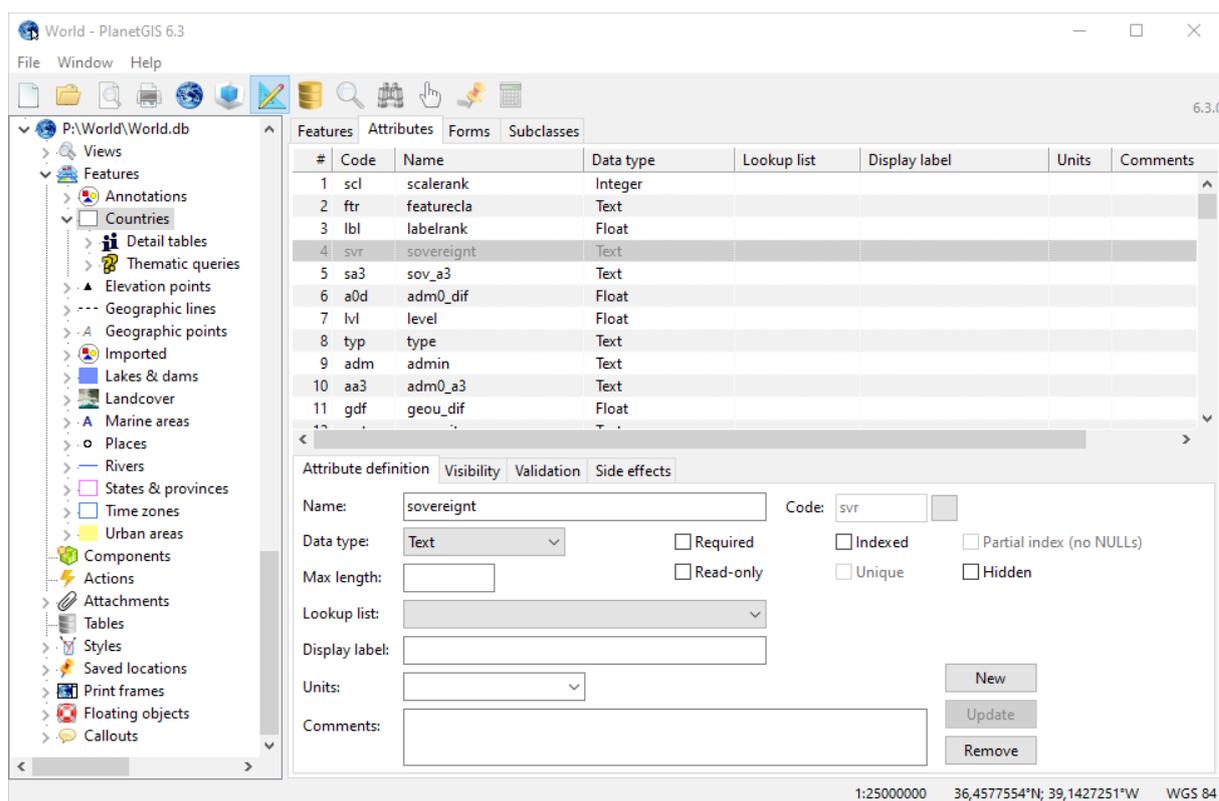


Figure 66: Attributes of feature class "Countries"

Attribute definitions are managed by selecting a class in **Design mode** (🖋️) and activating the **Attributes** tab. Click on an existing attribute to view or modify it or click the **New** button to start specifying a new attribute.

Attribute name

An attribute's name corresponds to the name of the column of the table in which the attribute's values are stored. The name may contain spaces, although most database administrators prefer underscores (_). Avoid special characters, especially the period (.). Commas (,) ampersands (&) and most special characters are allowed, but they make it more difficult to export information to other database systems. Keep attribute names as short as possible while trying to make the purpose of the attribute as clear as possible. There is no limit to the length of an attribute's name.

Data type

The data type of an attribute is a combination of an instruction on how to store values and how to display values or validate entered values. Internally, values are stored using only 4 storage classes (INTEGER, FLOAT, TEXT or BLOB)².

- **Integer** – whole numbers; signed 64 bit integer with a range of $-9,223,372,036,854,775,808$ to $+9,223,372,036,854,775,807$.
- **Float** – floating point numbers; IEEE 754 64 bit double precision with a range of 10^{-308} to 10^{308} , with 15 decimal digits precision.
- **Text** – Character string of unlimited length; UTF-8.
- **BLOB** – Binary Large Object of unlimited size.

2 Actually a fifth storage class, NUMERIC, will store numbers without fractions as Integers, otherwise Float and NULL values are technically a separate storage class. All the date types use NUMERIC.

- **Boolean** – True or False stored as 1 or 0.
- **DateTime** – Date and time stored internally as a floating point Julian Day number³.
- **Date** – Date stored internally as an integer Julian Day number.
- **Time** – Time of day or fractional number of days, stored as a floating point number where 1 means 24 hours.
- **UnixDate** – Date and time stored as the number of seconds elapsed since the start of the “Unix Epoch” – 1970/01/01 00:00:00. Normally stored as an Integer, but times containing fractional seconds will be stored as a floating point number.
- **UnixTime** – Same as UnixDate except meant to display either time only or a span of time in days, hours, minutes and seconds.
- **Any** – Data is stored and displayed as-is: Integer if possible, Float if fractional number, Text otherwise.

Required fields & NULL values

PlanetGIS will refuse to store a set of attributes (e.g. a form or the content of the Attributes tab) if one or more attributes have the “Required” option set and no value was entered by the user.

At the database level, such columns will have what is known as a “NOT NULL constraint”, but PlanetGIS uses the required flag to validate input fields before sending values to the database to avoid a database error message due to a violation of a NOT NULL constraint. It is also possible to have the “required” flag set on attributes which use columns without such constraint.

Contrary to standard database theory where NULL means “unknown”, Planet takes a more practical approach and stores all “blank” values as NULLs. (At the database level empty text is a known value and therefore not a NULL, but it is impractical and non-intuitive for most users to make a visual distinction on a computer screen between empty/blank text and a NULL value. Furthermore “required” in Planet means blank text is not acceptable while blank text (empty string or ‘’) does satisfy a NOT NULL constraint in the database).

Maximum length

The database engine used by PlanetGIS (SQLite) does not have the concept of a maximum length for data values. The “Max length” specification for attributes will be used to limit the length of text when a user enters values but is irrelevant at the database level, for example when data is imported from other systems.

Lookup list

Each attribute can have a lookup list to aid in selecting values from a “pick list” or limit the possible values that can be entered. More on lookup lists later in this chapter.

Display label

While it is preferable to keep attribute (and therefore column) names as short as possible⁴, it may be necessary to provide a longer label for an attribute in an input form in order to clearly state the attribute’s purpose. The Display label – if present – overrides the name of an attribute in situations where space is available.

3 A Julian Day number is the number of days since noon in Greenwich on November 24, 4714 B.C. according to the proleptic Gregorian calendar. The fractional part determines the time, 0 being noon and +0.5 midnight.

4 For the sake of those who need to type out the names in SQL scripts when doing data analysis or manipulation.

Units

Units can be defined separately from a display label so that they may be appended to values in a report or appended to a display label or attribute name as appropriate for the situation.

Comments

Comments are notes about the use, meaning or purpose of an attribute and is intended only for persons working with the structure/design of the database.

The Attributes tab

To see the attributes of a feature, activate **Tag mode** (?) and click on a feature. Using the World Map, click on Cape Town and expand the **Attributes tab** by clicking on it. Figure 67 shows the Attributes tab with the Cape Town “Places” feature selected.

The top part of the Attributes tab shows the feature class (“Places”) that has been tagged on the map and also feature classes of underlying features which you may have intended to select. To view attributes of the country instead, click on “Countries”.

Next is the FeatureId. If more than one feature has been selected, the drop-down list needs to be used to see the attributes of individual features.

Next is a tool bar with buttons to save changes, cancel changes, “tabular view” and other tools.

The rest of the Attributes tab shows all attributes of the selected feature. You can change any value by clicking in the white box and typing a value.

Tip: To extract the attributes for use in another application, click “Tabular view” in the toolbar; then right-click on the data sheet and click “All rows” followed by “Copy to clipboard” or “Open as spreadsheet”.

Note also the “Information” nodes at the top. These are **detail tables** set up to take you to Wikipedia for more information. Click on the hyper-linked attribute name to go to Wikipedia.

Common attributes of features

Now use the scrollbar to scroll to the bottom-most attribute. The last 10 attributes are common to all features (i.e. they belong to the root feature class). These are:

- **Easting, Northing, Altitude**
Coordinate of point, centroid of line or polygon.
- **Measure**
Any numerical measurement associated with the feature.
- **Label**
Text to display on the map.
- **Orientation**
Point features can have an orientation: 0 degrees is North, 90° is East.

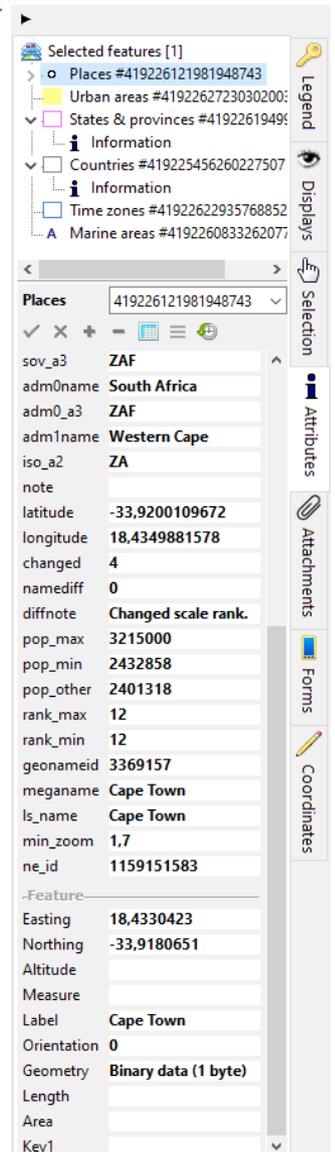


Figure 67: Attributes

- **Geometry**
This is a BLOB (Binary Large Object) field containing the geometry (all coordinates) of the feature.
- **Length**
Length of a line feature; perimeter of a polygon in coordinate system units (usually metres).
- **Area**
Surface area of polygon in square coordinate system units (usually sqm).
- **Key1**
User defined identifier for the feature, can be a number or text. (More keys may be added if needed).

Multiple selections

To clear your selection, click **Clear tags** (🗑️), second last button on the left).

Check that you are still in **Tag mode** and note the hint at the bottom of the screen when the mouse cursor is over the map. The hint instructs, among other things “Ctrl+click multi-selects”. If you hold down the [Ctrl] button you will also see that the mouse cursor changes to include a plus (+) sign. Now click on Saldanha, Vanhynsdorp and Springbok while keeping the [Ctrl] button pressed. (You may have to zoom in to the west coast if they are not visible).

Figure 68 shows the multiple selection. Note the correspondence between the FeatureIds in the yellow tags on the map and the FeatureIds in the drop-down list in the Attributes tab.

Notice how some attributes appear with a black font and some with a grey font. Attribute values appearing in black are the same for all selected features, while attribute values appearing in grey are different.

Select a FeatureId in the drop-down list to see the attributes of only one feature. (All attributes will appear black). Now change any attribute, e.g. “scalerank” to a different value. The field area will turn yellow to alert you that the value has changed and needs to be saved. The **Post changes** button (check mark button in the toolbar) will save the change(s) to the database.

Multi-feature attribute capture

A very useful function of Planet is to capture the same attribute for multiple features simultaneously.

Select “All records” again for the FeatureId and change any value. The field area will now turn red, alerting you that multiple records will be updated in the database if you save the changes.

Clicking on any of the grey values will assume that value for all features (unless you change it). This is most useful when you have one feature with data and then select other features with no data, but you know that certain attributes are the same. A single click on all attribute values that must be the same for all selected features (and the Save button) and you have captured data for all selected features without attributes.

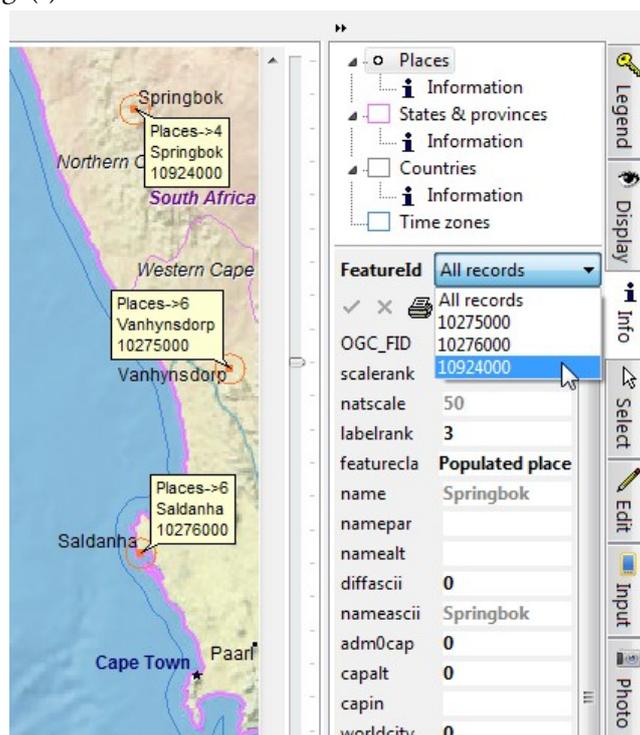


Figure 68: Multiple selection

Only changes are posted to the database. Attribute fields coloured yellow or red will be updated in the database. Fields with a white background will remain untouched.

Lookup lists

Lookup lists (often called “lookup tables”) are used to pick values from a list instead of entering them by hand. Lookup lists can reduce input errors and restrict input values to a predefined set. To define your own lookup lists, activate the **Database Manager** (🗄️) and select the database connection of your project. For a database connection, the first tab will be “Lookup lists”.

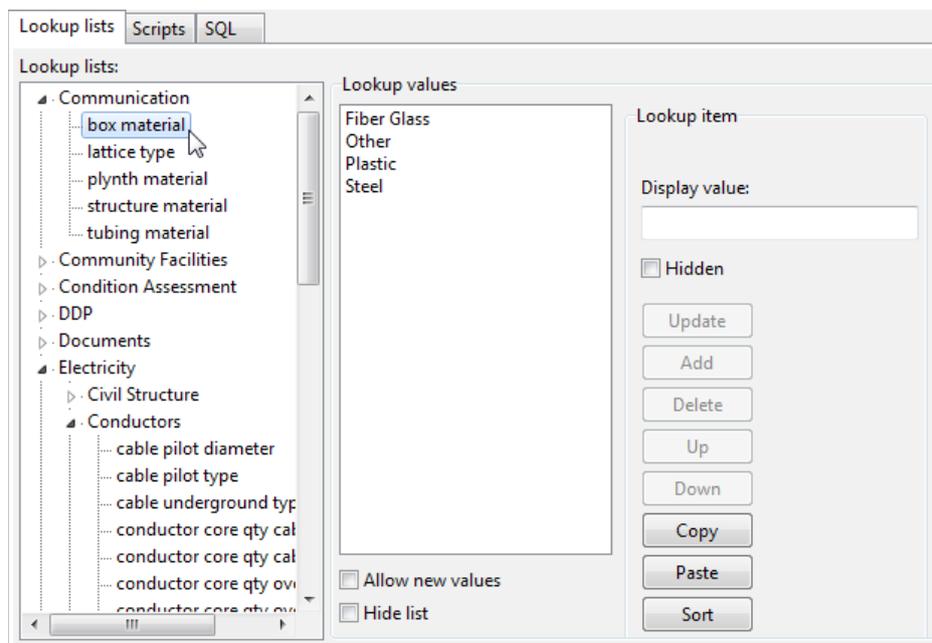


Figure 69: A project with hundreds of lookup lists

Right-click in the **Lookup lists** box and select **New list**, then enter a name. If you have many lookup lists, create lists with sub-lists. Figure 69 shows a project with many lookup lists, organized into sub-lists.

With a list selected, you can enter values in the **Display value** box and click on the **Add** button. If you already have the values in a word processor (or Notepad) you can copy them to the clipboard and paste them with the **Paste** button. (Values need to be one per line).

If you want users to be able to add new values while capturing information, check **Allow new values**. If you want to discontinue using a list, check **Hide list**. This ensures that any existing attributes using the list can still find it.

Tip: to copy lookup lists, or even groups of lists, to another project, simply drag them onto the database connection of another opened project.

A lookup item has a unique ID (unique inside the project database) that will be stored if the lookup is used with an Integer column. Lookups on Text columns will cause the display value to be stored⁵.

5 Some database administrators may frown upon storing text instead of an Id, but in the real world this is common and it may simplify things. Storing an Id saves space and allows for the display values to be changed easily, but inadvertently deleting a lookup list will cause data loss. You also cannot copy tables containing lookup Ids to other projects, unless you are certain that the projects have identical sets of lookup lists.

Attaching a lookup list to an attribute

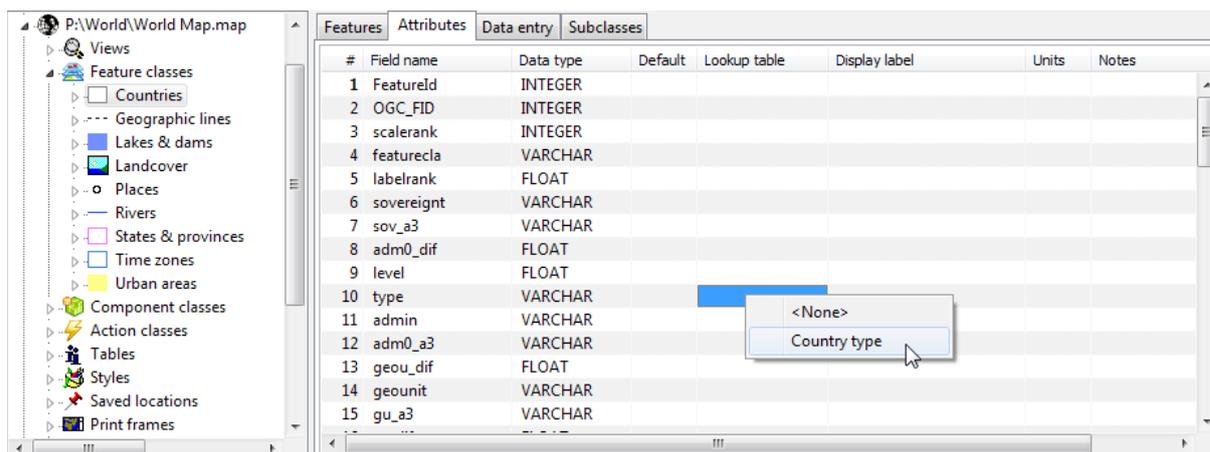


Figure 70: Attaching a lookup table to an attribute

The easiest way to attach a lookup list to a column (attribute) is to use **Design mode** (✎), click on the feature class and then the **Attributes** tab. Then, next to the field for which you want to assign a lookup list (and in the column for “Lookup table”), right-click to select the lookup list.

Now click on a country and you will see a dropdown list for the “type” attribute in the Attributes tab. (See Figure 71).

You can also attach a lookup list in the **Database Manager**. Locate the feature class' attribute table (starts with f_; expand the “f” node) and click on the **Structure** tab.

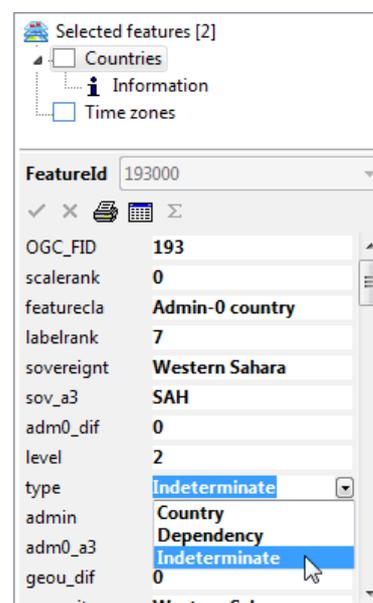


Figure 71: Attribute with lookup list

Popup Info

An alternative to using the Attributes tab on the right, is to use the “Info” click mode () instead of “Tag”. This provides more space for attribute information and may be a good alternative when using multiple monitors.

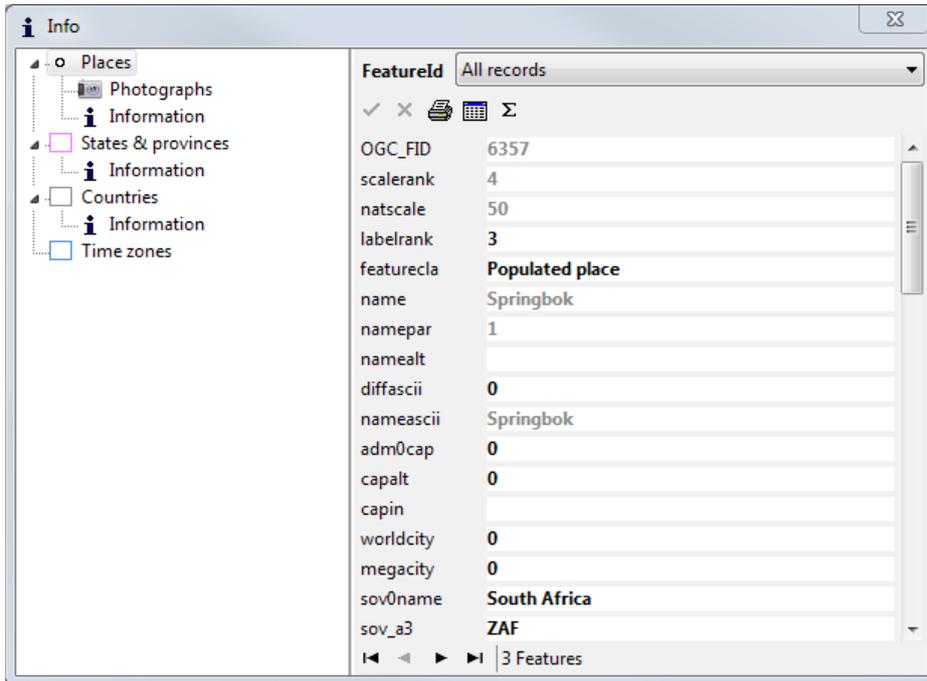


Figure 72: Popup information

Multi-media content

Linking content to regular attribute fields

Any computer file can be linked as an attribute. When the file resides on the same storage media (“drive”) as the Planet project, a relative path should be stored to keep the link portable. If the file is on a different drive, on a network location, or the Internet, the link will have to be absolute and the file will only be accessible if the media is connected.

If you want to link files to a project and be able to redistribute them together with your Planet project, it is best to keep such files in a subdirectory inside the directory (or “folder”) where the PlanetGIS project files reside.

To link such a file to a feature, you can simply enter the (relative, if possible) path to the file as a text attribute. For example, if you have survey diagrams for property boundaries, you would create a subdirectory called “Diagrams” inside your project directory and then enter a relative path as a text attribute. If the file is named 0004ZX02.TIF, (and inside a “Diagrams” subdirectory) you would enter the link as “Diagrams\0004ZX02.TIF”. Once you save the attribute, you will see that the name of the attribute becomes hyperlinked (blue and underlined). You can now click on the hyperlink to open the file with the default application set up on your system for viewing files of that type. It is your own responsibility to ensure that files of the type that you are linking (files with the same extension) can be opened on your computer. In other words, you must be able to double-click on it in Windows’ File Explorer (or the desktop) and an appropriate application must then be launched by Windows to view the file.

The completely correct way to enter a relative path to a file into a subdirectory is to start the path with a .\ (dot backslash). A single dot means current directory, and a double dot the parent directory. So, if for example the “Diagrams” directory (or folder, if you prefer...) was outside of your project directory and on the same level, the relative path would be “..\Diagrams\0004ZX02.TIF”. Starting the relative path with a .\ also gives Planet an indication that the attribute is a path to a file. Planet recognises common file types, e.g. .doc, .jpg, .xls, .pdf, etc. but to be completely explicit that an attribute is a link to a file, and especially if the file is also not relative, you need to prefix it with “file://”. So in the above example, “<file:///Diagrams/0004ZX02.TIF>”. (Notice how my word processor automatically “hyperlinked” it?)

Now that you know how it works, there is an easy way capture links to files on your computer or your network: drag them from Windows' File Explorer and drop them onto an attribute field. You'll need to place File Explorer and Planet side-by-side, or use a second screen. (See Figure 73).

Instead of a file, you can also link to an entire folder. If a folder is linked Planet will open File Explorer to show the contents of the folder.

Multiple links are also possible: select more than one file and drop them onto a text attribute field. The only caveat with this is that the hyperlink will open them all at once – not suitable for more than a handful links.

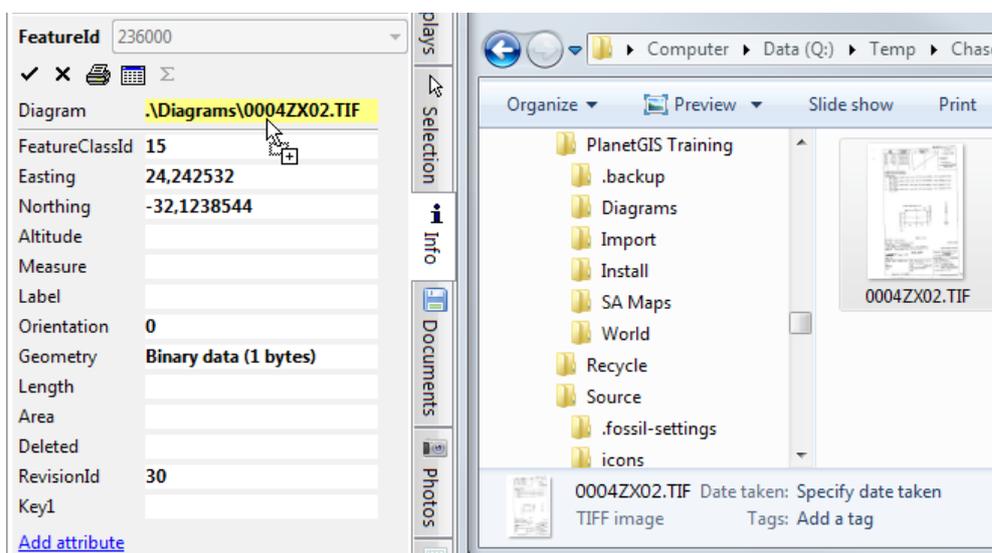


Figure 73: Capturing a file link by dragging from File Explorer

Lastly, you can also link to content on the Internet. “www.planetgis.co.za” will take you to the PlanetGIS website. Remember to save the attribute, you will see the hyperlink after saving. The “www.” tells Planet (and Windows) that it is an Internet link, but some web pages do not start with www. The best way to link to a website is to start with “http://”. Documents

PlanetGIS 5 has a built-in document manager for a much more structured method to link documents to features. The document manager resides in the “Documents” tab (📁). To add a document, expand the Documents tab and right-click on the white space (or existing document thumbnail). You need to have at least one feature selected.

Then click **Add** and you will be presented with the different options for adding or linking documents.

- **Store document(s) in database**

This is the recommended option unless database size is an issue or documents are accessed from a central server.

- **Link to document location(s)**
Similar to linking documents in the previous section, but still better for multiple links.
- **Link to folder**
Also similar to the previous section, but better for multiple links.
- **Link to document already in database**
Search the database for documents already stored.

The **Browse** button allows you to select any number of documents accessible to your system and the **Search** button allows for searching of documents of a specified type.

When storing a document in the database, Planet will not store a duplicate if the document is already in the database, but instead only create a link between the selected feature and the existing document. It is therefore safe to use the first option even you intend to link to an existing document.

To see or capture metadata for a document, click on the thumbnail. To open the document, click on the thumbnail in the information window.

Attributes tab vs documents tab

Documents can also be linked or viewed in the Attributes tab. (Right-click on a feature class to add documents and photographs). The Documents tab is more convenient for looking at documents of a multi-feature selection. In the Attributes tab, you need to navigate to a specific feature (or other type of) class.

The Documents tab also provides filters: feature class, component class, tags and date. The date filter is especially useful when you want to look at documents created/modified in a certain year, with the option to drill down to a specific month.

Tagging

Documents (and photographs) can be tagged to create a hierarchical (directory) structure. Use the “Tags” attribute field of documents to store tags. To create sub-levels use the backslash character (“\”). For example, you might tag one document as “Applications\Pending” and another as “Applications\Approved”.

You can also use multiple tags separated by a comma (“,”) to have a document appear in multiple “nodes” of your tag structure.

When importing a whole directory and subdirectory of documents (using the Search button when adding documents) you have the option to store the directory names as tags. This is a handy way to retain the original structure of your documents.

Use the Tags filter (fourth button at the top of the Documents tab) to see the tag structure and to filter to specific node.

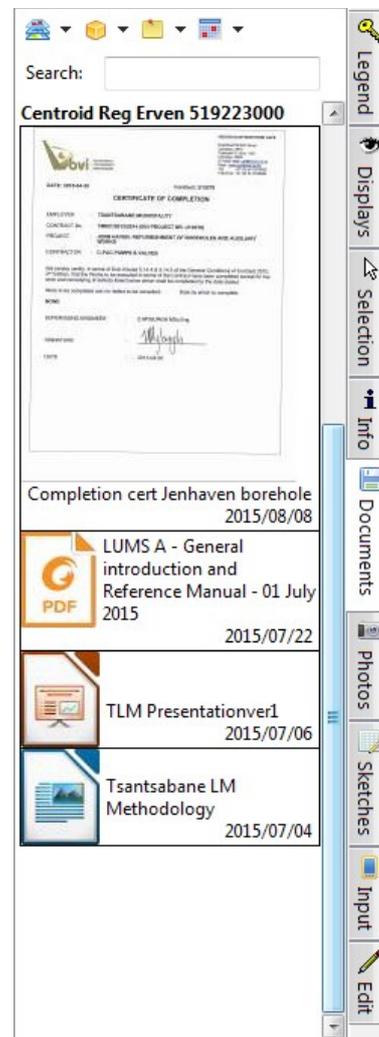


Figure 74: The document manager tab

Photographs

Photographs & sketches are another form of attributes. Activate the **Photos** tab and right-click on the white-space to add a photograph. (This can only be done when a single feature is selected). You can load any number of photographs for a feature and they will be displayed as thumbnails. Click on a thumbnail to view the original size image.

Use the mouse wheel or click to zoom in (right-click to zoom out) and drag the mouse to pan (if zoomed in). Use the up and down arrows on the keyboard (or PgUp and PgDn) to view the previous or next image.

If the photographs were taken by a camera with a gravity sensor (most smart phones), Planet will rotate the photographs so that the correct edge is “up”. If this information is not available inside the JPEG, you can manually rotate photographs by right-clicking on them.

You can also right-click → Copy to get the full resolution image on the clipboard, for pasting into another application or right-click → Save as... or Print... to launch Windows' “Print Pictures” application.

When viewing the full resolution image, you can also adjust the brightness and contrast (last button next to Print, Copy and Save to file). You can also leave the full resolution image open and open other photographs for comparison or capture attribute information for the selected feature. (Move the photograph window away to keep interacting with PlanetGIS). This is most useful when using multiple monitors and when capturing information which is being interpreted from a photograph.

PlanetGIS can also display panoramic images which are projected onto the inside of a three-dimensional sphere. These images are typically produced by specialized hardware on a tripod or stitched together from multiple images. Currently, any image with a width of twice or more than its height is assumed to be a panorama image.

Sketches

You can create your own freehand and line drawings in the **Sketch** tab. This function is especially useful on a hand-held device with a stylus. Figure 76 shows the sketch drawing functions.

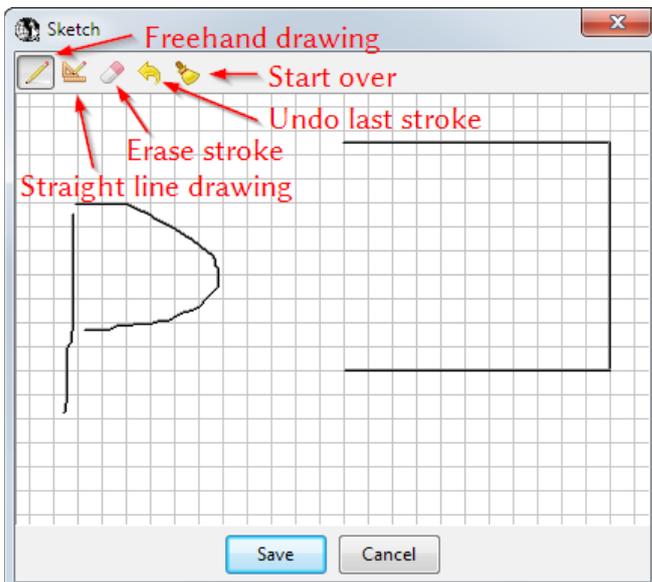


Figure 76: Drawing a sketch



Figure 75: Photo thumbnails

Detail tables

Detail tables are another way to connect information to features. The name “Detail” is because of the concept of a master-detail relation in relational databases. A Detail table has an (indexed) column/field with values that correspond to values in a column/field⁶ of a master table (“key”).

Attribute tables always have a FeatureId as the primary key. This means that an attribute table contains only one row of information for each feature⁷. Detail tables, on the other hand, may contain multiple rows for each feature, if allowed when creating the detail table link.

Detail tables can be connected to any attribute (which makes that attribute a “key”), but typically this is either the FeatureId column or the Key1 column. When using FeatureId, keep in mind that FeatureIds can change, for example when re-importing features or copying them to a different feature class.

Detail tables are used in the following situations:

- Linking to information in tables other than attribute tables
- Linking to tables with multiple rows of information per feature
- Linking to tables in an external database
- To use SQL to present information (e.g. the Wikipedia link of countries in the World map)
- To add additional levels of master-detail relations (a detail table becomes another’s master)

Creating a detail table

When you “create” a detail table in PlanetGIS, you are actually only creating a link to a table. If the table is inside Planet’s database you will have had to create or import the table in the Database Manager (see below). Use Design Mode to create a detail table (link). Expand “Feature classes” and expand a feature class to right-click on the “Detail tables” node, then click **New** or right-click on the feature class and click **New**→**Detail** table.

If the table is internal to your project, you only have to select the table from the drop-down list in the first tab. For external tables, see Connecting to databases.

In the second (“Master-detail”) tab, you need to select a master column (e.g. features.FeatureId or features.Key1) and an index column for the table you are linking. If you don’t see any columns when selecting the index, an index needs to be created. (See next section).

Change “One-to-one” to “One-to-many” if you expect more than one row to be linked to a feature.

Creating an empty detail table

If you are starting with no data, create a detail table by right-clicking on your project’s database connection in the Database Manager, then click **Create table...**

6 In relational database theory, a table is a matrix of columns and rows. However, it is common to refer to these as records and fields. While record and row might be the same, a field is really the intersection of the row and column (or a cell). To this author, fields and records are more appropriate when referring to the spaces in a user interface for entering or viewing the content of a table, while column & row is more abstract and relates better to describing a table. <http://dba.stackexchange.com/questions/31805/what-is-the-difference-between-a-record-and-a-row-in-sql-server> To complicate things further, in GIS an attribute is a cell/field value, but when thinking about the structure of a table (e.g. adding an attribute/column/field) you are really referring to the existence of the whole column, not adding any data.

7 Specialized attribute tables start with “f_” while the main attribute table is “features”. f_ tables can have zero rows if a feature doesn’t have any specialized attribute information.

Enter a name for your table. The convention in Planet is to use lower-case letters and underscores, but for detail tables it is a good idea to capitalize the first letter so that it appears at the top of table selection lists. It is a good way to distinguish tables you created/imported yourself from tables that were created by Planet. You can use spaces in table names (and columns) if you want. The convention in Planet for column names is to use CamelCase and no spaces.

For any changes to be allowed on a detail table, it must have a primary key. In Figure 77, the first column is type “Integer” and “Primary key” is checked. Click **Add** to start the list of column definitions. This first column will simply contain numbers starting at 1 and incrementing for each row. This value will not be of much interest to us, but is needed for making changes to the table.

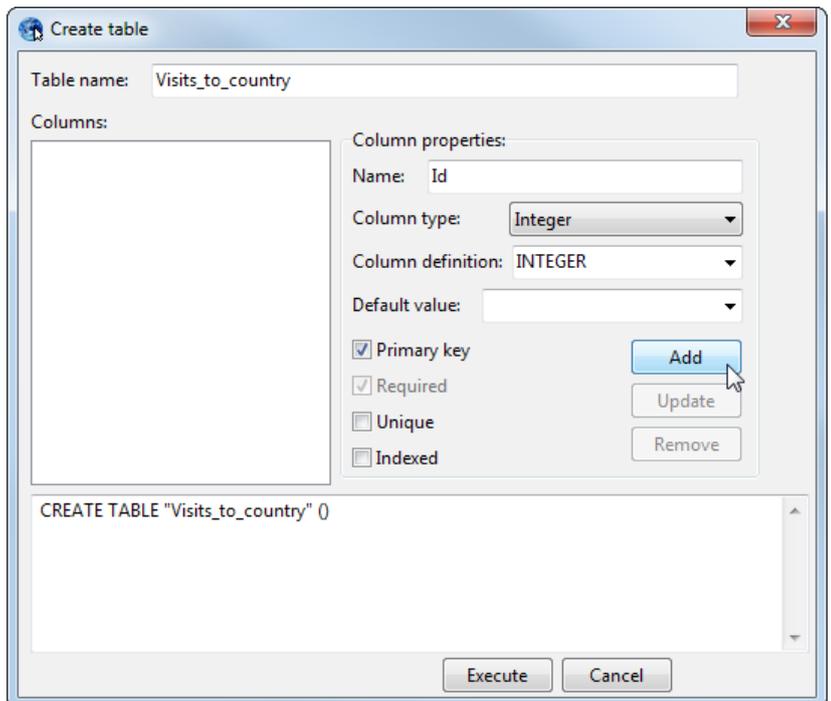


Figure 77: Creating a new table

Now add columns to contain your own information, but start with the column that will be used to link the information to features. In this example (using the World map), we add a column named “CountryCode” of type “Text”. It is important to uncheck “Primary key” before adding, but for this column we need to create an index, so click “Indexed” instead. Before adding the next column (“VisitDate” of type “DateTime”), be sure to uncheck “Indexed”. The last column in our example is “VisitDuration” of type “Integer”. (See Figure 5). Now click **Execute**.

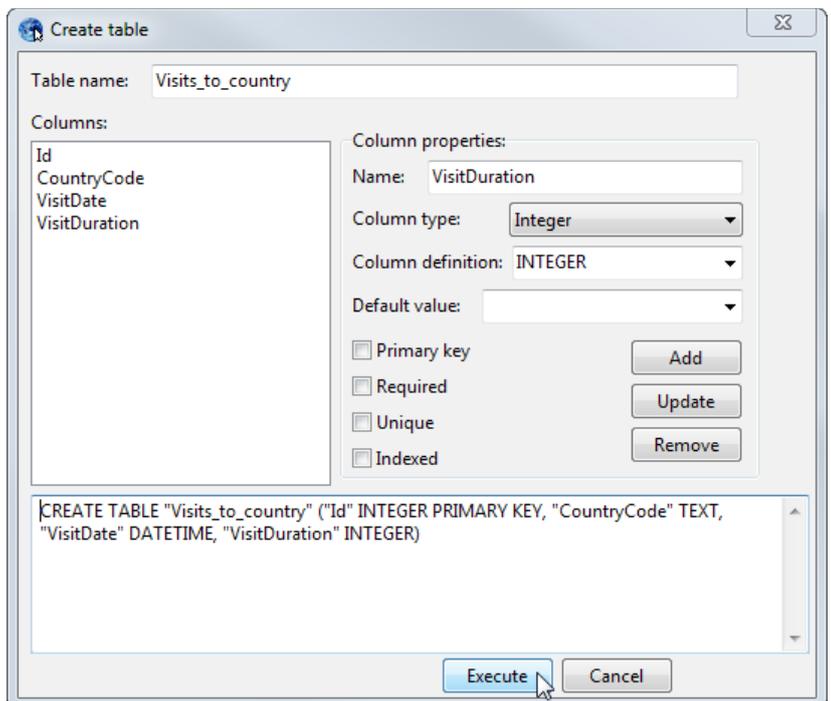


Figure 78: Adding columns

Now this table needs to be linked to the Countries feature class as described above. In the “General” tab, select the table “Visits_to_country” as the “Existing dataset” and select values as shown in Figure 79 for the “Master-detail” tab.

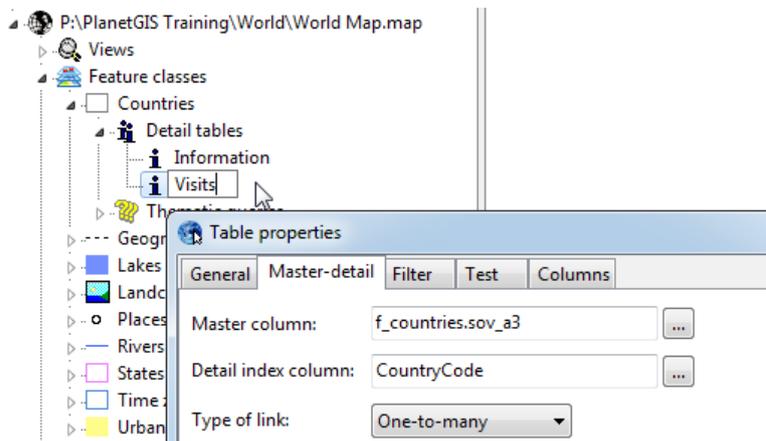


Figure 79: Detail table master-detail relation

Now go to Map mode and click on a country to test the detail table. To capture a visit, select a date for VisitDate and enter a number of days for VisitDuration. It is not necessary to enter the Id or CountryCode as Planet will do that for you.

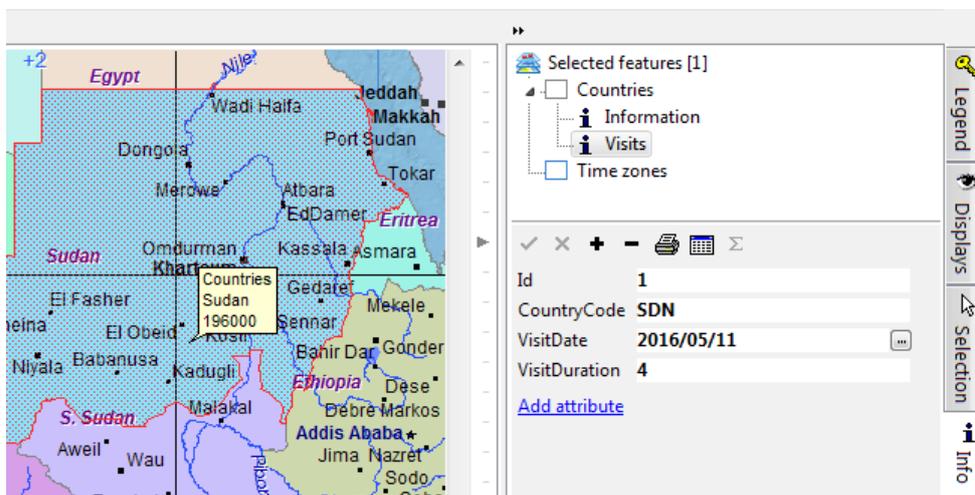


Figure 80: Entering data into a detail table

Importing a detail table

To get non-spatial data into your project there are 3 options:

- Comma Separated Values (CSV)
- dBase (DBF)
- SQL connection

The first two options are normally spreadsheet data. If you have information in an Excel (or Calc, etc.) spreadsheet, make sure the first row contains column names⁸ and then **Save as** a “Comma Separated Values” (.CSV) file. (Make sure you save changes to the spreadsheet to the native format first (e.g. .xlsx, .ods) and multiple sheets will have to be saved as separate CSVs). It is also important to close the spreadsheet because the spreadsheet software will lock the file after **Save as**. If your spreadsheet software has a “Save a Copy...” facility, you don’t need to close the spreadsheet.

In the Database Manager, right-click on the database connection for your project and click **Import**→**CSV...** and browse for the .CSV file with the ellipsis button.

⁸ Also check for empty rows, sub-totals and totals when converting a spreadsheet to a CSV file. Those could cause trouble.

As an exercise, you can download GDP data from the World Bank’s website: <http://data.worldbank.org/indicator/NY.GDP.MKTP.CD> There is a CSV and an Excel version, but the first row does not contain column names, so you might as well download the Excel sheet. Go to the first (“Data”) tab and delete the first 3 rows. Then **Save as**, or **Save a Copy** to a CSV file taking note of the location. In Planet, select the CSV file in the “CSV import options” screen.

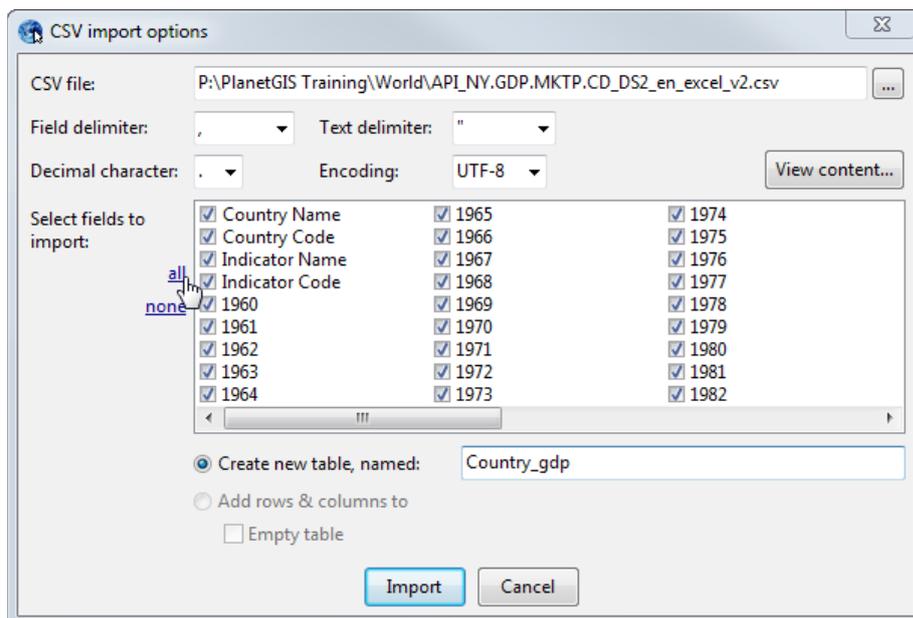


Figure 81: Importing a CSV

Figure 81 shows the CSV import options window. If you don’t see the columns as a list (but all together as a single item) it means you need to change the delimiter character, most likely to a semi-colon. You can also click the **View content...** button to make sure that Planet is interpreting the CSV correctly. Click on [all](#) to select all the columns and change the table name to “Country_GDP” (the current name, while it will work, is VERY database-unfriendly).

The next step is to create an index on the column “Country Code”. You can right-click on the table on the left and select **Alter table...** or click on the “Structure” tab, then right-click on one of the column definitions and select **Restructure table...** Then select the “Country Code” field and check **Indexed**, click the **Update** button and click **Execute**. See Figure 82.

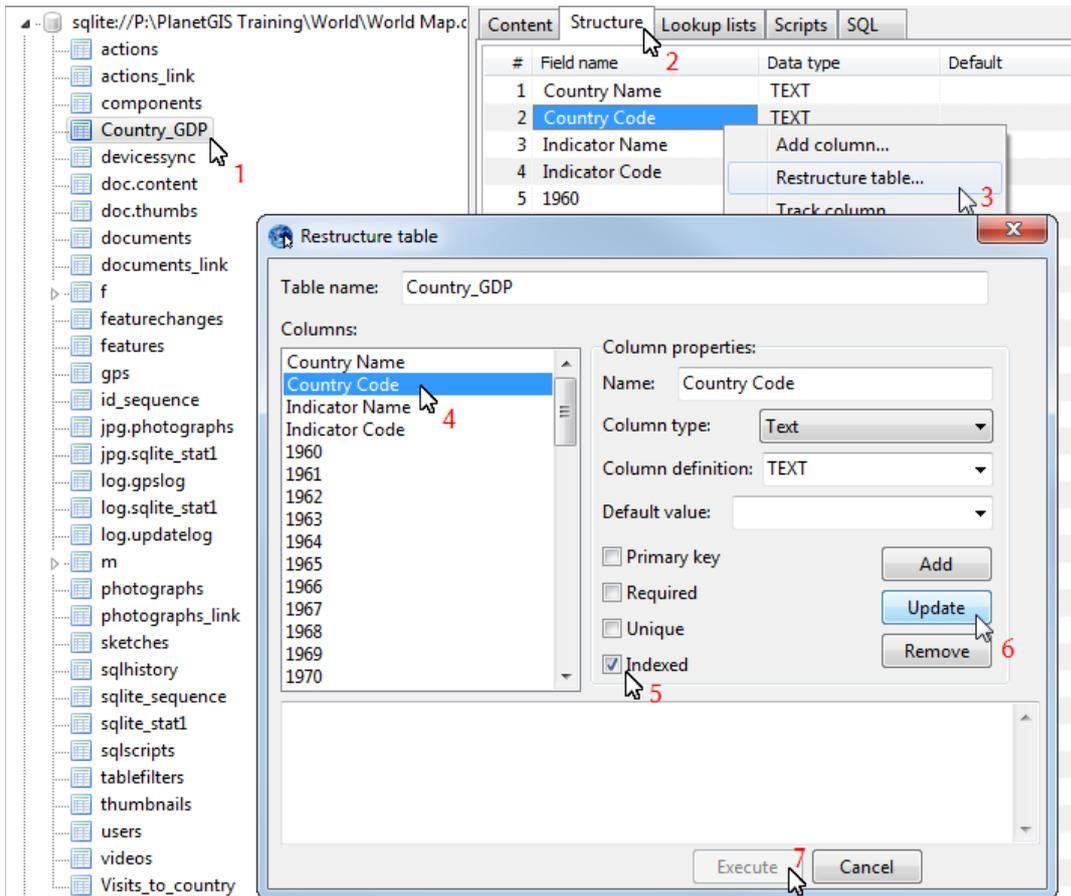


Figure 82: Creating an index on a detail table

Now you can link this detail table to the “Countries” feature class. Go to Design Mode and locate the Countries feature class. Expand the node and right-click on “Detail tables”, then click **New**. Enter “GDP” for the detail table description and select “Country_GDP” for “Existing dataset”. In the “Master-detail” tab, select columns as shown in Figure 83.

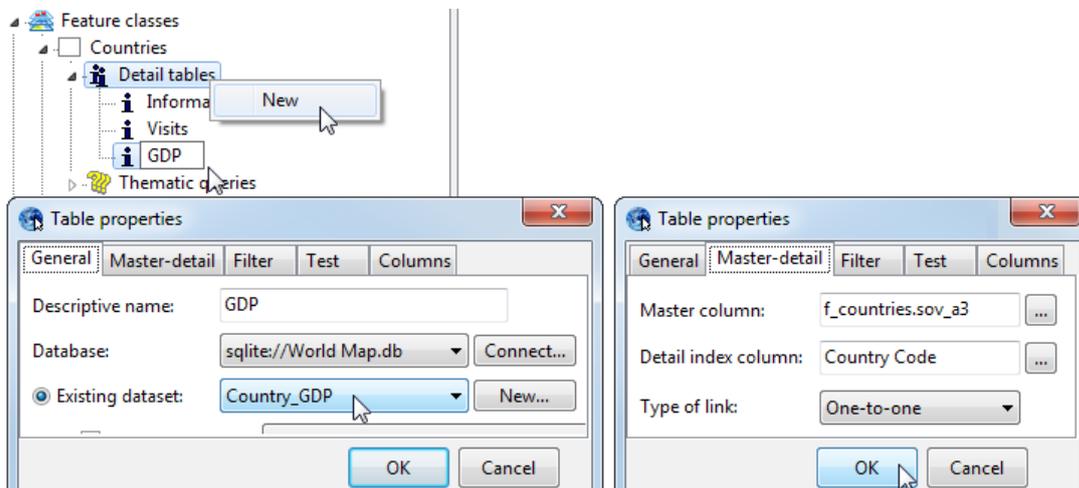


Figure 83: Setting up a link to a detail table

Now go back to the map and click on a country. In the Attributes tab you will see GDP information.

Chapter 10

***IMPORTING AND EXPORTING
INFORMATION***

Introduction

PlanetGIS can import and export spatial and attribute information from and to many formats. When importing and exporting spatial data (features), care must be taken to set up the correct coordinate system before importing and possibly convert the coordinate system before exporting. If the source or target is geographic coordinates (latitude & longitude), this is normally not an issue as long as the datum stays the same (normally WGS84). Projected (local) coordinate systems can always convert coordinates to and from latitude & longitude (of the same datum). See Chapter 4 for more information on coordinate systems.

There are three different paths for importing and exporting information:

- GIS exchange files – physical files containing geometries and (sometimes) attributes.
- Geo-databases – a database file or SQL connection to a server with tables containing coordinates or geometries.
- Spreadsheets (CSV files) – information can be opened immediately in a spreadsheet or placed on the clipboard.

Earlier versions of PlanetGIS could open many exchange files directly by creating a temporary project and importing them. More recent versions of PlanetGIS requires a project to be created first (and a matching coordinate system selected) into which exchange files can be imported.

To import an exchange file, click **File** → **Import** and browse to select the file. Depending on the type of exchange file, different options windows will be presented as discussed below. You can also right-click on the **Feature classes** node or on a specific feature class in Design to import exchange files.

To export an exchange file, first make sure you have one or more features selected, or if you want to export entire feature classes then make sure that nothing is selected on the map. Then click **File** → **Export** and select a file type and destination. If nothing was selected on the map, you will first be prompted to select one or more feature classes. You can also right-click on a feature class in Design or on a display in the Displays tab to export to an exchange file.

ESRI™ shapefiles

A “shapefile” is a format of spatial and attribute data exchange, introduced by ArcView 2 in the early 90's. Shapefiles are the most commonly used format for exchanging GIS information.

A shapefile is actually a collection of files with the same name, but different extensions and stored in the same directory. There can be around 10 different files, of which 3 are mandatory:

- **.shp** – feature geometries
- **.shx** – index for the .shp
- **.dbf** – attributes in dBase IV format¹

From now on, “shapefile” will refer to all three. PlanetGIS ignores any other files, and is able to open a **.shp** without the other two mandatory files present.

A fourth file with a **.prj** extension is starting to become mandatory in practice. This is a text file containing the coordinate system parameters and is useful in determining the shapefile's coordinate system. If this file starts with `GEOGCS["GCS_WGS_1984"...` then the shapefile contains geographic

¹ One of the biggest drawbacks to shapefiles is the storage of attribute data in dBase IV format, which among other limitations, limits field names to 10 characters.

coordinates (latitude & longitude) and can be imported into either a geographic or projected coordinate system that is based on WGS84 (eg. Hartebeesthoek94). If this file starts with GEOGCS but a different datum, you must ensure the datum of your project is the same or equivalent before importing the shapefile. If this file starts with PROJCS, that will be followed by the name of the coordinate system and it must be the same or equivalent to the PlanetGIS project's coordinate system before you import.

Importing a shapefile

1. Click **File** → **Import** and browse to find one or more shapefiles (you can select many shapefiles at once).
2. An options window will be presented for each shapefile selected. Importing will only start once all the options windows have been dismissed. This allows for unattended operation of lengthy imports. In most cases, the first decision to be made for each shapefile is the attribute field to choose for labelling features. The first step, therefore, is to click on the Preview tab in order to see the content of the **.dbf**
3. Figure 84 shows that one of the columns, “name” is likely the best choice for the feature label.
4. Now go back to the Source tab and select “name” for the label.

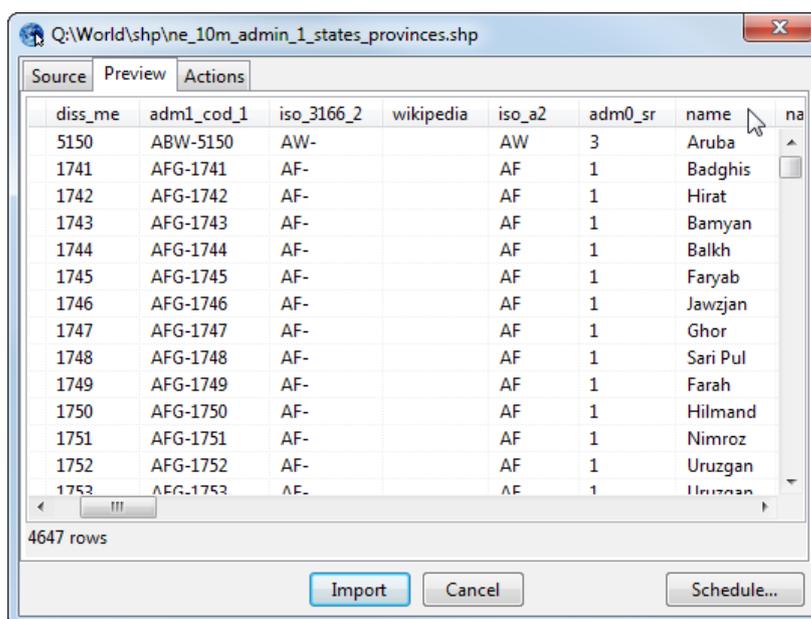


Figure 84: Previewing the .dbf of “a shapefile”

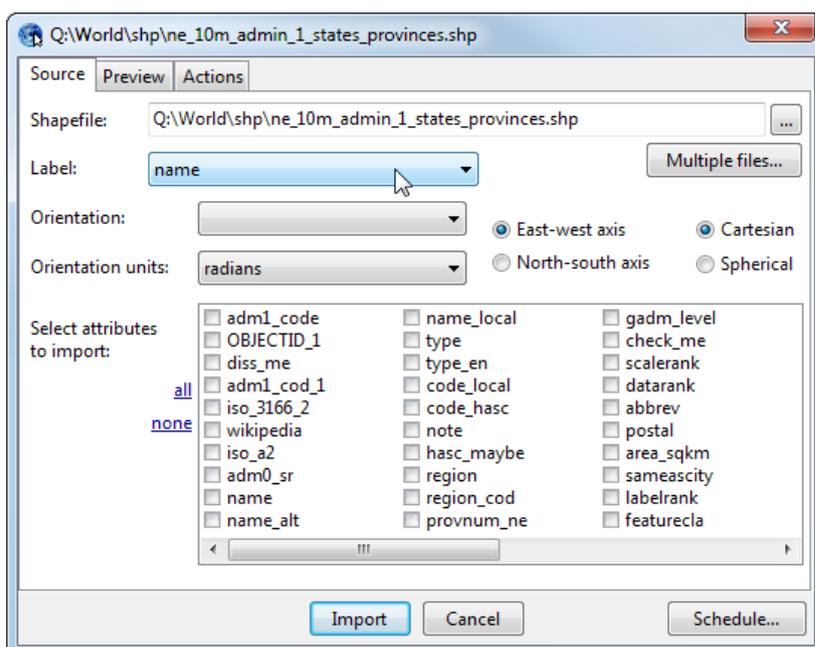


Figure 85: Selecting a label and attributes for shapefile import

5. The orientation values are for rotated text, where the rotation angle is specified as an attribute.
6. Also use the Preview tab to decide which attributes to import, or simply click [all](#).
7. The actions tab will be discussed later in this chapter. For first-time imports, it is not necessary to change anything.

8. Now click **Import**. If multiple shapefiles were selected, repeat from step 3.

Exporting a shapefile

1. To export a shapefile, click **File** → **Export**. If there are no features selected on the map, Planet will ask you to select one or more feature classes to export.
2. Browse to a directory where the shapefile will be created. Planet automatically gives the shapefile the name of the selected feature class, but you can change it if necessary.
3. A shapefile options window will be presented for each feature class to be exported. In this window you can change the name of the shapefile, select which attributes to export and specify a detail table which fields will be added to the attributes.
4. If your map selection contains multiple feature classes or you have chosen more than one feature class, successive options windows will be presented for each. Planet will not ask you to specify the location and name of each with the Windows “browse” function, but you can change the name of each in the options window, or click on the ... button to use the browse function.
5. Finally, if you are exporting a feature class containing multiple types, Planet will create additional shapefiles for each type and append “_points”, “_lines” or “_polygons” as appropriate, since shapefiles can only store one type of feature in each file.

Additional ways to export shapefiles are to right-click on a display in the Displays tab or on a feature class in Design.

Google Earth™ KML/KMZ

Many people are using Google Earth as a GIS. In some cases it can be convenient to capture features in Google Earth and then import them into Planet. In many cases Google Earth is an excellent way for people to visualize a small number of features without needing GIS software. For this reason, KML/KMZ is becoming more and more prevalent and will perhaps one day surpass shapefiles. See the chapter on Google Earth starting on page 68 for more detail on using Google Earth.

Instructions for importing and exporting KML/KMZ are on page 70.

AutoCAD™ DXF

A GIS needs to be able to exchange information with CAD (Computer Aided Design) systems. Most CAD systems have become “GIS aware” and in many cases *shapefiles* can (or should) be used. DXF is a standard of exchange for CAD systems that’s been around for a very long time. The DXF format has also evolved since its inception and there are many different versions. The format that Planet understands (and produces) best is called “*AutoCAD R12*”.

DWG (“Drawing” files)

AutoCAD (and some other systems) stores drawings in *DWG* or other formats. PlanetGIS cannot read or produce *DWG* files directly. *DXF* was the format intended for data *exchange*. All CAD systems can save drawings in *DXF* format and read (import) *DXF* drawings in many revisions of the format. If you don’t have CAD software, a handy utility to convert between *DWG* and *DXF* is *AnyDWG DWG DXF Converter*, which can be found here: <http://anydwg.com/dwg-dxf/>

Coordinate systems

Most CAD drawings use a “flat” (projected, X-Y) system in either metres or millimetres. If your GIS data is in a different coordinate system, reprojection is needed. For importing *DXF* drawings, your GIS project must be set up to match the coordinate system of the CAD. (Data can afterwards be copied between projects with different coordinate systems).

GPS Exchange files (GPX)

Modern GPS devices that act like external drives when connected to a computer via USB, store tracks and waypoints in .GPX files. PlanetGIS can import and export GPX files. Photographs referenced by GPX files are handled in the same way as described in the next section.

Geotagged photographs (JPG)

“Smart” devices with a location sensor active, can “geotag” photographs that they take. The coordinate (latitude and longitude) of the device is stored inside the JPG file, together with other camera information in a section called “Exif data”. You can check to see if a JPG image is geotagged by right-clicking on it in File Explorer and then click **Properties** and activate the **Details** tab. The latitude, longitude and altitude will be displayed in a section named “GPS” toward the bottom of the list of image metadata.

You can import such JPG files in the same way as you import other exchange files in this chapter. (Only geotagged images will be imported. For importing images that are not geotagged, see the section on multimedia content in *Attributes*). Point features will be created for each image and the images will be attached to each feature and stored in the project database. Images can then be viewed by clicking on a feature and activating the **Photos** tab to the right of your map.

Most smart devices and digital cameras will also store the orientation of the device inside the Exif section. Software can then tell which edge of an image should be placed at the bottom of a screen for viewing (“Which way’s down?”). PlanetGIS will automatically orientate images according to this information when importing them. You can also right-click on an image thumbnail to manually rotate it as needed. The actual date and time at which an image was taken is also stored in the Exif data and Planet extracts this and stores it as a *Timestamp* in the database².

Spreadsheet information (CSV)

Any information contained in a spreadsheet must be saved as a CSV (Comma Separated Values) file in order to import the information into PlanetGIS. Planet can also export features or attribute information to CSV files and can open your installed spreadsheet application automatically³ with any selected information.

CSV files are “plain text” files which you can open with, e.g. Notepad. There are some variations in the CSV format:

1. The actual character used to separate fields (columns). Normally a comma (,) but Microsoft prefers using a semi-colon (;). Another common separator is the [Tab] – an invisible character which text editor can interpret to be any amount of white-space, often two or four spaces.
2. Quoting of text values. Normally text without spaces, line breaks and quotation characters do not need to be quoted. Text containing any of the above must be quoted and nearly always the double-quote (“) is used.
3. Decimal points. In some localities (e.g. Germany) a comma is used as the decimal separator for numbers with fractional digits. In this case the use of a semi-colon to separate columns makes more sense.

² Image editing software can lose or modify Exif information. The Paint app in Windows 10, for example, preserves this information while in previous versions of Windows any changes to a JPG were saved without Exif information. The date of the JPEG file is not reliable because of image editing but will be used if Exif data is not present.

³ (If .CSV files are associated with your spreadsheet application, which they normally are).

4. Text encoding. Text files always need some encoding system to be able to display text characters (stored as numbers on a computer) into visible “glyphs” (symbols). This encoding is usually not specified. The modern convention is to use the UTF-8 encoding and recently to use two or three bytes at the beginning of such files to indicate the variant of UTF-8 (or UTF-16). Text files created using older conventions can be in many different encodings. For regular latin letters, the ISO-8859-1 encoding is “safe” even for UTF-8 files. Most people know this as simple “ASCII” or “ANSI” (though the latter is a misnomer), but the important thing to remember about these is that the encoding is fixed for all characters that have numbers represented by 7 or fewer bits (numbers up to 127) and this includes the latin alphabet and most other characters on a “US” computer keyboard. If you don’t expect any other characters in your data, ISO-8859-1 is a safe choice.
5. Line endings. Planet handles both variants (Unix LF vs DOS CR+LF), but there is a small chance you’ll need to change the way that PlanetGIS writes CSV to Unix line endings.

In many cases you simply need to experiment with the above options and view the results in the **Preview** tab. The most obvious problem occurs for mismatched column separators (commas) as you will see incorrect columns in the first tab if this setting is incorrect.

Geo-databases

Planet can connect to most database systems and read spatial information directly. The **Import table/SQL** function in Design mode assists with the various forms in which this can be done.

Chapter 11

THEMATIC MAPPING

Introduction

The true power of GIS presents itself with what is called “thematic mapping”. In the broadest sense a thematic map is a map that illustrates a “theme” or, if you will, “tells a story”. More specifically, in PlanetGIS a thematic map is one that has at least one classification of features into separate “thematic layers”. In Planet, this is called a “thematic query” because of the similarity to SQL queries.

It is possible to create thematic maps without using thematic queries. For example, to highlight a property boundary to stand out, you can simply copy it to a new feature class, add that class into a view and assign a (new) style to the display that stands out from other property boundaries. In this chapter we will not be doing that, but use attributes to determine the appearance of the map. The advantage to this approach is that when the data changes, so does the map.

To create a thematic query, either use **Tools**→**Thematic mapping**→**Create thematic query...** in Map Mode or use Design Mode to create thematic queries for a feature class (expand *Feature classes* and then the feature class on which you want to base the query and you will see a node called *Thematic queries* – right-click, then **New**→**Thematic query**).

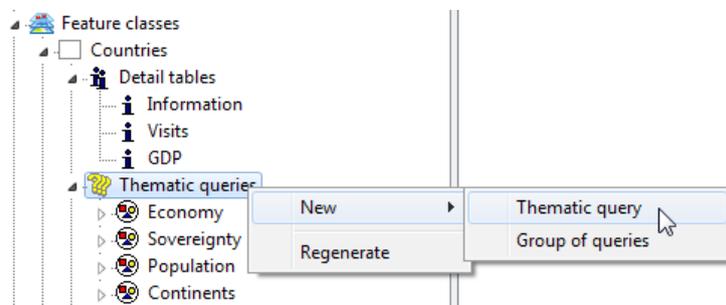


Figure 86: Creating a thematic query in Design Mode

A thematic query will also, typically, be used in a new *View*, which must be set up to contain background mapping to provide context. Figure 87 shows the creation of a new view, which will be needed for the next example. Right-click on the last view tab and select **New view**→**After this view**, then provide a name such as “Visited”.

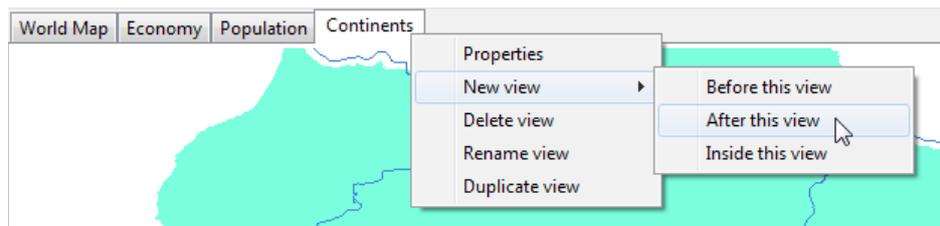


Figure 87: Creating a new view

The next step will be to add context. In the Displays tab, add (for example) “Countries” and “Land cover”. Design mode can also be used to create views and to copy displays from other view by dragging and dropping.

Select queries

The simplest type of thematic query is a “Select query”. The result is a single layer containing a subset of the feature class. This is basically a filter used to highlight features based on constraints set on one or more attribute values.

The simplest select query is one used to highlight features that have information in a detail table. Figure 88 shows a query using the detail table we created in the previous chapter. The query needs a descriptive name, an attribute or detail table and a type. Here the “Visits” detail table is selected and the type set to “Select”. Nothing more is required other than to run the query and add it into a view. This .query warns the user that the master column isn’t indexed, but with a small project the speed degradation is not noticeable.

In the Displays tab, add the thematic (expand “Countries” to see the new thematic). Now you will see all countries with data in the “Visits” detail table stand out with a solid colour. To change the style to something else, right-click on the display and click **Style properties...**

To make changes to a query, you can also use the Displays tab: right-click the display that references the query and click **Thematic query→Properties...** at the bottom.

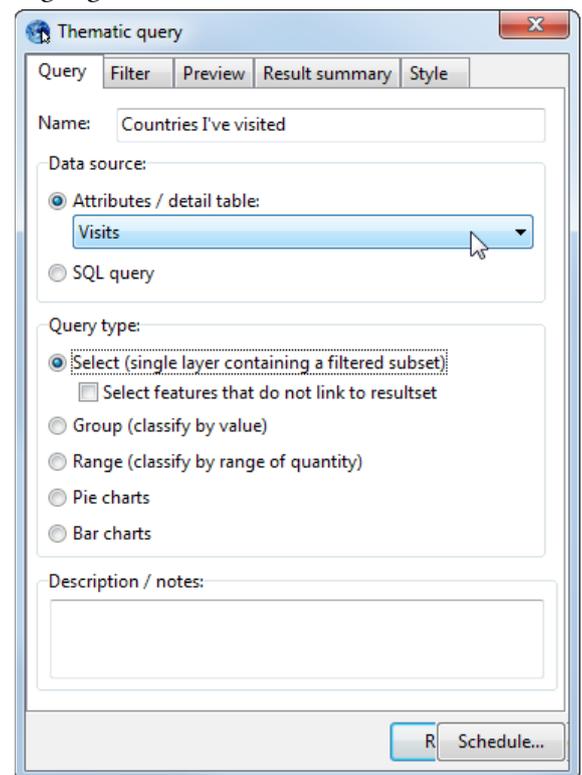


Figure 88: A simple select query

Group queries

Group queries put features with the same attribute values together in a sub-layer. In other words “classify by value”. An example of a group query is the query in the World map that gives each continent a unique colour.

Range queries

Range queries divide features based on numeric attributes into predefined ranges.

Pie and Bar charts

Pie and Bar charts are a variation of a group query, where a pie slice or a bar is a “classify by value” with another attribute used to determine the relative sizes.

