



Manual

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by

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an e-GEOS (ASI / Telespazio) Company

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1 GAFmap® Express - Overview

1.1 About GAFmap® Express

GAFmap® Express is a free software that allows you to open and reuse GIS projects that have been processed and created with the licensed Desktop GIS Software GAFmap® and the corresponding extension Pack&Go ("Pack&Go Container"). These GIS projects usually contain a 2D and/or 3D visualization of geographically located data, which you can view interactively, analyze in a simple way, and supplement with your own graphics and labels.

To use a 3D visualization in a team or to dive into the 3D world even more realistically, GAFmap® Express has a Multi User Mode and interfaces to various Virtual Reality Headsets.

Pack&Go Container

With GAFmap® Express exclusively Pack&Go Container created with GAFmap® can be read (*.cmp or *.cmpaux). In such a container all data that the project contains is stored next to the prepared GAFmap® project (*.xmp).

The project stored in the container and the contained data cannot be changed with GAFmap® Express, but only read. If you, however, e.g. add your own graphics, de/activate the on-the-fly functions or the display of data, you can save these customized adjustments separately. Therefore a sidecar file is created and stored next to the container. If you reopen the project, you can select your own sidecar file (*.cmpaux) or the original project file (*.cmp).

1.2 Software Requirements

1.2.1 System and Hardware Specifications

Minimum requirements for GAFmap® Express 2D/3D:

- Microsoft Windows 10/11, 64bit
- CPU: 2 GHz Dual Core
- Memory: 4 GB
- Graphics Card: the 3D Viewer requires a DirectX 11, Shader Model 5 compatible graphics card (any current NVIDIA, AMD, or Intel, dedicated or CPU-integrated GPU).
The visual quality in the 3D Viewer directly scales with the performance of the graphics card, so a faster graphics card is always better.
- Screen resolution min. 1024x768

Please note that docking windows (see chapter 2.2.4) is not possible if you work with two or more screens with different DPI scaling!

Recommendations for a great 3D Viewer experience:

- Microsoft Windows 11, 64bit
- CPU: 3 GHz Quad Core
- Memory: 16 GB
- Storage: SSD
- Graphics Card:
 - 4 GB dedicated video memory
 - 2000 GFLOPS Single Precision Computing Power (GAFmap® only uses SP, not DP)
 - Examples: NVIDIA GTX 1060 or AMD Radeon RX 480

Recommendations for a great Virtual Reality (VR) experience:

- Microsoft Windows 11, 64bit
- CPU: 3.5 GHz Quad Core
- Memory: 32 GB
- Storage: SSD
- Graphics Card:
 - 8 GB dedicated video memory
 - 8000 GFLOPS Single Precision Computing Power
 - Examples: NVIDIA RTX 3070 oder AMD Radeon RX 6700 XT

Please also note the VR hardware manufacturers' system & hardware requirements!

Regarding the Multi User component:

Here, a simple communication server (GAF.View3D.MultiUser.Server.exe, UDP application, Dedicated Server) is created and used. For the communication server, certain UDP ports (User Datagram Protocol) may have to be enabled for Windows and/or firewalls. By default, the communications server uses the UDP ports 9050 and 9051.

1.2.2 Installation

GAFmap® Express does not require an installer. Simply save the (unzipped) program folder to any mobile, local, or central drive where you have full read permissions; write permissions are not required to run the program. The software can then be started directly from the program folder (see chapter 2.1).

More detailed information on the installation and help with any error messages that may occur can be found in the installation guide included with the software package.

2 Getting Started with GAFmap® Express

2.1 Starting the Program

GAFmap® Express is started via the application file **GAFmapExpress64.exe** in the program folder or a corresponding (desktop) shortcut:

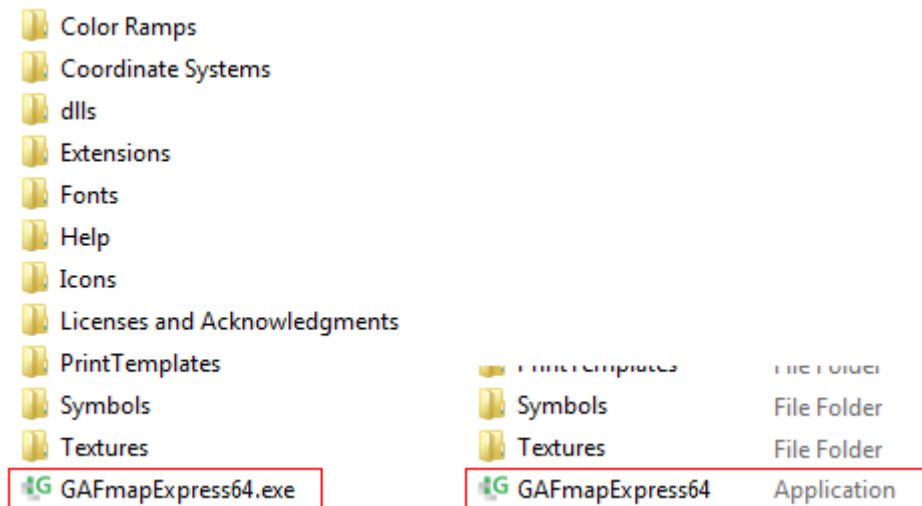


Figure 1: Content of the GAFmap® Express program folder. Run **GAFmapExpress*.exe** application starts the program.

When starting the application, the splash screen appears for some seconds, then the **Open Project** dialog opens (see chapter 3.1.1). Note that GAFmap® Express cannot be opened empty and will close again if no Pack&Go Container (*.cmp or *.cmpaux) is selected.

Alternatively, you can start GAFmap® Express by double-clicking a *.cmp or *.cmpaux file in your file browser. Note, if different GAFmap® applications are available on your PC (e.g. GAFmap® Desktop and GAFmap® Express): A Pack&Go container will always be opened with the GAFmap® application that was last used for this file type.

2.2 User Interface

The GAFmap® user interface mainly consists of the following components:

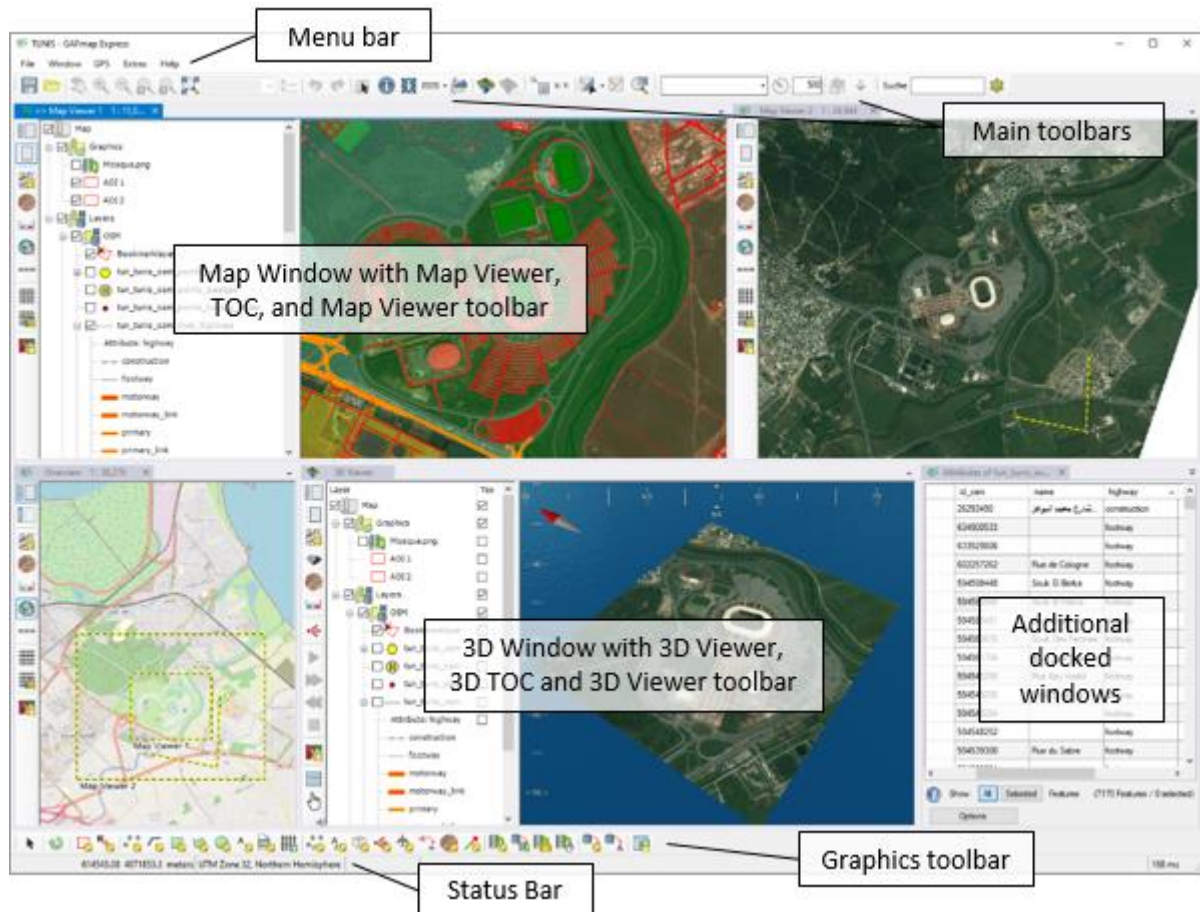


Figure 2: GAFmap® Express User interface

General information on the user interface, i.e. on the elements mentioned above as well as on (context) menus, dialogs, properties and settings windows, etc., can be found in the following chapters, information on all functions available in GAFmap® Express starting with chapter 3.

2.2.1 Main Window

2.2.1.1 Menu Bar / Main Menus

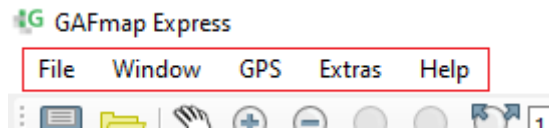


Figure 3: GAFmap® Express **Menu Bar**

Via the **Menu Bar** at the top of the User Interface, you can access the (main) menus available in GAFmap® Express. They include:

- Menu **File** (see chapter 3.1)
 - Save and load projects
 - End program
- Menu **Window** (see chapter 3.2)
 - Link map viewers
 - Save and load window layouts
 - View the list of open map viewers
- Menu **GPS** (see chapter 3.3)
 - Connect/disconnect and configure GPS
 - Center map on current position
- Menu **Extras** (see chapter 3.4)
 - Open general settings
 - Change language
- Menu **Help** (see chapter 3.5)
 - Open About GAFmap® Express
 - Open GAFmap® Express Manual

You can find information on all functions that can be accessed via the main menus in the chapters given above.

All menus and commands in menus are opened with a simple (left) click.

2.2.1.2 Toolbars

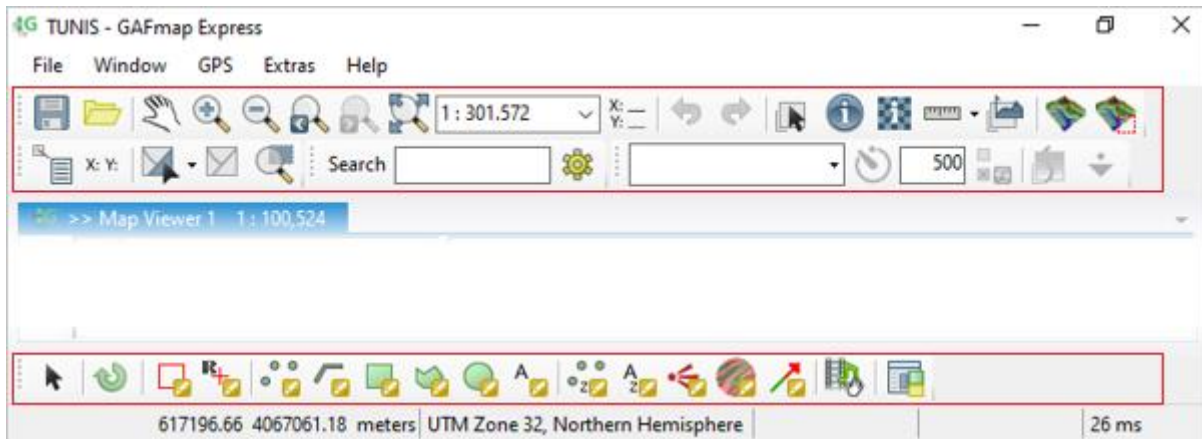


Figure 4: GAFmap® Express **Toolbars**

By default, the toolbars are located above the map viewer area in the main window; the Graphics Toolbar is located at the bottom.

By default, the toolbars are structured as follows:

- **Main Toolbar** (see chapter 4.1)



- Save and load projects
- Adjust map extent (Pan, Zoom etc.)
- Undo/redo Actions
- Query layers and perform simple analyses
- Update visible extent in 3D Viewer

- **Toolbar for Features** (see chapter 4.2)



- Select and query features

- **Toolbar for Feature Search** (see chapter 4.3)



- Find features with specific attributes

- **Toolbar for Layer Effects** (see chapter 4.4)



- Temporarily hide layers in different ways

- **Graphics Toolbar** (see chapter 4.7)



- Create and edit graphics
- Create auxiliary graphics for sight analyses
- Include multimedia objects
- Set default symbology for graphics

You can find information on all functions available in the toolbars in the chapters given above.

In addition to the toolbars mentioned above included in the main window, there is also a toolbar attached to each map window and 3D window. This **Map / 3D Viewer Toolbar** contains functions that directly and exclusively affect the respective Map/3D Viewer. For more information, see chapters 2.2.2.3 and 2.2.3.3 or 4.5 and 4.6.

Open/Activate Functions

All tools/functions in toolbars are opened with a single (left) click on the respective button. Depending on the function, an action is then performed directly (e.g. Save or Clear Selection) or the button / the respective tool is activated; the action must then be executed/initiated manually (e.g. Zoom or add a new graphic).

If a tool is active, the respective button is framed in blue:



Figure 5: An activated button is framed in blue; the respective action must then be executed manually (here: click into the map to zoom or draw a zoom rectangle)

An activated tool remains active until the button is deactivated by clicking it again or until another tool is activated. If you use a function in between that is executed directly, the activation status of the tool does not change.

Split Buttons

Small black ▼ arrows next to buttons mark so called **Split Buttons**, i.e. buttons behind which additional functions are "hidden" in addition to the displayed function. A single (left) click on a split button arrow opens a selection menu:

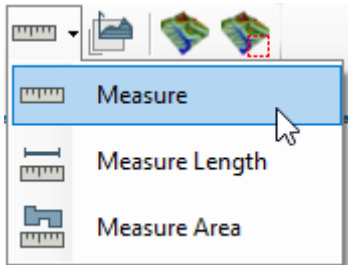


Figure 6: Split Button

If you select one of the functions in the menu, it is activated or executed directly and the menu is closed again. The split button always shows the function that was executed last. The displayed function can be activated/executed by a simple click on the button.

Adjust Toolbars

You can customize the toolbars as desired via the general settings, e.g. if you want to simplify the user interface or optimize it for special workflows. For example, you can hide or move individual buttons within a toolbar or restructure complete toolbars or create new ones. Also, various menu functions can be integrated into toolbars.

Customized toolbars are saved in the user settings. If necessary, they can be exported as an XML file and thus e.g. be passed on to other users. Note that the structure of the manual is based on the standard format of the toolbars.

For more information on custom toolbars, see chapter 3.4.1.6.

2.2.1.3 Status Bar

The Status Bar (Footer) is located on the bottom edge of the program window.

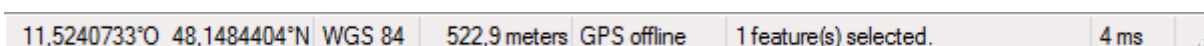


Figure 7: GAFmap Status Bar

Here, the following additional information is displayed in the given order:

- **X/Y-coordinates** of the current mouse position

You can specify the display format in the general setting under Viewing > Status Bar (see chapter 3.4.1.3).

If you move the mouse pointer slowly over the coordinate system in the Status Bar, a tool tip shows more detailed information.

- **Elevation** at the current mouse position (optional)

You can specify whether the elevation is displayed or not in the general settings under menu Extras > Settings > Viewing > Status Bar (see chapter 3.4.1.3). The elevation refers to the **base DEM** (see chapter 5.3.4) If no DEM is available at the current mouse position, no elevation is displayed.

- **Additional Information** (optional)

You can specify whether and which additional information is displayed in the Status Bar in the general settings under Other > Handling (see chapter 3.4.1.8). Available are e.g.

- the GPS status,
- the number of layers selected (in the TOC), or
- the size of the selected features.

- Information on **currently executed actions**/functions

For various functions, information is displayed in the status bar, e.g. about the success of an action, e.g. the number of selected features for **Select Feature** (see chapter 4.2.3.1).

A right-click on the info section of the status bar opens the **Log of last 20 messages**. It shows the date, time, and type of each action (for a maximum of 20, if existing):

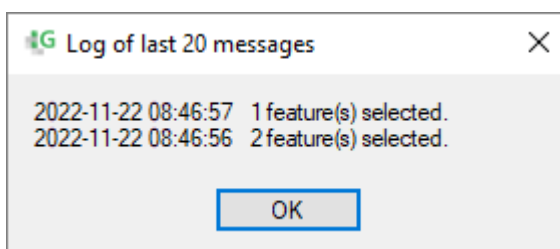


Figure 8: Log of last 20 messages

- Information about the duration of the **drawing process** in the map viewer [ms]

2.2.2 Map Window

Only available if the project contains a 2D window

The **map window** is the main component of each GAFmap® project. Here, all (geo) data contained in the project, i.e. all vector data, rasters, graphics, etc., are displayed:

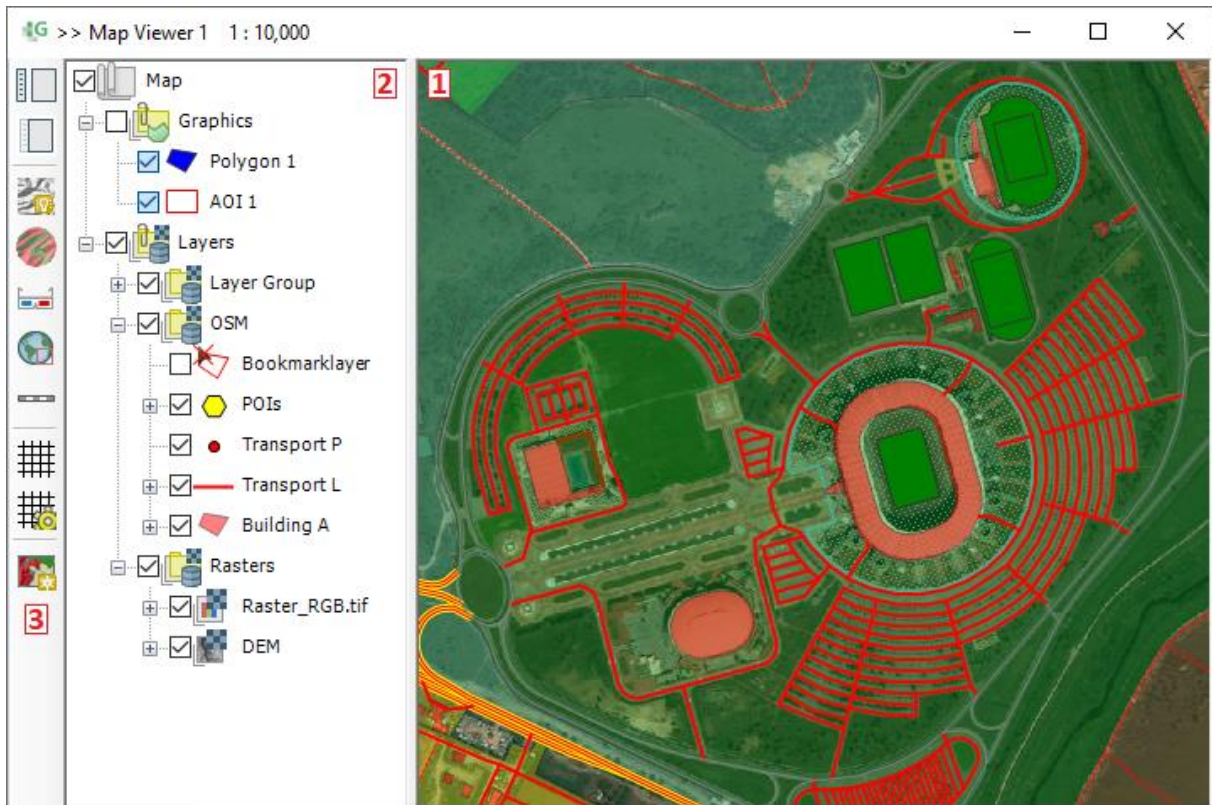


Figure 9: **Map window** with **map viewer** (map), **TOC** and **Map Viewer toolbar**

Each map window contains:

- a **Map Viewer (1)**

Here, the map with all data activated (checked) in the TOC is displayed graphically (see chapter 2.2.2.1).

- a **TOC (Table of Content) (2)**

It shows a listing of all data contained in the project. By activating/deactivating (check/uncheck) you can control which data is displayed in the map viewer (see chapter 2.2.2.2).

- a **Map Viewer Toolbar (3):**

It contains functions that refer directly and exclusively to its map window (see chapter 2.2.2.3).

Each GAFmap® project contains at least one map window, but it can also contain multiple map windows and/or a 3D window (see chapter 2.2.3). For more information see chapter 2.2.2.4.

Note that in GAFmap® Express you can neither close map/3D windows nor add new ones.

2.2.2.1 Map Viewer

The **map viewer** is part of the **map window** (see chapter 2.2.2). Here, the **map** is displayed graphically with all (geo) data activated (checked) in the TOC; data not activated (unchecked) in the TOC is hidden.

Note that even activated data is only displayed in the map viewer if it is within the currently visible map extent and is not obscured by other data. If necessary, adjust the map extent (see chapter 4.1.3 et seqq.).

The current map scale is displayed in the title bar of the map window.

2.2.2.2 TOC (Table of Content)

The **TOC** (Table of Content) is part of the **map window** (see chapter 2.2.2). It shows a listing of all (geo) data contained in the project, i.e. of all vector and raster layers, tables, graphics, etc. added to the project or newly created in the project, in tree structure.

Activate/deactivate elements in the TOC

By **activating/deactivating** (= checking/unchecking) individual elements in the TOC you can control which data is shown in the map viewer: checked elements are displayed, unchecked elements are hidden. If you deactivate groups, all contained elements are hidden; the subordinated check boxes are then "blued out":

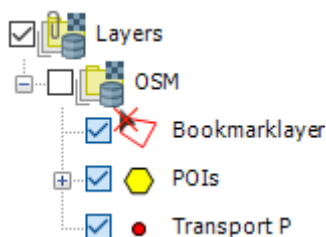


Figure 10: Deactivated Group

Note that even activated data is only displayed in the map viewer if it is within the currently visible map extent and is not obscured by other data. If necessary, adjust the map extent (see chapter 4.1.3 et seqq.).

Order of the Elements in the TOC / Drawing Order in the Map Viewer

The order of the elements in the TOC directly affects the order in which the data is drawn in the map viewer: data that is on top in the TOC is also on top in the map viewer.

Within a vector layer (see chapter 5.3.2), the drawing order depends on the order of the features in the attribute table in the current sorting (see chapter 5.3.2.1): Features that are higher up in the table are drawn first and are therefore at the bottom in case of overlaps.

Selecting Elements in the TOC

With a simple left-click on an element in the TOC (on a layer icon or name) you can **select** it; it is then highlighted in blue:

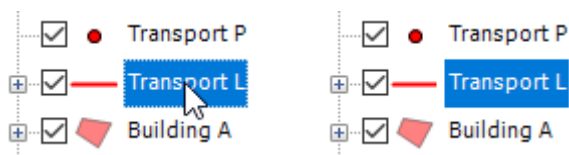


Figure 11 Element selected with the TOC

Multi selection is possible e.g. by pressing the Ctrl or Shift key.

For selected elements you can then perform various actions, e.g.:

- activate, deactivate, or switch them (collectively), e.g. by pressing the X key (see e.g. chapter 5.2.1.8).
- open their (common) context menu by right-clicking a selected element (see chapter 5).
- open their (common) properties, e.g. via the corresponding context menu command (see the respective subchapters of chapter 5, e.g. 5.2.1.10, 5.3.2.5, or 5.3.3.6).
- for a single selected element: rename it by clicking (again) on the layer name and then typing the new name (only possible for self-created graphics).

Main Groups (Group Map, Graphics, Layers)

The main group **Map** activates/deactivates the entire map in the map viewer. Below the map, a strict distinction is made between **Graphics** and **Layers**:

- **Graphics** are simple (vector) geometries, symbols, and shapes of all kinds, which are located in the map via coordinates. They are usually stored directly in the project file (*.xmp).

If you add additional graphics yourself (see chapter 4.7.3 et seqq.), these are marked with a *green star in the TOC. Unlike elements that are part of the original Pack&Go Container, such graphics can be changed or deleted as wished.

For more information, see chapter 5.2.

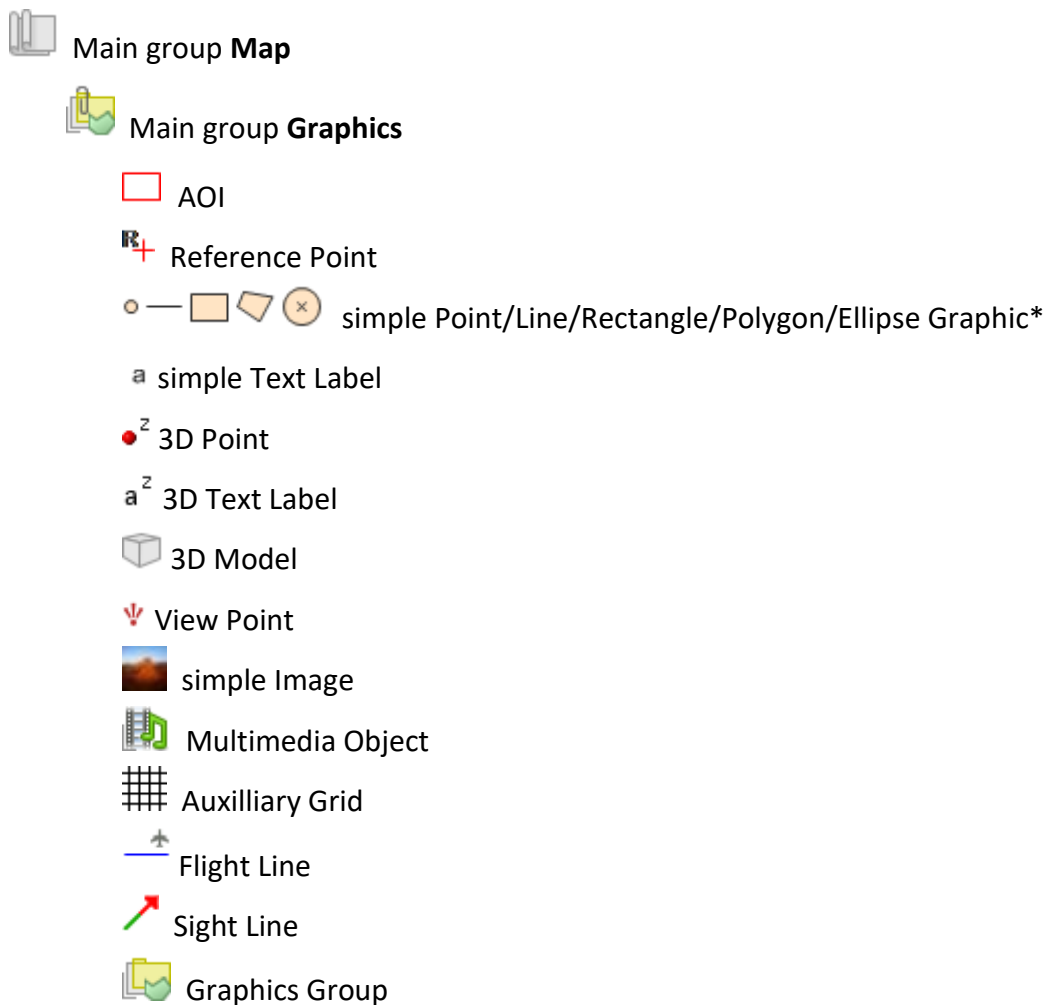
- **Layers** refer to an external dataset, e.g. a vector or raster file. Only the data connection and all display options are stored in the project file.

For Pack&Go projects, the dataset is usually stored in the container in addition to the project file (i.e. the layer usually refers to a dataset in the container).

For more information, see chapter 5.3.











Layer Icons / Symbols in the TOC

Based on the **layer icons** (symbols) you can usually directly identify the individual elements in the TOC:









Main group **Layer**

-  Vector Layer (Point Layer)*
-  Vector Layer (Line Layer)*
-  Vector Layer (Polygon Layer)*
-  Vector Layer (geometry collection)*
-  Raster Layer (multi-channel)
-  Raster Layer (single-channel)
-  Raster Layer (single-channel, DEM (Digitale Elevation Model))
-  Point Cloud
-  Table
-  Layer Group

* The layer icons of vector geometries (for graphics and vector layers) always correspond exactly to the icon with which the vector objects are displayed in the map viewer.



For explanations on the individual graphic and layer types, see chapter 5.

Additionally to the layer icons, a number of **overlay icons** can appear in the TOC, which are drawn over the layer icon and allow conclusions on certain layer properties. Examples of such overlay icons are:

-  Viewshed: the Point is used as Viewshed Point.
-  Not selectable: the graphic / vector layer is not selectable in the map viewer.
-  Z: the graphic / vector layer is z-aware / is 3D capable.
-  editable: the graphic is self-created / not part of the Pack&Go container and can therefore be deleted or edited.

The various overlay icons are mentioned in the manual at the respective function/property.

Expanding/Collapsing Layers

Via the  in the TOC you can expand main groups, groups as well as a number of layers or collapse them via the  and thus switch between a detailed and a compact TOC display:

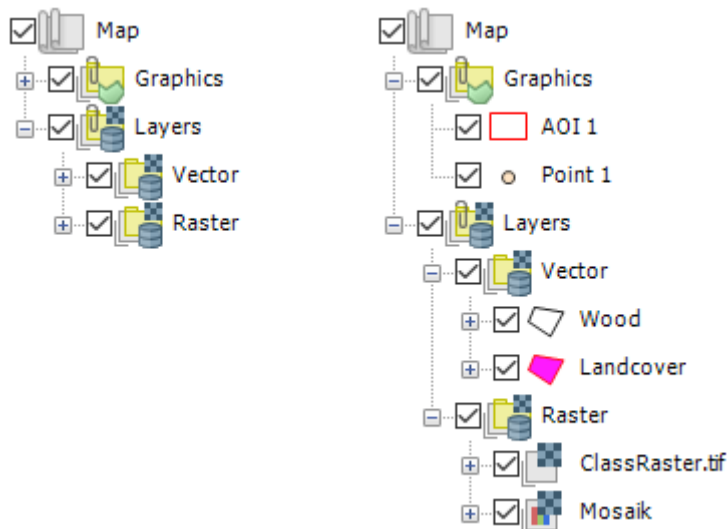


Figure 12: TOC display with collapsed or expanded groups

Depending on the **Renderer Type** (see chapter 5.3.2.5 or 5.3.3.6), different details are displayed when vector and raster layers are expanded, for vector layers e.g. specified unique values or classes, for raster layers e.g. unique values, classes, a corresponding raster statistic or band mapping or, in the case of mosaic layers (see chapter 5.3.6), the contained single rasters:

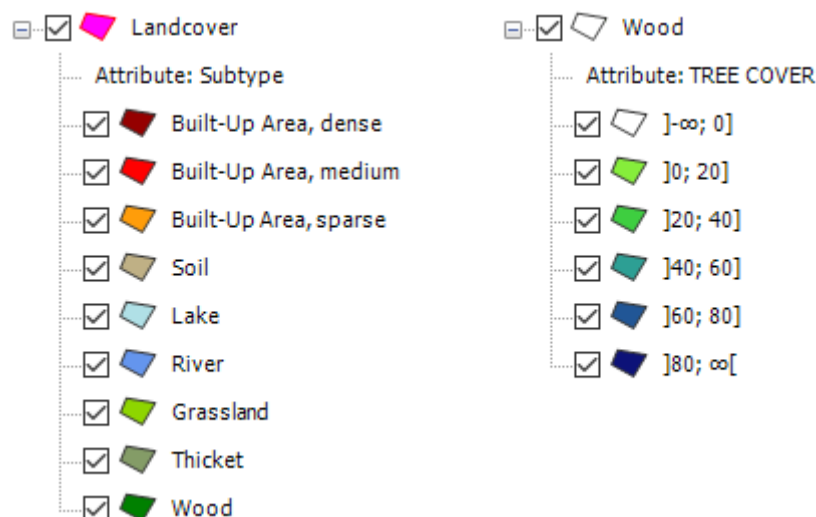


Figure 13: TOC display, examples of expanded vector layers: unique values (left) and classes (right)

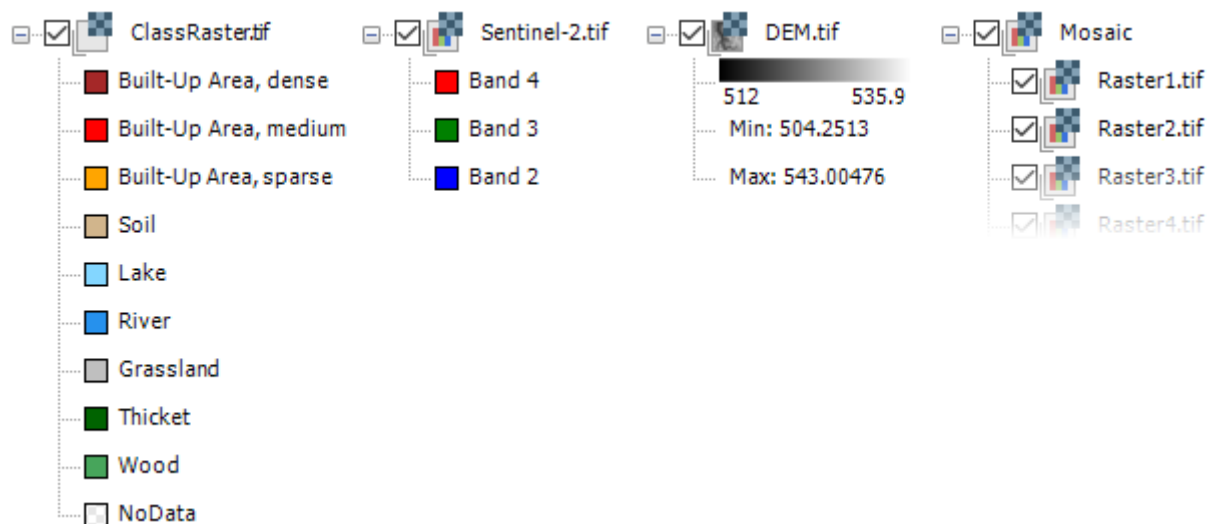


Figure 14: TOC display, examples of expanded raster layers (from left to right): unique values for a classification raster, band mapping for a color image, raster statistics Min/Max for a DEM with colormap, single raster for a mosaic layer

Show/hide/undock TOC

The TOC is a fixed part of the map window but can be undocked or hidden for a better project layout using the corresponding buttons in the Map Viewer toolbar. For more information, see chapter 2.2.4.4 and 4.5.1 et seqq.

2.2.2.3 Map Viewer Toolbar

The **Map Viewer Toolbar** is part of the **map window** (see chapter 2.2.2). All functions contained in the toolbar directly and exclusively affect the map window to which it is pinned.

- Via the **Map Viewer Toolbar** you can



- Dock/undock and hide/show the TOC of the map window
- Activate/deactivate various on-the-fly analyses in the map viewer
- Show/hide visual hints in the map viewer
- Export the current map extent as raster

For more information on all functions contained, see chapter 4.5 et seqq.

Unlike the toolbars in the main window (see chapter 2.2.1.2) the Map Viewer toolbar is fixed to its map window and cannot be moved or adjusted via the general settings.

2.2.2.4 Projects with multiple map windows

The **Multi Window Technique** of GAFmap® allows for working with any number of map windows (see chapter 2.2.2) in parallel within one project. The content, i.e. the layers and graphics in the TOC including their order, structure, and properties, is the same for all map window, as are all cross-map settings such as the map spatial reference. However, the activation status of the layers and graphics (visible / not visible), the displayed map section, and/or the activation status of the on-the-fly analyses and visual hints available in the Map Viewer toolbar may differ in the individual windows. This allows you e.g. to display the same map section with different contents and/or different sections of the same maps in parallel.

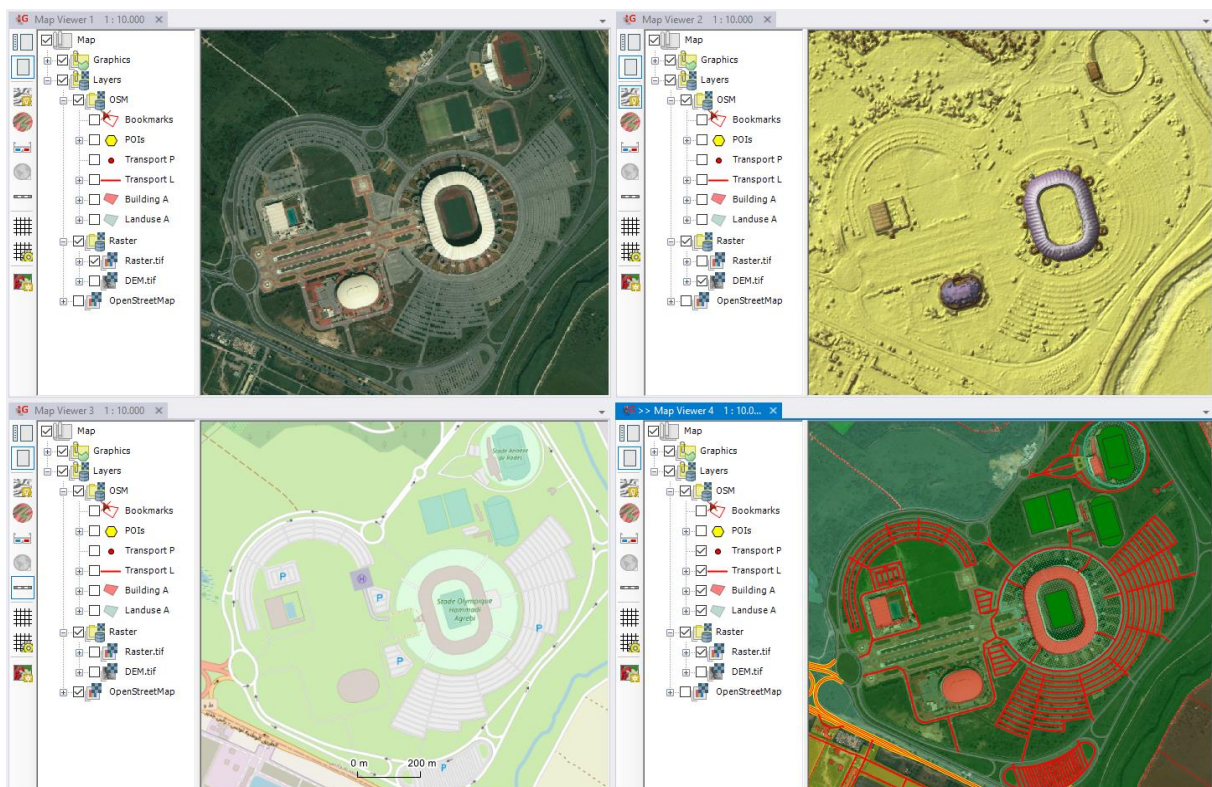


Figure 15: Project with multiple map viewers, example 1: same map section with differently activated layers (Link map viewers, see chapter 3.2.1)

Included map windows cannot be closed, but can be rearranged if desired.

Via the **Menu Window**, you can always

- determine whether and how the individual map viewers are linked to each other (see chapter 3.2.1)
- show/hide a multi cursor (see chapter 3.2.2), and
- view a list of all current map viewers (see chapter 3.2.5).

Overview Windows

To provide a better overview with multiple map viewers open, a map window can be defined as **overview**. In this overview, all other map viewers are then displayed as a rectangle (see chapter 4.5.8).

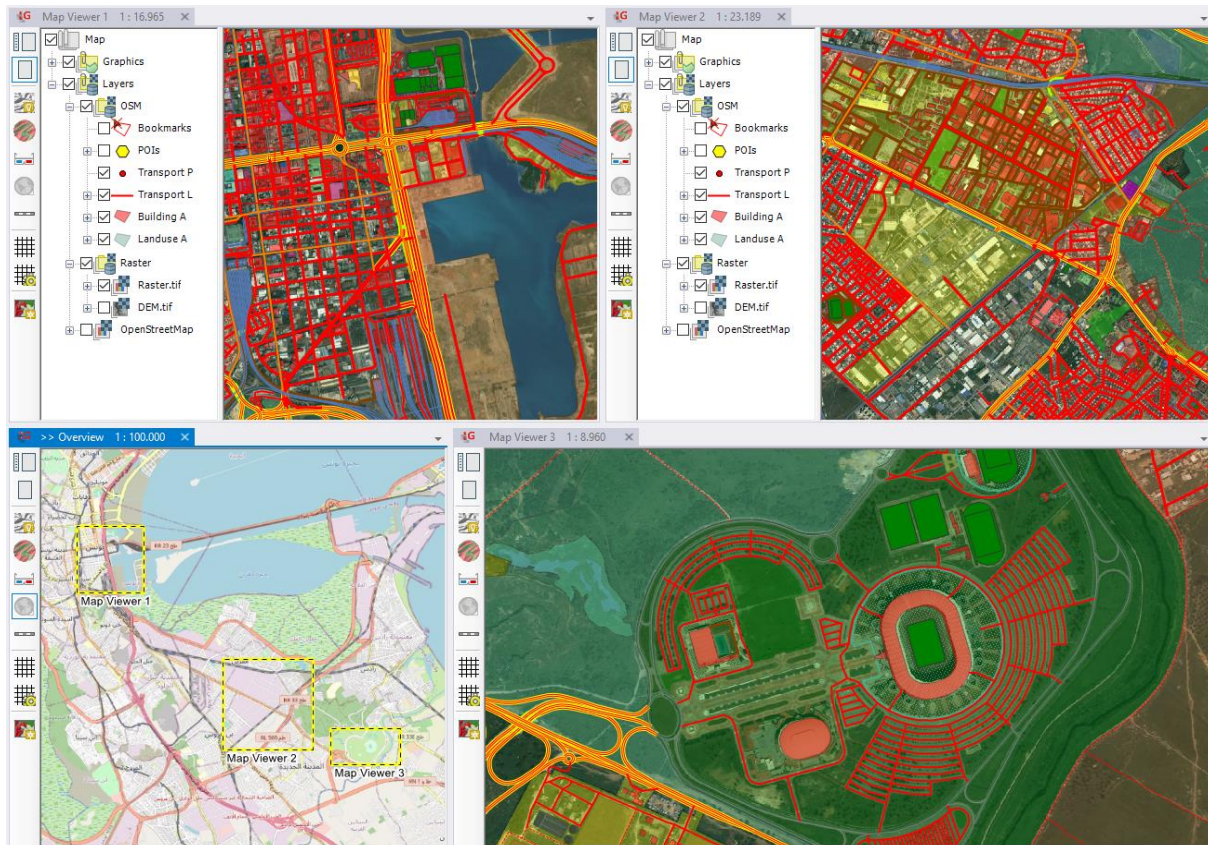


Figure 16: Project with multiple map windows, example 2: different sections of the same map with overview (bottom left)



You can tell whether a map window is an overview by the (grayed-out) button **Enable/Disable Overview** (see chapter 4.5.8): for overviews, it is activated (i.e. framed in blue).

Active Map Windows

If the project contains multiple map windows, one of the windows is always active. This window is marked with a >> shift sign in front of the map window name in the window title and is usually also highlighted in blue when the map window is docked:



Figure 17: Active map viewer

If you click into a map window, it gets activated automatically; i.e. the map window in which an action was last performed is usually active.

Usually, the activation status of the map windows not relevant. However, it is important e.g. for various functions that directly affect the map section displayed in the map viewer such as **Pan** or **Zoom** (map extent) (see chapter 4.1.3 et seqq.), or those that affect the activation status of the layers in the TOC, e.g. **Toggle** (Layer) (see chapter 4.4.2).

If a function only affects the active map window, this is stated in the corresponding chapter of the Manual.

Additional 3D Window

In addition to one or more map windows, a project can contain a 3D window (see chapter 2.2.3). For this window, the above described applies analogously.

2.2.3 3D Window

Only available if the project contains a 3D window

The structure of the 3D window corresponds to that of the (2D) map window (see chapter 2.2.2):

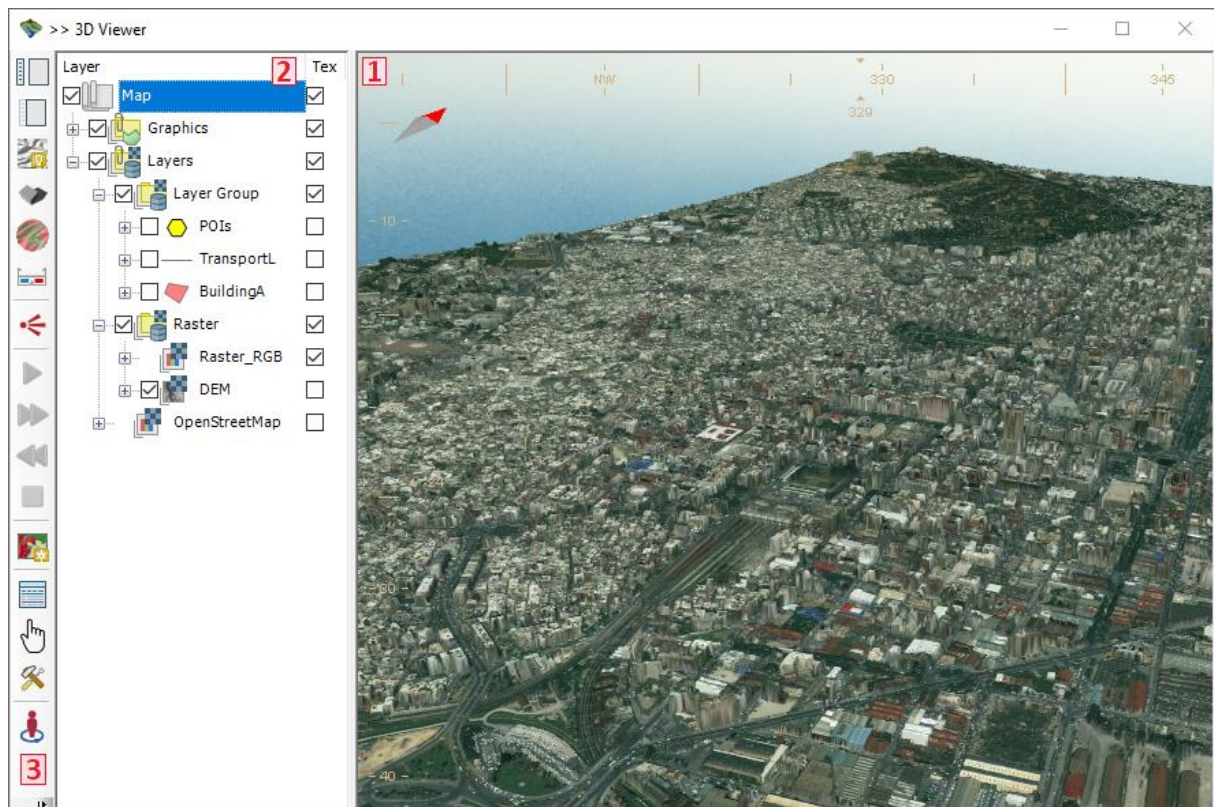


Figure 18: 3D window

The 3D window contains:

- the **3D Viewer (1)**

Here, all data activated (checked) in the 3D TOC are visualized in 3D space (see chapter 2.2.3.1).

- the **3D TOC (Table of Content) (2)**

It shows a listing of all data contained in the project. By activating/deactivating (check/uncheck) you can control which data is displayed in the 3D viewer; here, a distinction is made between 3D data and textures (see chapter 2.2.3.2).

- the **3D Viewer Toolbar (3):**

It contains functions that refer directly and exclusively to the 3D window (see chapter 2.2.3.3).

Each GAFmap® project contains at least one map window (see chapter 2.2.2) or a 3D window, but it can also contain one or multiple map viewers and a 3D window (see chapter 2.2.2.4).

Note that in GAFmap® Express you can neither close map/3D windows nor add new ones.

2.2.3.1 3D Viewer

The **3D viewer** is part of the **3D window** (see chapter 2.2.3). Here, all layers and graphics that are activated (= checked) in the **3D TOC** are visualized in 3D space. A distinction is made between **3D data** and **textures** (see chapter 2.2.3.2).

You can adjust the data extent that is displayed in the 3D viewer using the buttons **Start 3D Viewer** or **Start 3D Viewer with Current Map Extent** (see chapter 4.1.15). Depending on the amount/size of data and hardware, reducing the size of the displayed section can significantly increase performance in the 3D Viewer, i.e. image buildup and movement speed.

The 3D viewer can optionally also be output stereoscopically or via a VR headset ("virtual reality") (see chapter 5.1.7, paragraph **Stereoscopic Views**).

For information on the 3D Viewer controls, see chapter 7.

2.2.3.2 3D TOC / Distinction Between 3D Data and Textures

The **3D TOC** is part of the **3D window** (see chapter 2.2.3). Here, all data contained in the project are listed. The **3D TOC** contains the same elements as the **2D TOC**, including their structure/order. The functionality also corresponds to that of the 2D TOC - except for the special features mentioned below. For more information on the TOC, see chapter 2.2.2.2.

In the **3D Viewer** only graphics and layers are displayed that are activated (= checked) in the TOC. Here, a distinction is made between **3D data** and **textures** (see below). You can adjust the activation status of the elements in the TOC as you wish.

Show/hide/undock 3D TOC

The 3D TOC is a fixed part of the 3D window but can be undocked or hidden for a better project layout using the corresponding buttons in the 3D Viewer Toolbar. For more information, see chapters 2.2.4.4 and 4.6.1 et seqq.

Distinction Between 3D Data and Textures

For the visualization of data in the 3D space, it is to be distinguished whether these are represented as 3D objects ("3D data") or as texture:

- **3D Data** can themselves be displayed as three-dimensional objects located in space. The height information necessary is usually stored directly in the dataset. For the

visualization of the 3D data, especially the properties under category **3D Symbology** are decisive (see chapter 5).

The 3D data includes

- digital elevation models (DEMs and 3D surfaces) (see chapter 5.3.4)
- 3D models
- vector layers with and without Z coordinates
- various 3D capable graphics elements

Not all layers can be visualized as 3D object. Whether a layer is 3D capable or not depends on the type.

- **Textures** cannot be visualized by themselves in space, but need another object on which they are drawn as image/raster. In GAFmap® all layer textures are exclusively placed on the **base terrain** (i.e. on DEMs, see below and chapter 5.3.4).

All layer textures in the 3D Viewer are visualized with the set 2D Symbology (especially properties under category **Symbology**, see chapter 5).

All layers can be displayed as textures, as long as base terrain is loaded and activated as "texture base". Vector data is rasterized for texturing.

Any number of layers can be activated as texture simultaneously. They are then combined on-the-fly as an (overall) raster and placed as a (top) texture on the DEM. If textures cover each other, the texture that is higher up in the TOC has higher priority and is drawn (as in the (2D) map viewer, see chapter 2.2.2).

The **3D TOC** reflects the distinction mentioned above for data visualization: In addition to the checkbox in front of a layer, by which it can be enabled/disabled as 3D object, you can find another checkbox behind the layer in the column **Tex** to activate it as texture:

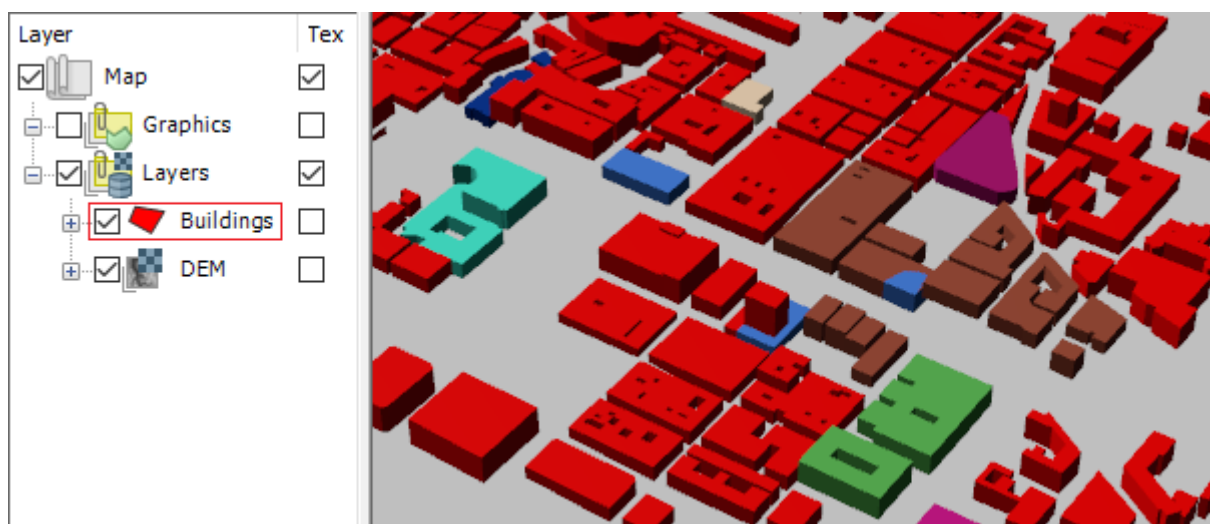


Figure 19a: Polygon layer visualized as 3D object (front checkbox)

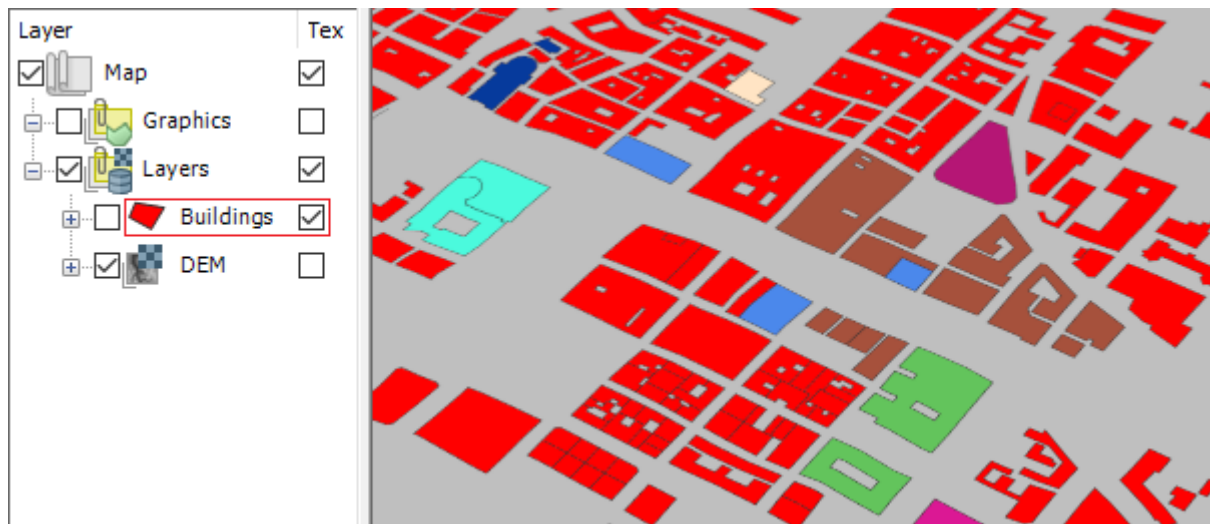


Figure 19b: The same polygon layer visualized as texture on an underlying terrain/DEM (back checkbox)

Note that a texture is also only activated if all groups above the layer are checked (incl. parent/main groups):

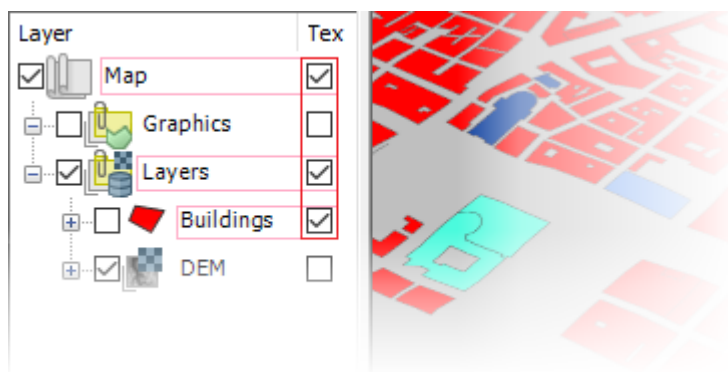


Figure 20: A layer is only activated when all groups above are checked.

A layer can also be displayed as 3D object and texture at the same time, e.g. if some features of a vector layer contain height information and others do not:

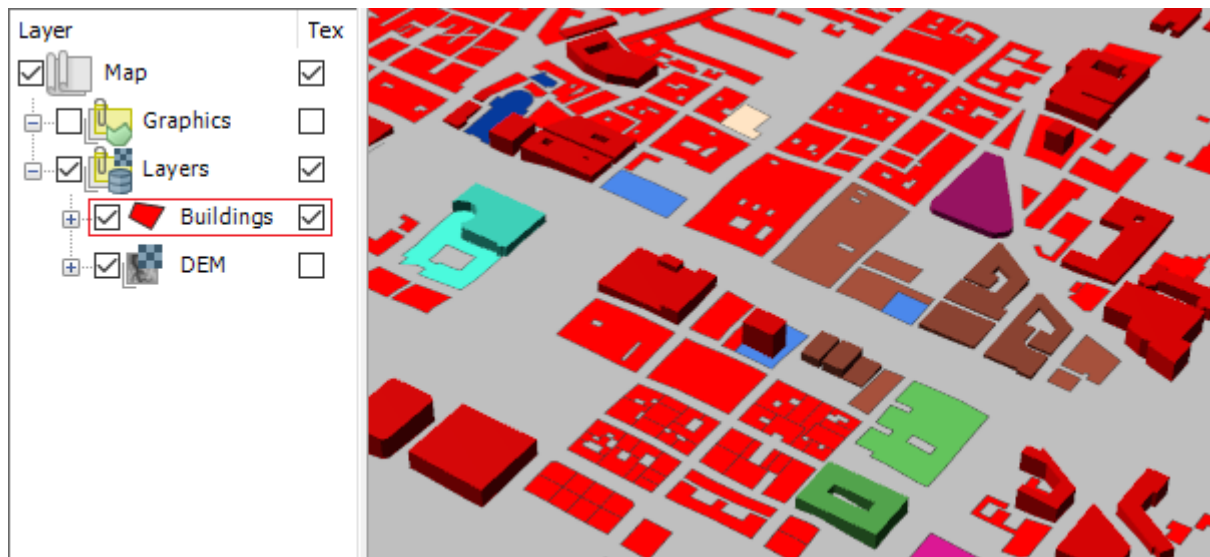


Figure 21: Polygon layer, for which not all features contain height information, visualized as 3D object (front checkbox) and texture (back checkbox)

If a layer is not 3D capable (e.g. multi-channel rasters or simple graphics), the front checkbox is missing. These layers can only be used as texture:



Figure 22: For layers/graphics that are not 3D capable, the checkbox in front is missing. They can only be used as texture.

Special Case "RPC Textures"

Simple layer textures are applied as "top textures" to the base terrain / DEM, i.e. they are placed vertically from above on the DEM and are distorted accordingly if the terrain is inclined and/or relieved.

In addition to simple layer textures, GAFmap® supports RPC textures. These are satellite images that contain exact information about the acquisition geometry and therefore can be applied to the terrain exactly opposite to the direction of acquisition. This way, they can even be used for vertically sloping side surfaces if the acquisition angle is sufficiently inclined ("RPC based sight views). For more information, see chapter 5.3.5.

2.2.3.3 3D Viewer Toolbar

The **3D Viewer Toolbar** is part of the **3D window** (see chapter 2.2.3). All functions contained in the toolbar directly and exclusively affect the 3D window.

- Via the **3D Viewer Toolbar** you can



- activate/deactivate various on-the-fly analysis and visual aids,
- start, pause or stop animations and
- configure the 3D Viewer and the 3D controls.
- change into the stereoscopic, VR or Multi User mode,

For more information on all functions contained, see chapter 4.6 et seqq.

Unlike the toolbars in the main window (see chapter 2.2.1.2) the 3D Viewer Toolbar is fixed to the 3D window and cannot be moved or adjusted via the general settings.

2.2.4 Window Layout

The **Window Layout** in GAFmap® Express is variabel, i.e. you can determine to a certain extent whether, where, and how certain windows are anchored/docked in the main window (see chapter 2.2.1 and 2.2.4.3) or how the windows are structured/arranged.

- The term **floating** is used for all windows and dialogs that are not docked, but float "above" the main window and can thus be positioned freely and independently on the screen(s). All windows and dialogs are (initially) opened floating, including dockable windows.

For more information, see chapter 2.2.4.1.

- **Dockable Windows**, especially the map windows and the 3D window (see chapter 2.2.2 and 2.2.3 as well as 2.2.4.4) can be anchored and/or embedded in the main window after opening. Not all windows are dockable.

For more information, see chapter 2.2.4.2 et seqq.

Tips and notes:

- Please note that docking windows is not possible if you work with two or more screens with different DPI scaling!

2.2.4.1 Floating Windows

Usually windows/dialogs are opened floating, i.e. by default they are not docked in the main window or in any other window and can be positioned freely and independently on the screen(s).

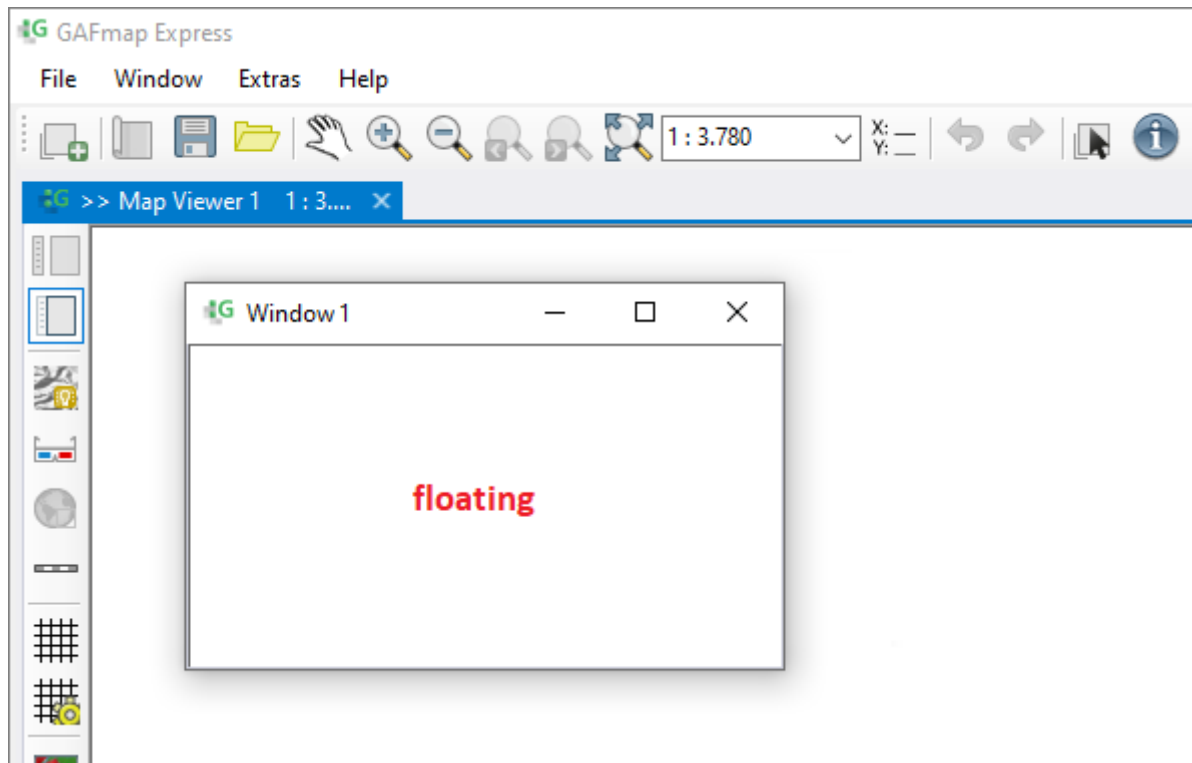


Figure 23: Floating window

All floating windows can be closed via the x button in the top right of the title bar, some of them, e.g. all dockable windows (see chapter 2.2.4.2) can be minimized separately or maximized to the screen. Exceptions are map windows and 3D window: they can never be closed.

All floating windows are listed separately in the Windows taskbar next to the GAFmap® main window and can be opened there again at any time, e.g. if they have been moved to the background or have been minimized while working.



Figure 24: Windows Taskbar using the example from above: the GAFmap® Express main window and the floating window are listed separately (display depends on the Windows settings)

Dockable windows can be used floating after opening or be anchored in other windows (see chapter 2.2.4.2).

2.2.4.2 Dockable Windows

Dockable Windows can be anchored ("docked") in the main window (see chapter 2.2.4.3) as well as in other dockable windows. The windows then share a common, superior window and close neatly and space-saving with each other in it. Common borders can be easily moved/adjusted with the mouse and remain even if e.g. the size or aspect ratio of the superior window changes.

You can tell that a window/dialog is dockable if docking navigation elements appear when you grab it by the header bar and drag it to another dockable window (see below); for non-dockable windows, the navigation elements do not appear.

Docking windows / anchoring in other windows

Docking of windows is done via drag & drop and with the help of navigation elements/crosses, which appear as soon as you grab a dockable window by (left-)clicking the header bar and drag it to another dockable window:

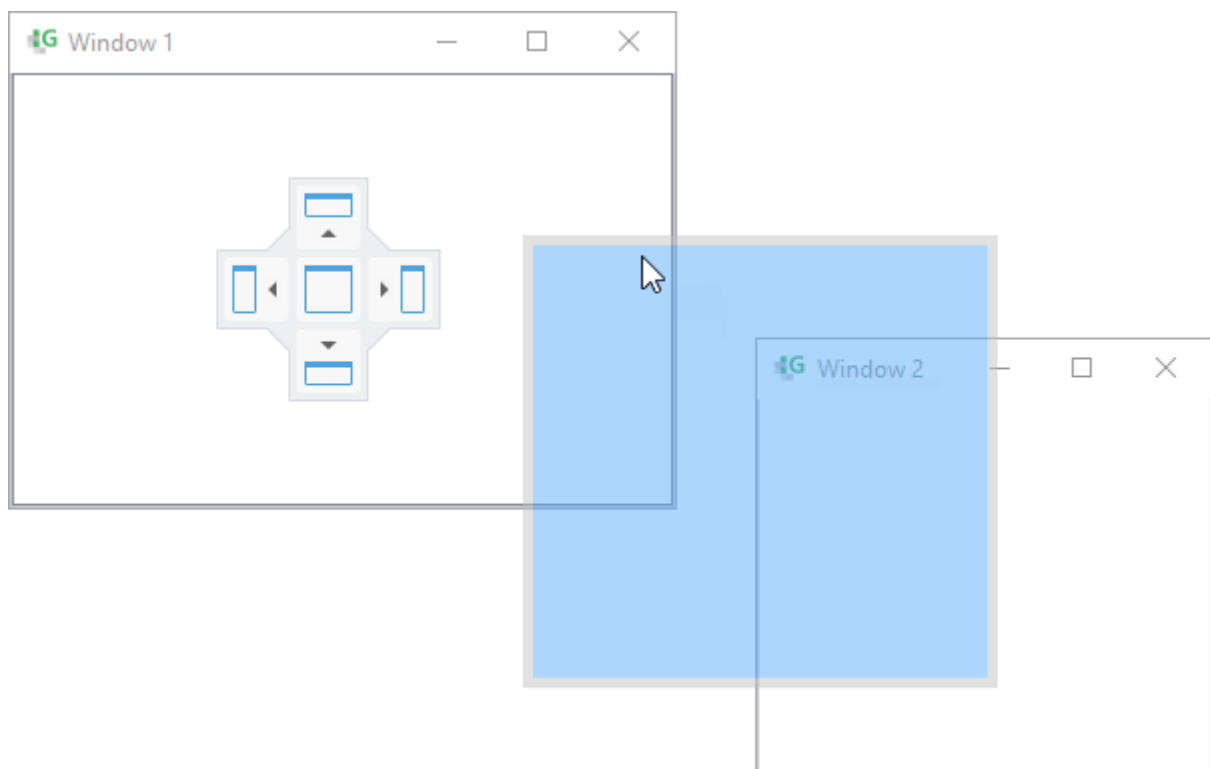


Figure 25: **Control cross** for anchoring a window within another window

While moving, the potential new position of the window is displayed as a semi-transparent blue rectangle. If you move the mouse pointer across one of the navigation element icons, the window preview jumps to the corresponding docking position. If you release the mouse button, the window is positioned as displayed in the preview.

Example from above:

If you release the mouse button next to the navigation cross symbols (as displayed in the figure above) or press the Ctrl key while releasing it, window 2 is not anchored, but remains floating (see chapter 2.2.4.1).

If you move window 2 to one of the outer navigation cross symbols of window 1, it is anchored respectively left/right or top/bottom within window 1.

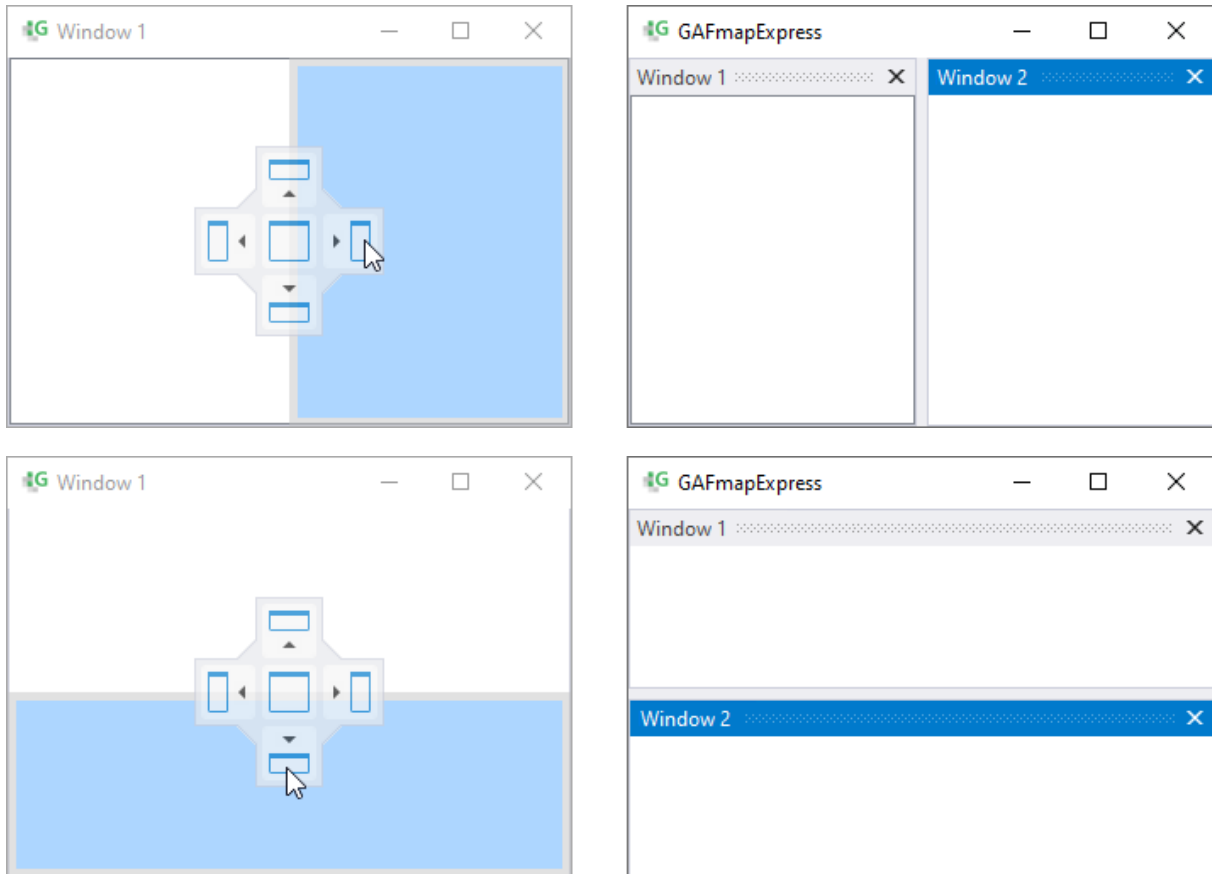


Figure 26: **Control cross/element** to anchor a window inside another window - moving a window to outer symbols

If you move window 2 to the center navigation cross symbol of window 1, it is included as a tab in window 1:

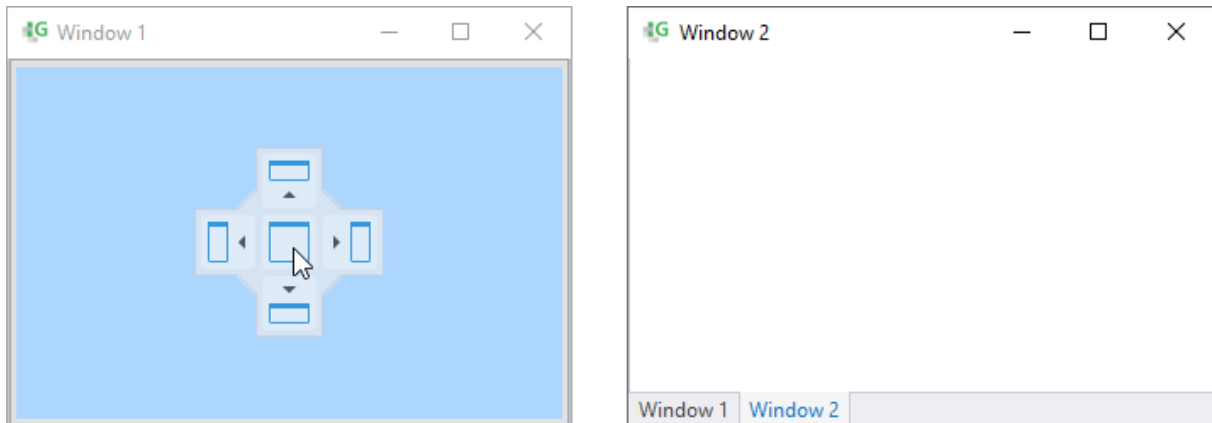


Figure 27: **Control cross/element** to anchor a window inside another window - moving a window to the center symbol

You can then switch between the windows by clicking on the respective map title. You can adjust the order of the tabs subsequently via drag & drop, i.e. by grabbing a tab title with the mouse button, moving it to the desired position, and releasing it there again.

In this way you can anchor as many other windows as you like in one window, regardless of whether it is floating (as in the example above) or docked itself. Note that docking is only possible in other dockable windows and in the main window.

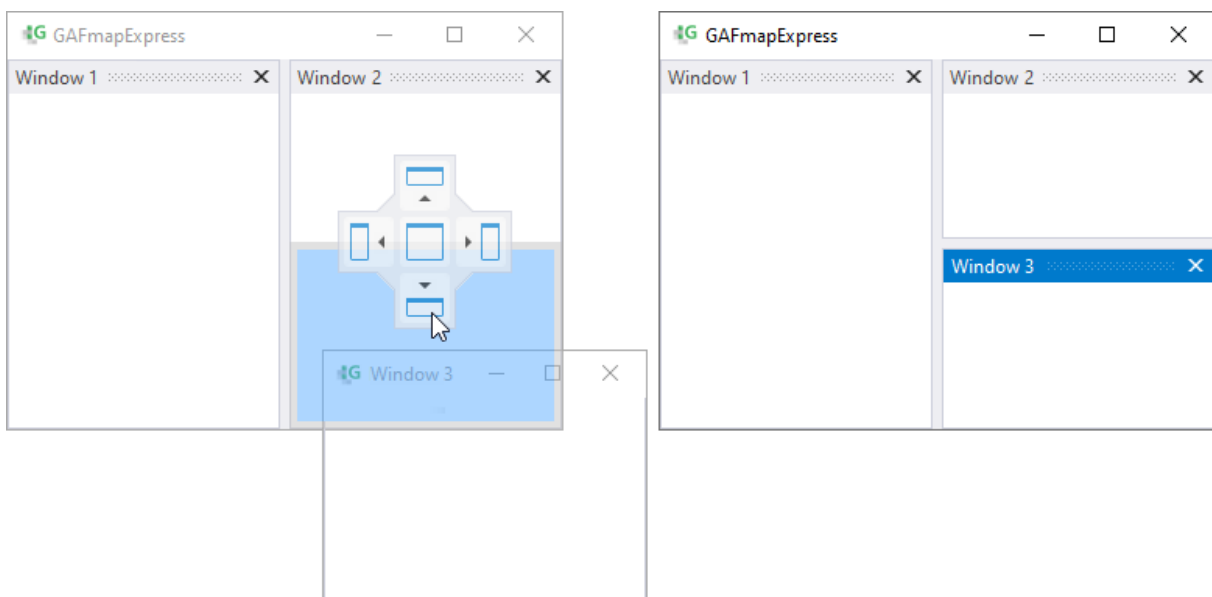


Figure 28: Anchoring a window within another docked window

Undock windows / detach from other windows

You can undock/release an anchored window at any time by grabbing it with a (left) click at the window/tab title, dragging it out of the other window and releasing the mouse button; it is then floating again.

Close dockable windows

Open windows can be closed at any time with the x button. For dockable windows, depending on the layout, it is located either in the top right corner (for floating windows or windows anchored to the outside of the main window; see also chapter 2.2.4.3) or at the tab title (for windows anchored to the inside of the main window).

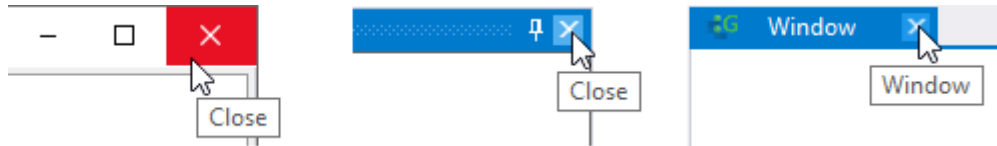


Figure 29: Working with multiple map windows - close map window

If multiple windows are anchored in a floating window, the x button in the superior title bar closes all contained windows. If you only want to close a single window, use the blue x button in the respective (single) window title. If a window is included as a tab in a floating window, it must first be released (see above) before it can be closed individually.

Note that map windows and the 3D window cannot be closed.

Open hidden, covered and/or minimized windows

To all open, dockable windows applies: If they are called up again by clicking the respective button or command in the interface, they are brought up and activated (highlighted in blue). This way, you can e.g. "find again" windows that have been moved to the background, minimized or hidden while working.

Map windows and 3D window can be opened via the **List of Map Windows** in the menu Window (see chapter 3.2.5), separated **TOCs** via the button **Activate TOC** in the respective map/3D window (see chapters 4.5.3 and 4.6.3).

Tips and notes:

- Please note that docking windows is not possible if you work with two or more screens with different DPI scaling!
- Since the size of dockable windows must be flexible, there is no limitation in size for them. Note that this also means that they can be minimally reduced. They can always be maximized again:



Figure 30: Minimally reduced dockable window

2.2.4.3 Dockable Areas within the Main Window

Within the main window (see chapter 2.2.1), you can anchor dockable windows either in the central map window area or above/below or to the side outside of the map window area:

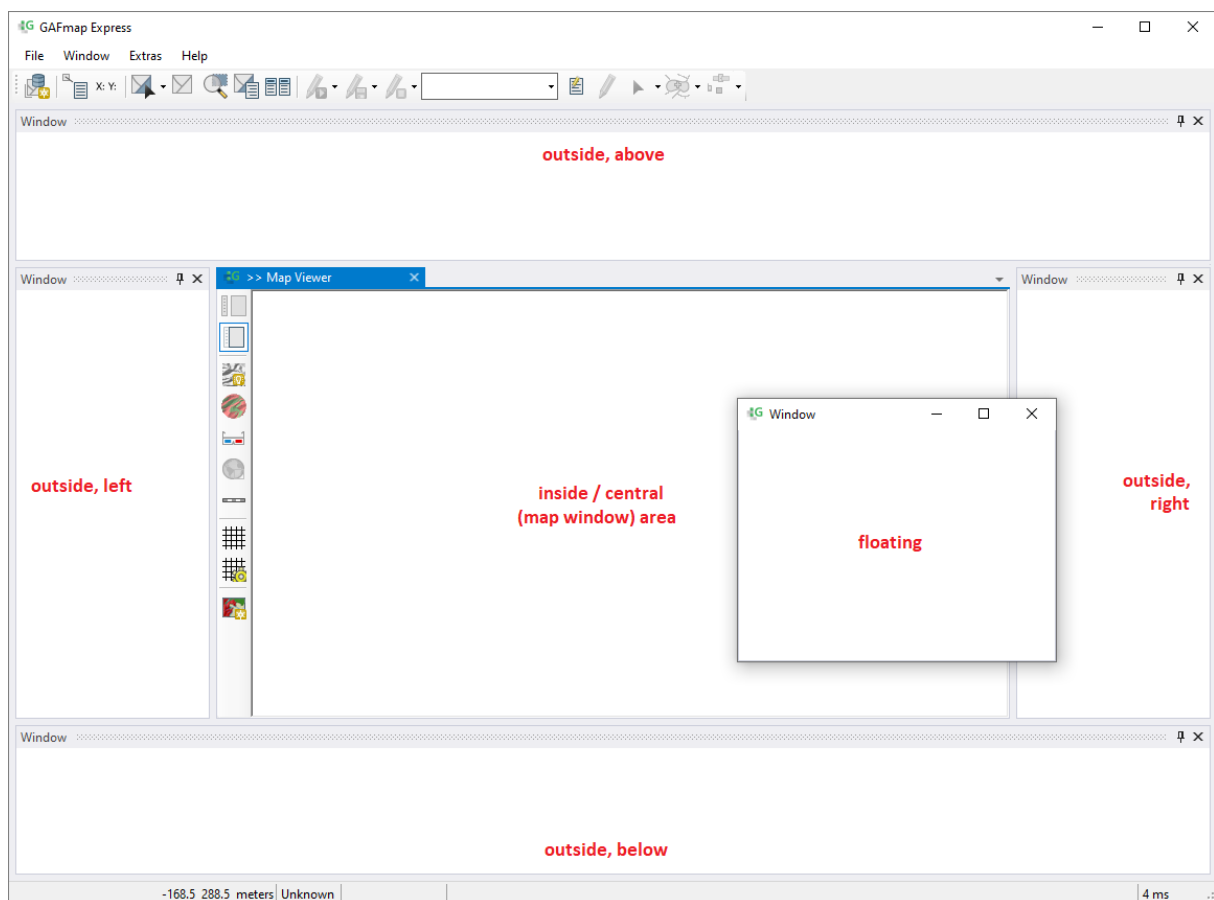


Figure 31: Dockable areas within the main window

If you now drag a dockable window (e.g. the Identify window; see chapter 4.1.11) into the main window, the following anchoring variants are offered via navigation elements:

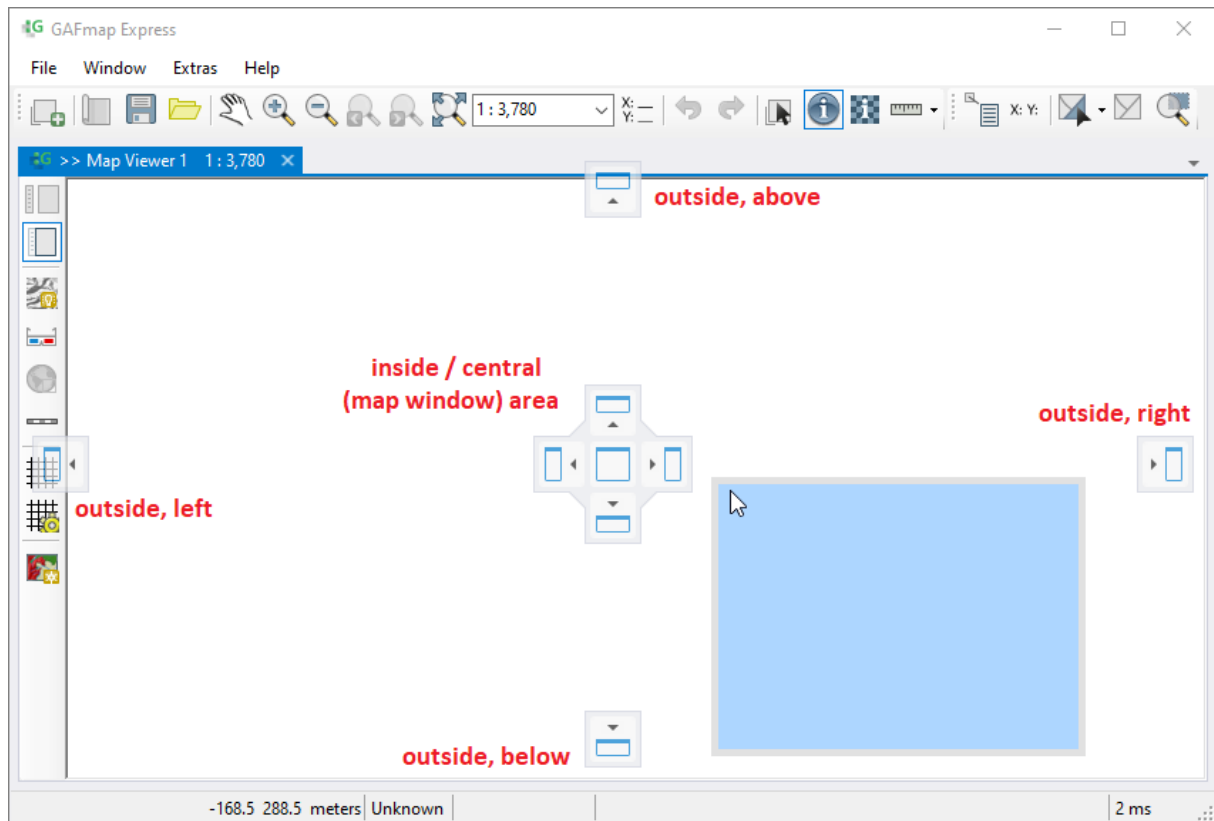


Figure 32: Dock/anchor window within the main window

If you drag the window onto the navigation cross in the middle it is anchored in the central map window area as described in chapter 2.2.4.2, if you drag it onto one of the outer navigation element symbols, it is docked accordingly above/below or laterally outside the map window area.

You can tell whether a window is anchored inside or outside the map window area by the window title (header): centrally docked windows always have a tab map title at the top (even individual ones), externally docked windows have a simple title line. Within the map window area the window titles of tabs are always at the top, outside the map window area they are always at the bottom.

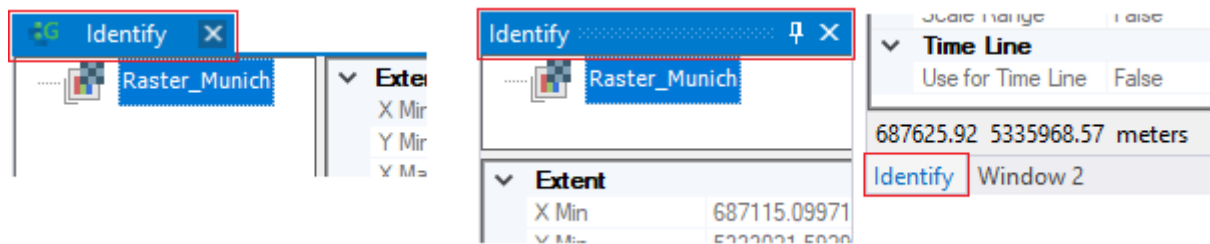


Figure 33: Window title of the Identify window: left: when anchored in the central map window area, centered/ right: when anchored on the outside as tab

If/where a window is docked has no influence on the functionality, but it may lead to a different structuring: Thus, for example, in the **Identify** window (see chapter 4.1.11) the two window areas are displayed side by side if they are floating or anchored centrally in the main window, and below each other if they are anchored on the outer side in the main window.

Note that map windows and 3D window in the main window can only be docked in the central map window area, but not on the outer side in the main window (see also chapter 2.2.4.4).

Automatically hide windows docked to the outer side in the main window ("Auto Hide")

If you anchor a window to the outer side in the main window (see above), it is "pinned" by default, i.e. it is always visible as long as it is not actively closed. If you click the pin button in the top right corner of the header bar, the window is released and "hidden" at the edge of the main window:

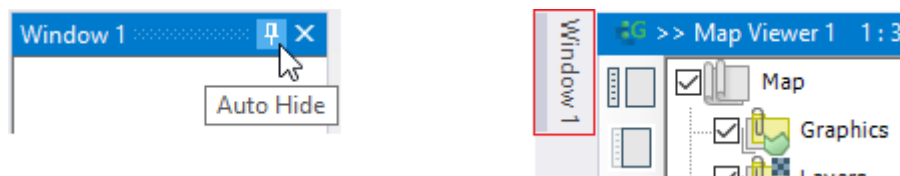


Figure 34: Window 1, docked in the main window on the outer left, hidden (with Auto Hide)

The window is always hidden at the edge where it is docked (top/bottom/left/ right). It can be called up again at any time by clicking on the window title. Via the pin button the window can be pinned again at any time.

If you release the pin in a window that contains multiple window tabs (see chapter 2.2.4.2), all are pinned and listed individually at the edge:

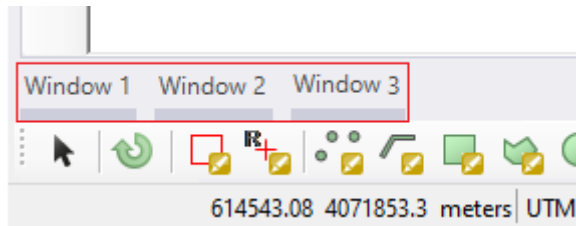


Figure 35: Windows 1-3, docked in the main window at the bottom outside, hidden (with Auto Hide)

Tips and notes:

- Note that windows can also be (unintentionally) "hidden", e.g. if the main window is subsequently reduced in size and there is no longer enough space for all anchored windows. The windows can then always be called up again via the arrow button in the top right corner.



Figure 36: Automatically hidden windows

- To all open, dockable windows applies: If they are called up again by clicking the respective button or command in the GAFmap® Express interface, they are brought up and activated (highlighted in blue). This way, you can always find again "lost" windows.
- Note that multiple window layouts can be stored in the project (see chapter 3.2.4).

2.2.4.4 Special Case Map/3D Window and TOC

Map windows (see chapter 2.2.2) and **3D window** (see chapter 2.2.3) can only be anchored inside the main window in the central map window area, but not outside (see chapter 2.2.4.3). Alternatively you can use it floating (see chapter 2.2.4.1), e.g. if you want to maximize it outside the main window on a second screen.

Undocking the TOC

The **TOC** (see chapters 2.2.2.2 and 2.2.3.2) is an integral part of each map window; it is embedded in its map window by default (i.e. fixed integrated on the left side).



Via the button **Separate/Embed TOC** in the Map Viewer toolbar the TOC can be released from its map window (see chapters 4.5.1 and 4.6.1). It is then opened in a separate, initially floating, dockable window. The title of the TOC window always corresponds to that of the associated map/3D window:

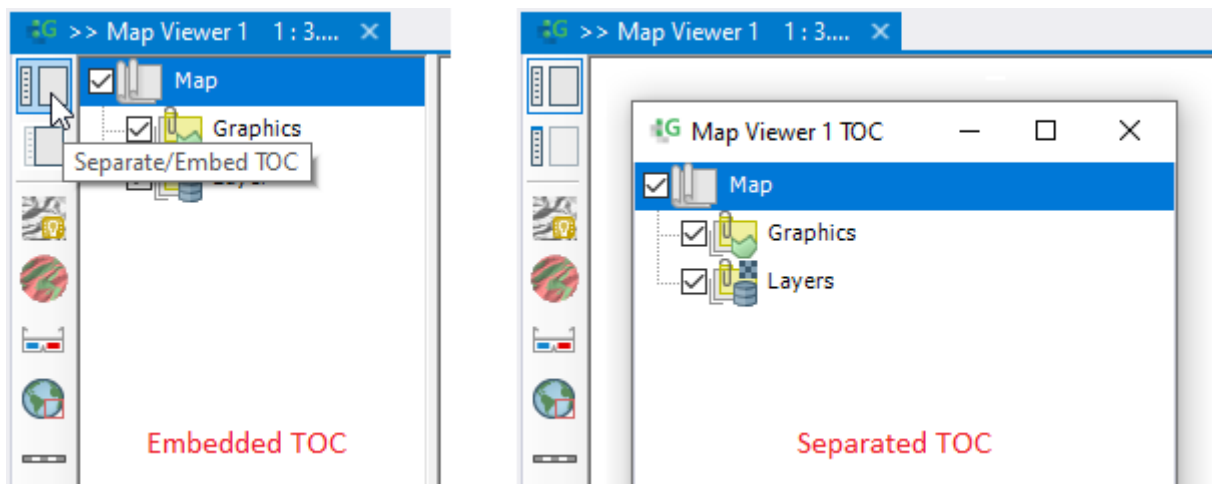


Figure 37: TOC separated from map window (floating)

As long as the button is activated (framed in blue), the TOC remains separated from its map window. By clicking it again, the button can be deactivated at any time and the TOC can be embedded in its map window again.

Like all dockable windows, a separate TOC can be anchored anywhere in the main window or in other dockable windows (see chapter 2.2.4.2 et seq.) or closed separately.

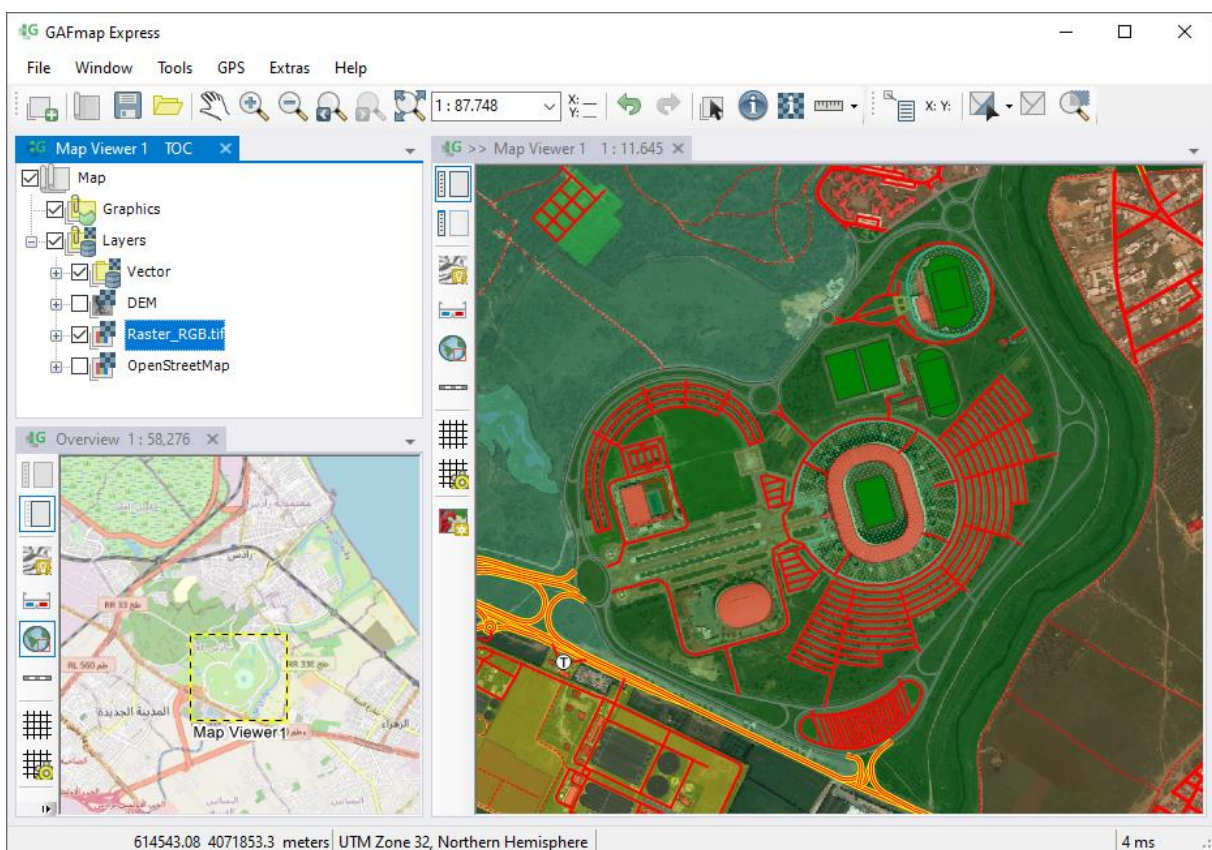


Figure 38: TOC separated from map window, docked above an overview inside the main window

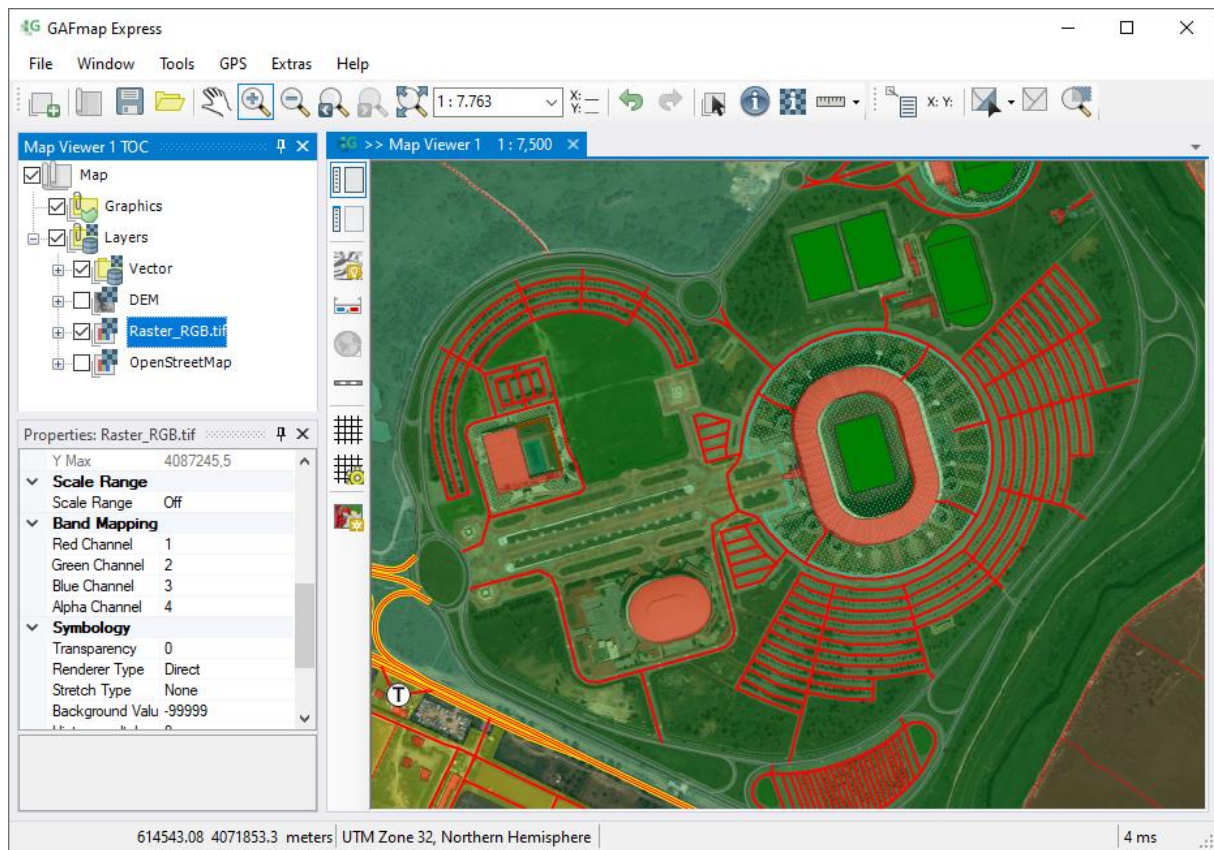


Figure 39: TOC separated from map window, docked on the outside left above the properties window in the main window

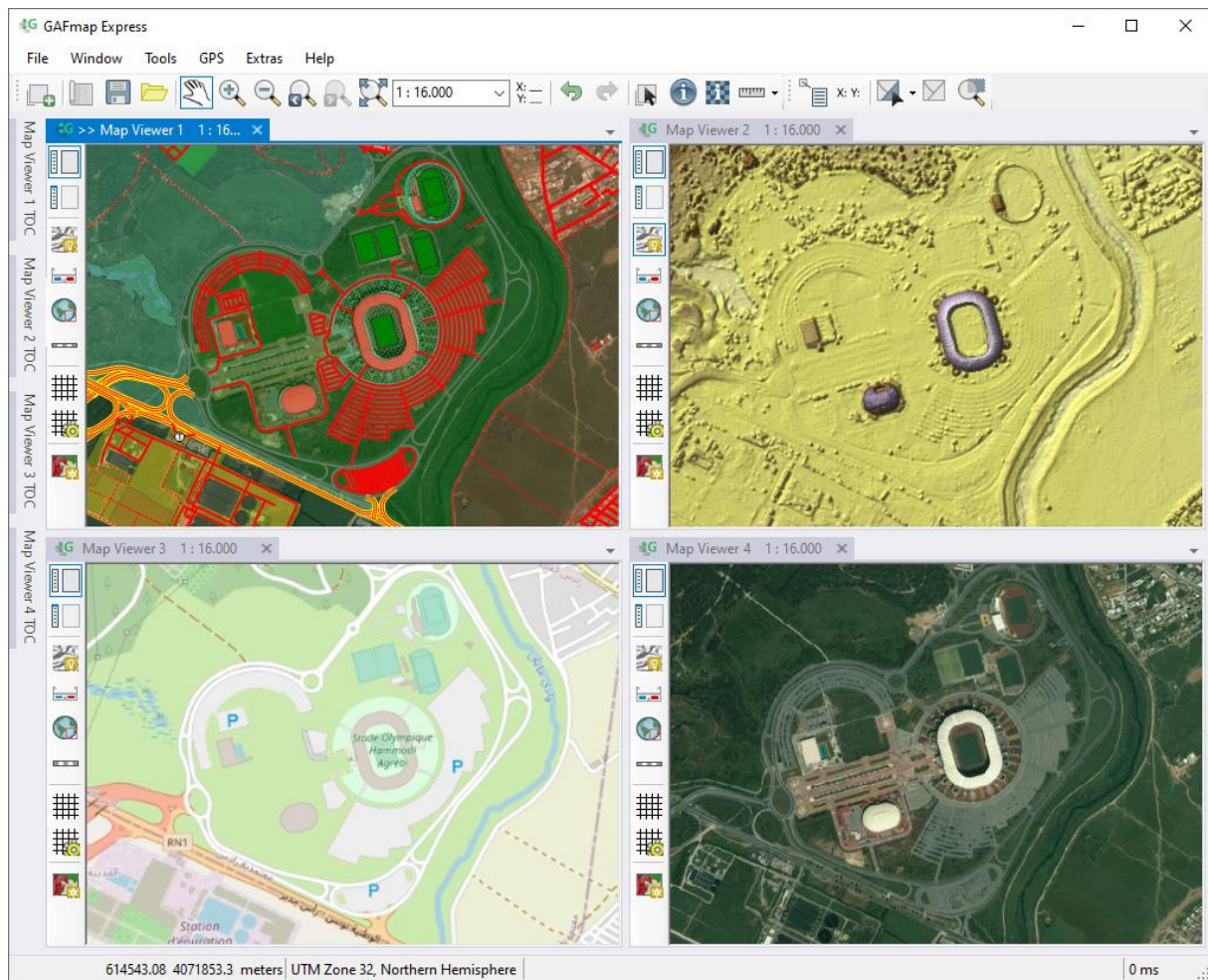




Figure 40: 4 TOCs separated from map window, docked in the main window on the outer left, with Auto Hide (see chapter 2.2.4.2)

 If the TOC is separated, you can activate/reopen it at any time via the button **Activate TOC** in the respective map window (see chapters 4.5.3 and 4.6.3), e.g. if it was moved to the background, minimized, hidden or closed while working. The TOC is then brought up and highlighted in blue.

 Note that an embedded TOC can also be "hidden" via the button **Show/Hide TOC** (see chapters 4.5.2 and 4.6.2); the button is then activated (framed in blue). Click the button again to deactivate it and show the TOC again.

Tips and notes:

- Note that multiple window layouts can be stored in the project (see chapter 3.2.4).

2.2.4.5 Saving Behavior / Window Layouts

The window layout, i.e. the opening status (open/closed) and the last position of all dockable windows is saved in the project. If you load an existing project, the window layout is the same as when it was last saved. Among other things, this means: If a GAFmap® project was packed with open dockable windows, these are also open when you load the resulting Pack&Go container, regardless of whether the windows are docked or floating.

Load Project Window Layout lets you always restore the (original) project window layout (see chapter 3.2.3).

If you save a Pack&Go project with own changes (see chapter 3.1.3), a changed window layout is also stored. Note that the "Project Window Layout" is then also replaced.

Tips and notes:

- Note that multiple window layouts can be stored in the project (see chapter 3.2.4).

3 GAFmap Menus

See the following chapters for a description of all functions in GAFmap® Express menus.

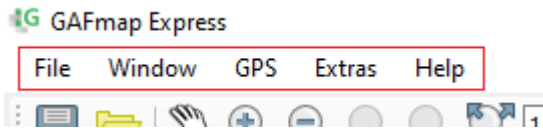


Figure 41: GAFmapExpress **Menu Bar**

3.1 Menu File

3.1.1 Open Project

In **GAFmap Express: Menu File**

Open Project lets you search and open a(nother) GAFmap® Pack&Go Container (*.cmp or *.cmpaux). The following dialog appears:

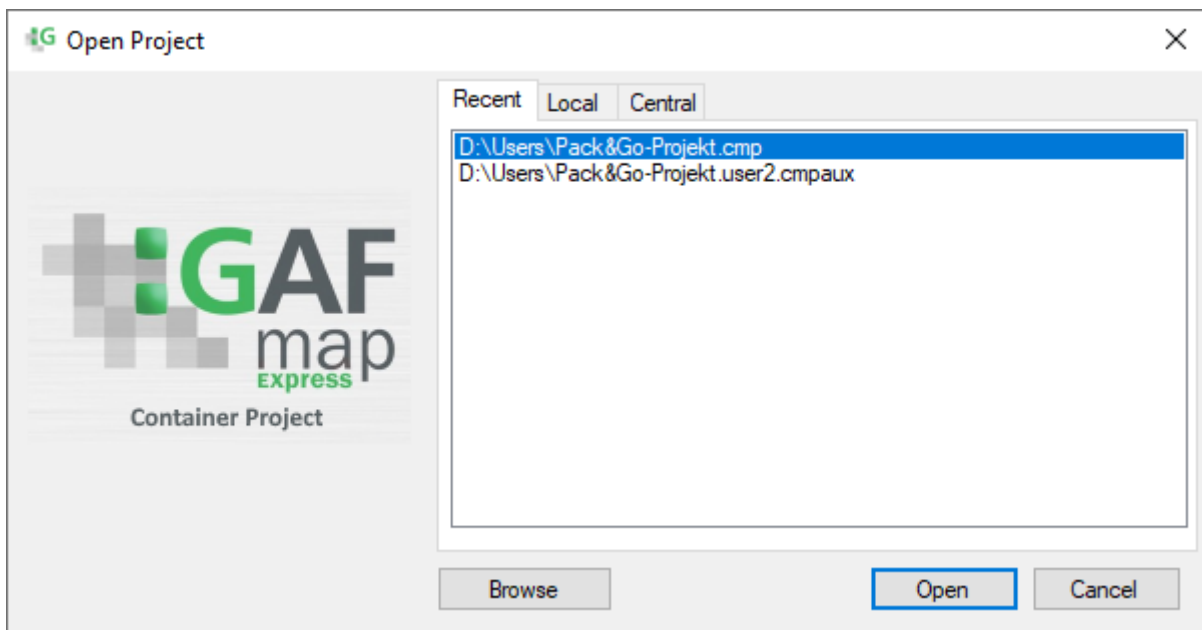


Figure 42: Open project dialog

Tabs:

- **Recent:** Here, a list of GAFmap® Pack&Go containers you had opened last is displayed (sorted chronologically). You can load one of the listed projects by selecting it and pressing the **Open** button or by double-clicking it.

Note that this way only containers can be loaded that have not been renamed or moved since the last opening. If you try to open a container file that is no longer at the specified location with the same name, you get a corresponding error message.

The list of recently opened projects is stored in your user profile.

- **Local** and **Central**: Here, you can directly access your default directory for locally / centrally stored GAFmap® Pack&Go containers. Here, all *.cmp or *.cmpaux files are displayed that are stored in the default directory. You can load one of the displayed projects by selecting it and pressing the **Open** button or by double-clicking it.

You can set the default directories in the general settings (under menu Tools > Settings > Other > Directories; see chapter 3.4.1.8). If the set default directory no longer exists, you receive an error message when you open the Local / Central tab.

In the general settings, you can specify which tab (Recent/Local/Central) is pre-selected in the Open Project dialog (under Settings > Other; see chapter 3.4.1.8).

- The **Browse** button opens a file browser via which you can search and load any *.cmp or *.cmpaux file.

Open confirms the selection and the corresponding project is loaded. **Cancel** takes you back to the currently opened project.

Tips and notes:

- If you want to open a project with self-created, saved changes, do not start the original container (*.cmp), but the created sidecar file (*.cmpaux). For information also see chapter 3.1.3.
- Possibly not all data was stored directly in the Pack&Go Container when the project was created, but connection details to external data sets instead. If you do not have access to this data, or if it has been moved, renamed or deleted, the corresponding layers cannot be loaded and displayed in the project. You can manually reconnect to the missing records. If this is not possible, please contact the creator of the project.
- If you open a project that contains data that require **credentials** (e.g. certain WMS layers or linked data from a cloud directory), these are requested when you open the project and then stored in your user profile. If you enter no or incorrect access data, the layer cannot be loaded. If you do not know the correct access data, please contact the creator of the project.

Note that incorrectly entered credentials are also saved. They will then not be requested again when you reopen the project and affected layers can (again) not be loaded.

All access data stored in your user profile are listed in the general settings in the tab **Credentials** (see chapter 3.4.1.7). They can there by viewed, edited/corrected, or deleted again at any time.

- Note if the project contains a 3D window:
 - The 3D Viewer puts high demands on the hardware, especially on the graphics card (see chapter 1.2.1). If your system requirements are significantly lower than those of the project creator and the performance in the 3D Viewer (i.e. movement speed and rendering) is insufficient, it is recommended to reduce the data section displayed in the 3D Viewer (see chapter 4.1.15) and/or deactivate as many layers as possible (if possible also in the (2D) map viewer).

If the 3D Viewer cannot be displayed performant even then, please contact the creator of the project.

- If you open a GAFmap® project with a 3D window for the first time, at first the (3D) **Edit Configuration** dialog appears (see chapter 4.6.19). All values are first determined automatically here and can usually be taken over unchanged.
- Note when you **Start** GAFmap® Express: The program cannot be started empty and will be closed again if no Pack&Go container is selected.

3.1.2 Browse Project

In GAFmap Express: Menu File

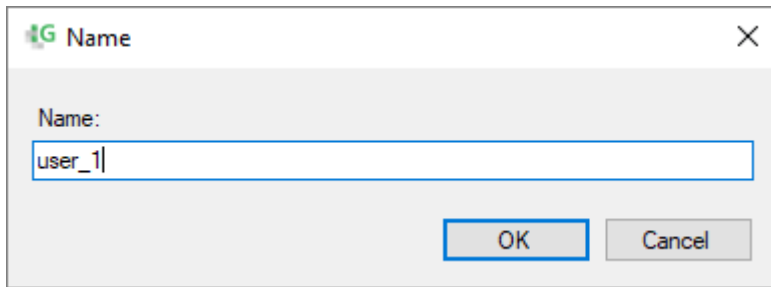
Browse Project lets you load a(nother) GAFmap® Pack&Go Container (*.cmp or *.cmpaux). For this purpose a file browser opens. Select the desired project there and confirm with **Open**.

3.1.3 Save Project / Save Project As

In GAFmap Express: Menu File

Save Project lets you save the project including your changes. A **sidecar file** with the extension *.cmpaux is then created and stored next to the Pack&Go Container (*.cmp). All your changes are saved in this file, the original *.cmp remains unchanged.

When you save the project for the first time, a dialog appears where you can enter a name attachment for the sidecar file:

Figure 43: **Save Project** dialog

The sidecar file is always stored in the same directory as the respective *.cmp file. Its file name is always

- [name *.cmp file]_[entered name extension].cmpaux



Name	Type
 Pack&Go-Project.cmp	GAFmap Container Project
 Pack&Go-Project.user_1.cmpaux	GAFmap Auxiliary Container Project File

Figure 44: Pack&Go Container with sidecar file

Note:

- If you want to reopen the project with your changes, you must open the sidecar file (*.cmpaux). If you directly open the Pack&Go Container (*.cmp), always the original project is opened.
- The link between the sidecar file and the Pack&Go Container is made via its storage location ("next to the container") and the file name. If the file name of the *.cmp or the *.cmpaux is changed, or if both files are in different folders, the link cannot be restored.

Save Project As always opens the dialog above. This way you can create any number of sidecar files with different name extensions.

Shortcuts, Key Commands, etc.:

- Ctrl+S: Save Project

3.1.4 Exit

In **GAFmap Express: Menu File**

Exit closes GAFmap® Express including all open product components.

3.2 Menu Window

The **multi-window technique** of GAFmap® provides the possibility to work with any number of map viewers and a 3D Viewer in parallel within one project. Via the menu **Window** you can link map viewers and save and recall window layouts at any time:

Tips and notes:

- For general information on the map window and working with multiple map windows, see chapter 2.2.

3.2.1 Link Map/3D Viewers

In GAFmap Express: Menu Window

Only active if the project contains multiple map windows or an additional 3D window

All commands and tools for adjusting the visible map extent within a map viewer, e.g. **Move** or **Zoom** (see chapter 4.1.3 et seqq.), only affect the active map window, i.e. the one highlighted in blue / marked with >>. Linking the map windows causes the view in all other map viewers to change accordingly, so that always the same area of the map is visible in all map viewers.

You can choose between the following linking types:

- With **Link Extent**, center coordinate and map scale are adopted in all map viewers. I.e. you always see the same map extent in all map viewers. If the size or aspect ratio of a map viewer differs from the active one, the visible map extent in this map viewer is cropped or expanded accordingly.
- With **Link Center**, the center coordinate is adopted in all map viewers; the map scale can be set individually. I.e. you always see the same "spot" in all map viewers, but possibly in different zoom levels.
- If no link is active, center coordinate and map scale can be set individually in all map viewers. There is no automatic adjustment.

Select the desired linking type by clicking the corresponding command in the menu Windows. The active link is then displayed with a check mark in the menu:

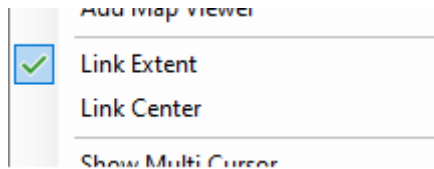


Figure 45: Menu Window - active link **Link Extent**

You can always detach an active link by clicking the command again.

If the project contains a 3D window in addition to one or multiple (2D) map windows, the command **Link 3D Viewer** is also displayed in the menu. If activated, the map viewers are automatically centered to the current viewing position when you move around in the 3D viewer. The viewer's position in 3D (= the apex of the open triangle used to indicate the viewer's position, viewing direction and viewing angle in the map viewer) is then always at the center of the map viewer(s). If you move the map in a map viewer, the viewing position in the 3D viewer does not change, i.e. not even if the windows are linked.

If a map windows serves as **Overview** (see chapter 4.5.8), an active link has no effect for this window.

Tips and notes

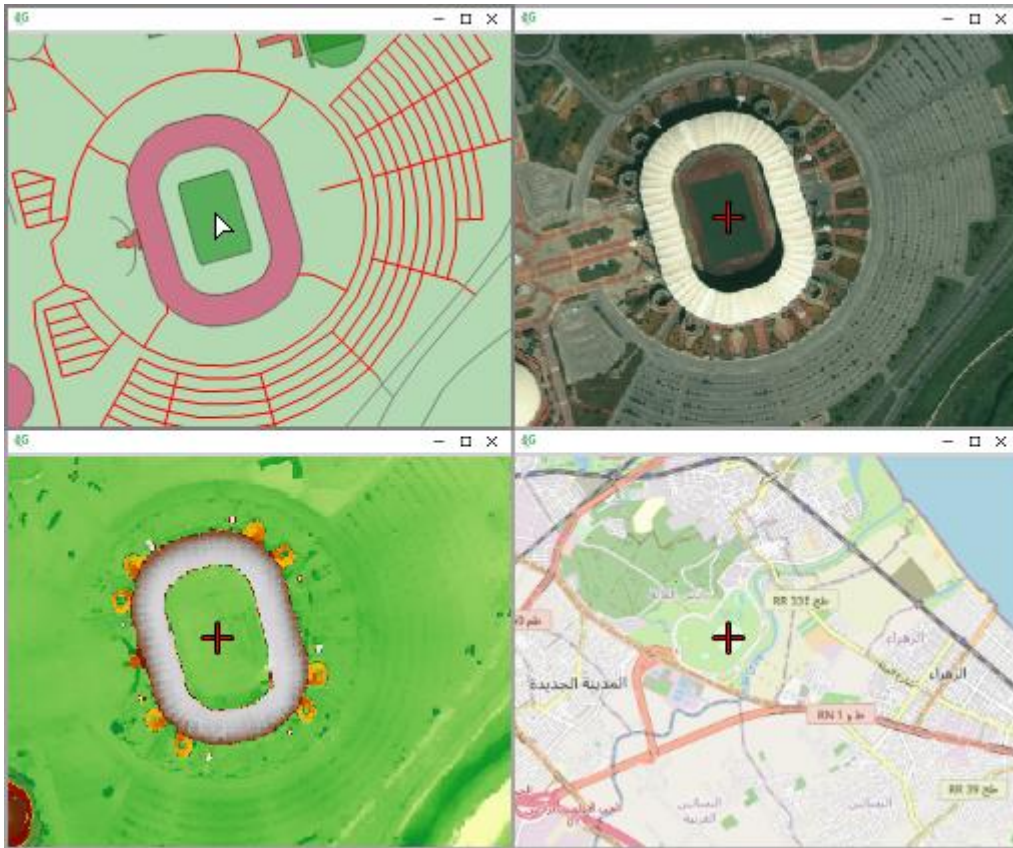
- For general information on the map window and working with multiple map windows, see chapter 2.2.

3.2.2 Show Multi Cursor

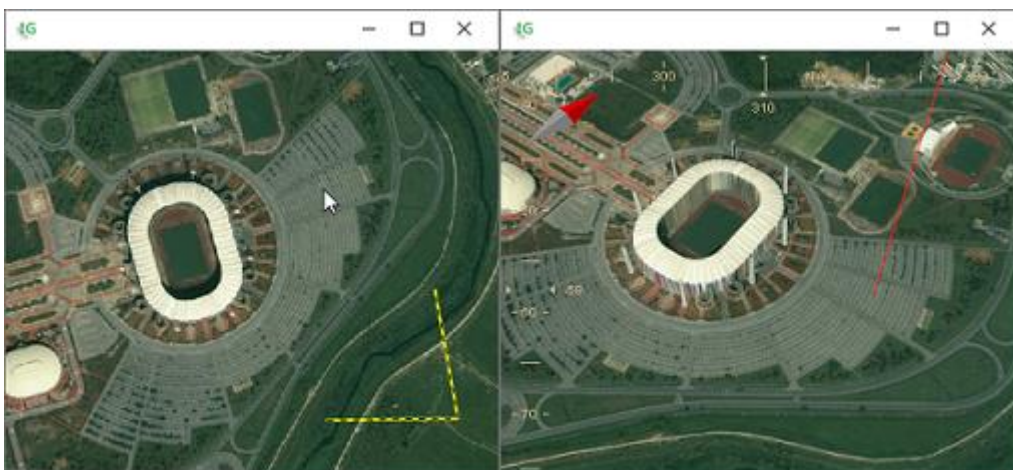
In **GAFmap Express: Menu Window**

Only active if the project contains multiple map windows or an additional 3D window

If **Show Multi Cursor** is enabled, the current mouse position is displayed in all map viewers when you move the mouse cursor over any map viewer. This makes it easier to find the same spot in all map viewers, even if the map content or scale differ:

Figure 46: **Multi Cursor**

If the project contains a 3D window in addition to one or multiple (2D) map windows, the multi cursor is displayed there as vertical red line:

Figure 47: **Multi Cursor** in the 3D Viewer

You can enable **Show Multi Cursor** by clicking the corresponding command in the menu Windows; it is then marked checked. It can always be disabled by clicking it again.

Tips and notes

- You can adjust the symbol the multi cursor is displayed with in the general settings under Viewing (see chapter 3.4.1.3).
- For general information on the map window and working with multiple map windows, see chapter 2.2.

3.2.3 Load Project Window Layout

In GAFmap: Menu Window

Load Project Window Layout lets you reset the window layout to the layout stored in the project. This is either the original window layout stored in the Pack&Go project, or, if you have saved the project with own changes (see chapter 3.1.3), the layout when the project was last saved. Note that your current window layout is directly discarded and the action cannot be undone.

Tips and notes:

- For general information on window layouts in GAFmap®, see chapter 2.2.4.

3.2.4 Load Saved Window Layout

In GAFmap: Menu Window

Only active if the project contains saved window layouts

The command **Load Saved Window Layout** opens a submenu listing all window layouts saved in the project. If you click on one of the saved layouts, the corresponding window layout is directly taken over. Note that your current window layout is directly discarded and the action cannot be undone.

Tips and notes:

- For general information on window layouts, see chapter 2.2.4.

3.2.5 List of Map Viewers

In GAFmap Express: Menu Window

The last section of the menu Window shows a list of all map windows in the project. If a map window is e.g. minimized or hidden behind another window as tab, you can bring it up again at any time by clicking on it in the list.

Tips and notes:

- For general information on the map window and working with multiple map windows, see chapter 2.2.
- For general information on window layouts, see chapter 2.2.4.

3.3 Menu GPS

GAFmap® supports integrated GPS modules (Windows Location Provider) and external GPS devices (via NMEA protocol). If a GPS receiver is connected/available, you can configure and connect it via the GPS menu and then center the map on the current GPS location.

3.3.1 Connect/Disconnect

In GAFmap Express: Menu GPS

Connect activates the GPS connection. If in the general settings under **Other** the option **GPS** is selected as **Additional Status Bar Info** (see chapter 3.4.1.8), you are now shown there if a GPS signal is received and if so, the number of currently available satellites incl. PDOP value (Position Dilution Of Precision), which indicates the position accuracy:

686243,63m	5335775,47m	WGS 84 / UTM zone 32N	GPS offline
686243,63m	5335775,47m	WGS 84 / UTM zone 32N	No Signal
686243,63m	5335775,47m	WGS 84 / UTM zone 32N	9 GPS Satellites, PDOP: 1.7

Figure 48: GPS information in status bar (top: GPS disconnected; middle: GPS connected, but no GPS signal is received; bottom: GPS connected, GPS signal is received)

A GPS connection can only be established if the connection parameters for the connected/available GPS receiver are set correctly in the GPS settings (see chapter 3.3.2 or 3.4.1.2), taking into account the manufacturer's specifications. The connection can be checked directly there.

If no GPS connection can be established, e.g. because no GPS receiver is connected or the connection parameters are incorrect, you receive a corresponding error message.

If a GPS signal is received, your current GPS position including the viewing direction is displayed on the map:



Figure 49: GPS position displayed on the map (including GPS height)

The (point) symbol that is used to display the GPS position on the map and whether the GPS height is additionally displayed can be defined in the GPS settings.

If the project contains a 3D window, you can also display your GPS position in the 3D viewer.

With **Disconnect** an existing GPS connection is disconnected again.

3.3.2 Settings

In *GAFmap Express: Menu GPS*

Settings takes you to the **GPS** tab of the general settings (Tools > Settings > GPS menu). There you can e.g. configure and test the GPS connection.

For more information, see chapter 3.4.1.2.

3.3.3 Center on Position/Stay centered on Position

[Menu Extras > Extensions > Location Services > GPS Connection]

In **GAFmap**: Menu GPS

If you execute **Center on Position**, the map viewer is centered (once) on the current GPS position.

If **Stay Centered on Position** is enabled, the map viewer is continuously centered on the current GPS position; the menu item is then then marked checked. Centering can always be disabled again by clicking the menu item anew.

3.4 Menu Extras

3.4.1 Settings

3.4.1.1 Settings for Search Layers

In **GAFmap Express**: Menu Extras > Settings

Under **Search Layers** all sources are listed that are generally available for the **Feature Search** (see chapter 4.3). These include all loaded vector layers and geocoding services (by default OSM and GeoNames, can be extended with your own if required).

Settings

Search Layers | GPS | Viewing | Editing | Shortcuts | Toolbars | Credentials | Other

Search
Use Regex: Off

Use Regex
Whether to use Regex when searching via toolbar or finding in attribute table. Geocoding Services will not be used, when using Regex.

Feature Layer	Use for Search	Search Fields
Road	<input type="checkbox"/>	Name; Type; Subtype
City	<input checked="" type="checkbox"/>	Name
River	<input type="checkbox"/>	Name

Geocoding Service	Use for Search	Service Options	Query Options
OSM	<input checked="" type="checkbox"/>	SERVICE=OSM_NOMINA...	LIMIT=100
GEONAMES	<input type="checkbox"/>	SERVICE=GEONAMESIU...	MAXROWS=100

Restore Add Delete Import Export

? OK

Figure 50: Settings for **Search Layers**

The **Feature Search** searches all layers/services for which the check mark is set in the column **Use for Search**. Layers/services for which the check mark is not set are ignored.

For vector layers, you can control which attribute fields are to be included in the search via the column **Search Fields**. You can reduce/adjust the search fields for each layer by clicking into the corresponding **Search Fields** cell. A field selection panel then opens. Check all the attribute fields that are to be searched and/or uncheck those that are not to be searched, and confirm with **OK**. Under **Search Fields**, only the checked fields that are actually taken into account are then listed.

Via the setting **Use Regex** at the top of the tab, you can control whether regex ("regular expression") is used for the search (**On**) or not (**Off**). For more information on this, see chapter 4.3. Please note

- that this setting not only affects the **Feature Search**, but also the search in the attribute table (**Find** command; see chapter 5.3.2.1.1).
- that an online search is not possible with regex. If regex is activated, the geocoding services are deactivated and the corresponding area in the tab cannot be operated.

At the bottom of the tab / settings window you can find the following buttons:

- **Restore:** sets the geocoding services back to default. Settings for vector layers remain unchanged. The command has to be confirmed before it is executed.
- **Add:** here, you can insert additional geocoding services. An entry **New Service** appears. See https://gdal.org/doxygen/ogr_geocoding_8h.html for information on how to enter the service parameters
- **Delete:** deletes selected geocoding services (highlighted in blue) from the list. Multi-selection is possible when pressing the Ctrl key. The command has to be confirmed before it is executed.
- **Export/Import:** saves selected geocoding services (highlighted in blue) as *.xml file / opens a file browser to browse for and load exported geocoding services.

OK or the X button in the upper right corner of the window close the settings window. All changed settings are directly applied.

3.4.1.2 Settings for GPS

In GAFmap Express: Menu Extras > Settings

If a GPS device is available (when using GAFmap® on a mobile device, e.g. a laptop or Surface tablet), either in the form of an integrated GPS module or a connected, external GPS device, you can use the settings under **GPS** to configure it, make certain user-defined settings for position recording in GAFmap® and adjust the GPS display options (symbology).

Category **GPS:**




- **Provider Type:** specifies the provider type. Available are **ComPort** (for external GPS devices connected via a COM port) and **WindowsLocation** (for integrated GPS modules).
- **COM Port** (*only available for Provider Type = ComPort*): specifies via which COM port the GPS device is connected.
- **Baud Rate** (*only available for Provider Type = ComPort*): specifies the baud rate of the GPS device. If unknown, please refer to the GPS device's manual.
- **WGS84 Ellipsoid Height** (*only available for Provider Type = ComPort*): specifies if the height above the WGS84 ellipsoid is recorded (**On**) or the geoidal height. Not all GPS devices support ellipsoid heights.
- **Use GGA Dilution** (*only available for Provider Type = ComPort*): specifies which tag of the NMEA protocol is used to determine the values for the position accuracy (HDOP

and PDOP). If **Off**, the exact values from the GSA (Satellite Status) tag are used; if **On**, the HDOP value from the GGA (Global Positioning System Fix Data) tag is used for both instead. Skipping the (more precise) GSA tag only makes sense for special NMEA protocols that do not contain this tag.

- **Position Update Frequency [s]**: determines the time interval in seconds at which the current GPS position is to be stored.
- **Position Invalidation Time [s]**: determines the time span in seconds within which a GPS signal must be received for a position to be considered valid. If the time is exceeded, the position is discarded.
- **Signal Timeout Time [s]**: determines how long the GPS connection is maintained without a signal. If the time is exceeded, the GPS connection is disconnected.
- **Max PDOP**: determines the maximum PDOP value for a position to be considered valid. If the value is exceeded, the point is discarded.

The PDOP (Positional Dilution of Precision) indicates how strongly the measured values scatter. The higher the value, the less reliable the GPS position. Commonly, values > 10 are considered unreliable (see e.g. [Wikipedia - Dilution of Precision \(Navigation\)](#)).

Category **Symbology**:

- **GPS Position Symbol**: specifies the point symbol used to indicate the GPS position in the map viewer.
 opens the Point Symbol dialog (see chapter 6.1)
- **GPS Position 3D Symbol** (*only shown if your GAFmap® license includes the 3D Viewer extension and this extension is activated*): specifies the 3D point symbol used to indicate the GPS position in the 3D viewer.
 opens the 3D Point Symbol dialog (see chapter 6.6)
- **GPS Height Label**: specifies the label style with which the GPS height is labeled in the map viewer.
 opens the Labeling dialog (see chapter 6.4)
- **Show GPS Height**: determines whether the GPS heights are shown in the map viewer (**On**) or not (**Off**).

Using the **Test** button, you can check whether a GPS signal is being received. The NMEA data received is then displayed in the box below. If no data is received, the box remains empty. The test can always be ended with **Stop** button.

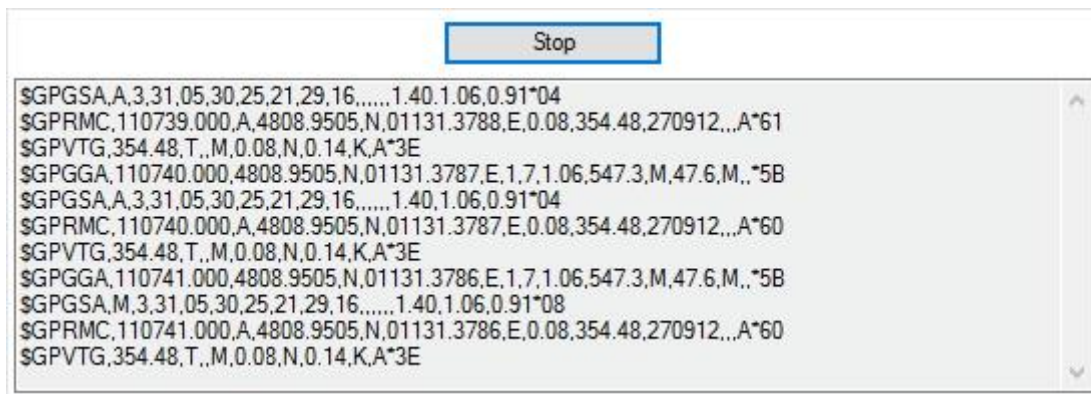


Figure 51: Test image for GPS signals

At the bottom of the tab / settings window you can find the following buttons:

- **Restore:** sets all settings within the tab back to default. The command has to be confirmed before it is executed.

OK or the X button in the upper right corner of the window close the settings window. All changed settings are directly applied.

The settings in this tab are stored in your user profile. They are uploaded from your profile when you open GAFmap® Express and written back when you close it. So when working with multiple GAFmap® Express instances, be careful in which order you close them to avoid overwriting changed settings unintentionally.

3.4.1.3 Settings for Viewing

In **GAFmap Express: Menu Extras > Settings**

Under **Viewing**, various basic settings can be made for the visualization of data in the map viewer / on the screen ("rendering options").

Category General

- **Anti Aliasing:** specifies an anti-aliasing effect applied on vector data and graphics on screen. If enabled, inclined lines appear less pixelated. This effect is visible using large scales and/or broad lines.

Category Status Bar

- **Coordinate Display Format:** If you move the mouse pointer over the map viewer, its X/Y coordinates are displayed in the status bar (see chapter 2.2.1.3). With this setting you can influence the display format.







If you select **Custom**, the spatial reference entered below at **Custom Spatial Reference** is used .







- **Custom Spatial Reference:** specifies your preferred spatial reference. It is e.g. used as **Coordinate Display Format** if you select **Custom** (see above), and is suggested as **Other Spatial Reference** when you use **Go to Coordinate** (see chapter 4.1.8).
- **Show Z-Coordinate:** if **Off**, only the X/Y coordinates of the mouse pointer are displayed in the status bar when you move it over the map viewer. If **On**, additionally the (terrain) height is displayed.

601116.41m 4081287.34m | WGS 84 / UTM zone 32N | 159.4m

The height is derived from the **base DEM** (see chapter 5.3.4). For areas for which no DEM is available, no height can be displayed.

Category **Symbology**

- **Background Color:** specifies the background color of the (2D) map viewer.
 opens the Color Picker dialog (see chapter 6.5)
- **Selection Color:** specifies the color in which features are selected.
 opens the Color Picker dialog (see chapter 6.5)
- **Multi Cursor Symbol:** specifies the point symbol used for the multi cursor (see chapter 3.2.2).
 opens the Point Symbols dialog (see chapter 6.1)
- **Drag Rectangle Symbol:** specifies the (sketch) line symbol used when dragging a rectangle.
 opens the Line Pen dialog (see chapter 6.2)
- **Overview Extent Symbol:** specifies the line symbol used to indicate the other map viewer in an Overview map.
 opens the Line Pen dialog (see chapter 6.2)
- **Overview Extent Label:** determines whether the other map viewers are labeled with their names in an Overview map (**On**) or not (**Off**).
- **Highlight Point Symbol:** specifies the point symbol used to highlight (selected) features in the map viewer.
 opens the Point Symbols dialog (see chapter 6.1)

- **Highlight 3D Point Symbol** (*only available if the project contains a 3D window*): specifies the 3D Point symbol used to highlight (selected) features in the 3D Viewer.
 opens the 3D Point Symbols dialog (see chapter 6.6)
- **Highlight Line Symbol**: specifies the line symbol used to highlight (selected) features in the map viewer.
 opens the Line Pen dialog (see chapter 6.2)
- **Highlight Label**: specifies the label style used to highlight text labels in the map viewer.
 opens the Labeling dialog (see chapter 6.4)
- **Highlight Fill Symbol**: specifies the fill symbol used to highlight (selected) features in the map viewer.
 opens the Fill Symbols dialog (see chapter 6.3)
- **Small Cross Symbol**: specifies the point symbol used to indicate "small crosses".
 opens the Point Symbols dialog (see chapter 6.1)
- **Big Cross Symbol**: specifies the point symbol used to indicate "big crosses".
 opens the Point Symbols dialog (see chapter 6.1)

Category Anaglyph

- **Anaglyph Shift [px]**: determines the shift between the two images (normally a red and a green one) calculated for the anaglyph that have to overlay each other to cause the 3D effect. The unit of the shift is presented in pixels and the default value is 30. An anaglyph shift with more than 30 pixels leads to a higher exaggeration and causes a stronger 3D effect.
- **Anaglyph Area of View**: determines whether the anaglyph depth is adjusted to the area of view (**On**) or to the full extent of the dataset (**Off**).

Category Viewshed

- **Eye Height [m]**: determines the default eye height used for viewshed calculations (see chapters 4.5.6 and 4.6.6) or sight lines (see chapter 4.7.15) (= starting height).
- **Target Height [m]**: determines the default target height used for viewshed calculations (see chapters 4.5.6 and 4.6.6) or sight lines (see chapter 4.7.15).
- **Viewshed Quality**: determines the accuracy with which the 2D viewshed is performed. The higher the selected quality, the better the pyramid level used and its reconstruction within the map viewer and the more sampling steps are carried out outside the visible map extent.




For more detailed information, see chapter 4.5.6.

Please note that a higher quality has a negative effect on the performance, i.e. on the image build-up in the map viewer.

This setting has no effect on the 3D viewshed (see chapter 4.6.6).

Category **Scalebar**

Settings of this category affect the scalebar that can be switched on/off via the map viewer toolbar. For more information, see chapter 4.5.9.

- **Line Style:** specifies whether the scalebar is drawn as a classical bar (**Off**) or as a simple line (**On**).
- **Color:** specifies the color of the scalebar.
 opens the Color Picker dialog (see chapter 6.5)
- **Background Color:** specifies the background color of the scalebar.
 opens the Color Picker dialog (see chapter 6.5)
- **Scalebar Labeling:** specifies the font style for the labeling of the scalebar.
 opens the Labeling dialog (see chapter 6.4)

Category **Labeling**

- **Prevent Overlaps:** if **On**, it is checked across all layers whether labels overlap. If this is the case, it is searched for a "free" space within the **Maximum Shift** and the **Shift Step Size** specified below and the label is moved there.

If no free space is found within the maximum permissible shift or if a labeling shift on layer level is suppressed, overlapping labels are not drawn (i.e. the feature concerned is not labeled).

Note the following priorities when shifting/drawing labels: The further up in the TOC, the higher the priority of a layer and the further down in the attribute table in the current sorting, the higher the priority of a feature (analogous to the drawing order of the feature geometries; see chapter 2.2.2.1 or 5.3.2.1).


- **Adjust Label Positions:** determines whether the caption of features that exceed beyond the visible map extent is always shifted into the visible map extent (**On**) or not (**Off**).
- **Shift Step Size [px]:** determines the step size (in screen pixels) used when searching for a free space for the label (i.e. how coarse/fine a label is shifted). Note that placing the label in small steps may take a long time. Choose a compromise if necessary.

- **Maximum Shift [px]:** determines the maximum distance a label can be shifted when searching for a free space (in screen pixels). If no free space is found within this radius, the label is not drawn.

Category **Symbology for new Graphics**

Settings in of this category are, if applicable, automatically applied to all newly created point, line, and polygon graphics and text labels.

- **Point Symbology:** specifies the default symbology for newly created point graphics.

 opens a window with all symbology properties of point graphics. For more information, see chapter 5.2.4.2.

If the project contains a 3D window, the default symbology for 3D points is also set under Point Symbology. For more information on 3D point properties, see chapter 5.2.12.1. Also note the following:

- **Generate 2D Point Symbol from 3D Point Symbol:** if **On**, 3D points are displayed by default with an image of the 3D point symbol in the (2D) map viewer. If **Off**, 3D points are displayed by default with the default point symbol for (2D) point graphics in the (2D) map viewer.


A 3D point is always listed with the 2D point symbol determined for it in the TOC.

- **Set New Symbol as Default:** if **On**, the symbology applied to a 3D point in the **Add 3D Point** dialog is used as default symbology, i.e., **Set as default point symbology** is checked by default in the dialog (see chapter 4.7.11). If **Off**, the box is not checked by default in the dialog.


You can always check or uncheck the option in the dialog if the default symbology is to be replaced or not replaced by the symbology in the dialog.

The default 2D symbology of 3D points (2D point Symbol, 2D labeling including label style etc.) corresponds to the default symbology for (2D) point graphics.


- **Line Symbology:** specifies the default symbology for newly created line graphics.

 opens a window with all symbology properties of line graphics. For more information, see chapter 5.2.5.4.

- **Polygon Symbology:** specifies the default symbology for newly created polygon graphics (incl. circle/ellipse and rectangle graphics).

 opens a window with all symbology properties of polygon graphics. For more information, see chapter 5.2.7.2.

- **Label Symbology:** specifies the default symbology for newly created text labels.


 opens a window with all symbology properties of text label graphics. For more information, see chapter 5.2.9.2.

The label text can be edited any time later via Text in the Graphic Properties (see e.g. chapter 5.2.4.2).

If the project contains a 3D window, the default symbology for 3D text labels is also set under Label Symbology. For more information on 3D text label properties, see chapter 5.2.13 or 5.2.12.1.

The default 2D symbology of 3D labels (i.e. the style of the text on the labeling panel) corresponds to the default symbology for (2D) labels.

- **Viewshed Point Symbology** (*only with extension Data Analysis > Viewshed Visualization*): specifies the default symbology for newly created viewshed point.

 opens a window with all symbology properties of point graphics. For more information, see chapter 5.2.4.2

If the project contains a 3D window, the default symbology for 3D viewshed points is also set under Viewshed Point Symbology (analog to 3D point, see above).

The default symbology for newly created graphics can also be specified via the button **Symbology** in the Graphics Toolbar (see chapter 4.7.17). Settings that are made there are automatically applied here and vice versa. The symbology of graphics can be adjusted any time later via the Graphic Properties. For more information, see chapter 5.2.

At the bottom of the tab / settings window you can find the following buttons:

- **Restore:** sets all settings within the tab back to default. The command has to be confirmed before it is executed.

OK or the X button in the upper right corner of the window close the settings window. All changed settings are directly applied.

The settings in this tab are stored in your user profile. They are uploaded from your profile when you open GAFmap® Express and written back when you close it. So when working with multiple GAFmap® Express instances, be careful in which order you close them to avoid overwriting changed settings unintentionally.

3.4.1.4 Settings for Editing

In GAFmap Express: Menu Extras > Settings

Under **Editing**, you can make various settings relating to the capture and editing of new/own graphics (see chapter 4.7).

Category **General**

- **Show Measurement:** If **On**, the current length of lines is displayed while a line is created or edited, the area size is displayed while creating or editing areal graphics. The displayed unit depends on the **Length Unit** and the **Area Unit** specified below.

The measuring method corresponds to that of the **Measure** tool (see chapter 4.1.13.1).

- **Length Unit:** determines the displayed length unit for measurements when creating or editing Graphics (see e.g. chapter 5.2.5.4). Select the desired unit from the drop-down list. If you choose **Automatic**, the unit is automatically adjusted depending on the current length of the sketch line.

The unit is always metric, independent of the used coordinate system. If no spatial reference is set for the map, metric is assumed.

- **Area Unit:** determines the displayed area unit for measurements when creating or editing Graphics (see e.g. chapter 5.2.7.2). Select the desired unit from the drop-down list. If you choose **Automatic**, the unit is automatically adjusted depending on the current area of the sketch polygon.

The unit is always metric, independent of the used coordinate system. If no spatial reference is set for the map, metric is assumed.

Category **Sketch**

Settings of this category affect the symbology of the edit sketch.

- **Sketch Line Symbol:** specifies the line symbol used for edit sketches. It affects, amongst others, the line sketch and the outline of the polygon sketch.



opens the Line Pen dialog (see chapter 6.2)

- **Sketch Fill Symbol:** specifies the fill symbol used for sketch polygons when creating / adding area.



opens the Fill Symbols dialog (see chapter 6.3)

- **Vertex Symbol:** specifies the point symbol used for the vertices in vertex editing mode.



opens the Point Symbols dialog (see chapter 6.1)

- **Delete Vertex Symbol:** specifies the point symbol used for the highlighted vertex in vertex editing mode.



opens the Point Symbols dialog (see chapter 6.1)

- **Insert Vertex Symbol:** specifies the point symbol used for an indicated new vertex in vertex editing mode.



opens the Point Symbols dialog (see chapter 6.1)

Category **Snapping**

Settings of this category affect the snapping to existing vertices or edges in general, as well as the display of the symbols that indicate snapping.

- **Snapping Distance [monitor pixels]:** defines the maximum distance at which an existing vertex or line segment is snapped. Regardless of the entered distance, you can always temporarily disable the snapping function by holding the N key.
- **Snap to Sketch:** if **On**, sketch vertices are snapped while editing if they fall below the snapping distance. If **Off**, the sketch geometry is excluded from snapping.
- **Snap Symbol Vertex:** specifies the point symbol used to indicate vertex snapping.



opens the Point Symbols dialog (see chapter 6.1)

- **Snap Symbol Line:** defines the line symbol used to indicate line snapping.



opens the Line Pen dialog (see chapter 6.2)

- **Snap Symbol Auxiliary Line:** specifies the line symbol used to indicate snapping to an auxiliary line.




opens the Line Pen dialog (see chapter 6.2)

- **Show Snap Hint Label:** if **On**, snap hints are shown in the map viewer during editing: the layer that is snapped to and where. Possible are:
 - layer_xyz : Vertex (when snapping to a vertex)
 - layer_xyz : Line (when snapping to a line segment)
 - layer_xyz : Intersection (when snapping to an intersection of line segments without vertex)
 - layer_xyz : Intersection at Vertex (when snapping to a vertex at an intersection of lines/rings or to a common vertex)

If **Off**, no snap hints are shown.

Alternatively, the snap hints can be enabled/disabled in the map viewer with Ctrl+G.

The labeling style for the description can be customized via **Snap Hint Labeling**.

 opens the Labeling dialog (see chapter 6.4)

Category **Tracing**

- **Toggle Tracing for All Tools:** if **On**, tracing is activated/deactivated for all suitable tools at once when using the set keyboard command (F4 by default). If **Off**, tracing is only toggled for the one tool that is currently active, i.e. framed in blue.

You can tell that tracing is activated for a tool by the tracing hint (**t**) above the mouse pointer:




- **Tracing Across Multiple Features:** determines whether lines are traced across features (**On**) or whether only a single feature or graphic is traced (**Off**).

If **Off**, the start and end points for line tracing must be set on the same line or polygon feature. For line tracing across features, an intermediate vertex must then be set at each feature transition.

- **Maximum Lines Count** (*only available if tracing across multiple features is enabled*): specifies the maximum number of line objects allowed within the currently visible map extent for line tracing to be performed. For (multipart) lines, each line part counts as one line object; for polygons, each ring counts as one line object.

The number can be increased as needed. However, please note that this will reduce the performance!


- **Tracing Hint Label:** specifies the labeling style used for the tracing hint (**t**) above the mouse pointer:

 opens the Labeling dialog (see chapter 6.4)

Category **Digitizing Halo**

- **Digitizing Halo Radius:** determines the radius of the halo around the mouse pointer in meters. You can also specify multiple halos separated by semicolons (e.g. 50;100;150). The halo(s) can always be toggled on/off with the set key command (Ctrl+H by default), e.g. during feature capture.

Digitizing Halo Line: specifies the line symbol used for the halo.

 opens the Line Pen dialog (see chapter 6.2).

Category **Tolerances**

- **Sticky Move Tolerance [monitor pixels]:** specifies the distance that has to be exceeded once before a self-created graphic can be moved.

At the bottom of the tab / settings window you can find the following buttons:

- **Restore:** sets all settings within the tab back to default. The command has to be confirmed before it is executed.

OK or the X button in the upper right corner of the window close the settings window. All changed settings are directly applied.

The settings in this tab are stored in your user profile. They are uploaded from your profile when you open GAFmap® Express and written back when you close it.

3.4.1.5 Settings for Shortcuts

In GAFmap Express: Menu Extras > Settings

In the tab **Shortcuts** you can look up and customize shortcuts for various functions/commands.

Up to two shortcuts can be applied for each listed function. Possible shortcuts are single keys or key combinations.

You can enter new ones or change already applied shortcuts by clicking on the corresponding field (**Key 1 /Key 2**) twice and entering the new key(s). If you want to enter a key combination like Ctrl+Shift+S, you have to press all desired keys at once. You are warned if an entered shortcut is already applied to another function. A set shortcut can be deleted by double-clicking the corresponding field and pressing the assigned key or, in the case of key combinations, pressing any key twice in succession.

At the bottom of the tab / settings window you can find the following buttons:

- **Reset Selected / Reset All Shortcuts:** sets the shortcuts for selected (highlighted in blue) / all functions back to default.
! Please note that the reset cannot be undone.
- **Export/Import:** saves selected shortcuts (highlighted in blue) as *.xml file / opens a file browser to browse for and load exported shortcuts. If you press the Ctrl key while exporting, a list of all assigned shortcuts (predefined and custom) is played out as *.csv.

OK or the **X** button in the upper right corner of the window close the settings window. All changed settings are directly applied.

Custom shortcuts are stored in your user profile. They are uploaded from your profile when you open GAFmap® Express and written back when you close it.

3.4.1.6 Settings for Toolbars

In **GAFmap Express: Menu Extras > Settings**

Under **Toolbars** you can customize the toolbars in the user interface according to your needs. For this purpose, you can either show, hide, or move individual functions in existing toolbars, or create and organize new toolbars from scratch.

The **Command** column always shows a complete list of functions, which are assigned to buttons (in the main window). These functions cannot be deleted, but can be unchecked and thus hidden and/or rearranged if desired.

The **Map Viewer toolbar** and the **3D Viewer toolbar** cannot be adjusted or rearranged, as the contained functions always refer to the associated (2D) map / 3D window and are therefore permanently assigned to it (see chapter 4.5). This toolbar and all the contained functions are therefore missing in the list.

Toolbars under **Top/Bottom Panel** are arranged in the GAFmap® Express main window above/below the map window area, those under **Left/Right Panel** to the left/right of the map window area. The individual buttons/functions appear in the toolbar under which they are sorted, optionally grouped under split buttons or separated with separators (see below). The order of the toolbars and the functions within a toolbar in the list determines their order in the user interface, in each case "in reading direction" from top left to bottom right.

You can reorganize entire **toolbars** as follows:

- **show/hide** it by checking/unchecking it.
- **move** it via drag & drop to the required position (also across panels).
- **rename** it by clicking onto a selected toolbar and entering the new name.
- **create** a new toolbar by calling up **Add Toolbar** in the panel's context menu. You can then move the toolbar to the required position and/or rename it.

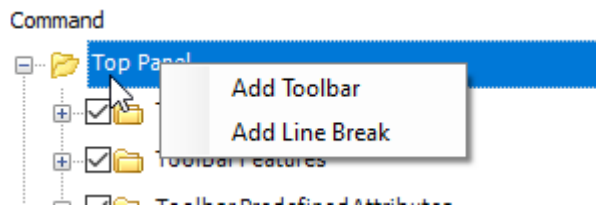


Figure 52: panel context menu

- **remove** a toolbar by calling up **Remove** in its context menu.

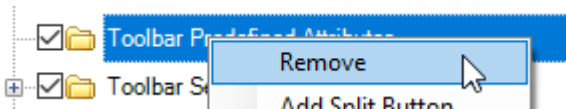


Figure 53: toolbar context menu: remove toolbar

Note that a toolbar can only be removed if it does not contain any functions.

- **separate toolbars** with line breaks to make the panel easier to read. To do this, call up **Add Line Break** in the panel's context menu. The line break can then be moved to the desired position via drag & drop.

You can remove a line break by calling up **Remove** in its context menu.

You can reorganize individual **functions/commands** in a toolbar as follows:

- **show/hide** it by checking/unchecking it,
- **move** it via drag & drop to the required position (also across toolbars),
- **group** them by moving them under a split button folder.

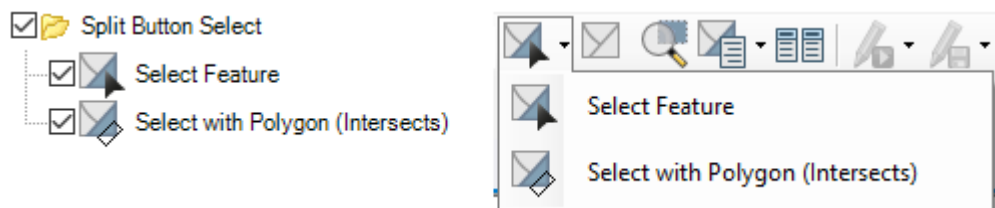


Figure 54: example of a split button

A split buttons can be added by calling up **Add Split Button** in a toolbar's context menu and moved via drag & drop.

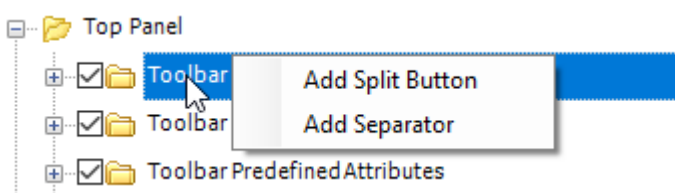


Figure 55: toolbar context menu

You can remove a split button by calling up **Remove** in its context menu. Note that a split button can only be removed if it does not contain any functions.

- **divide them with vertical separators** to make the toolbar easier to read.

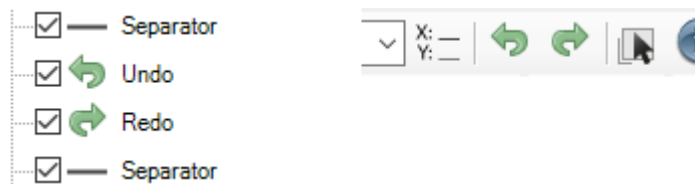


Figure 56: examples of separators

A split buttons can be added by calling up **Add Separator** in a toolbar's context menu, moved via drag & drop, and removed by calling up **Remove** in its context menu.

At the bottom of the tab / settings window you can find the following buttons:

- **Restore:** resets the toolbars to default.
! Please note that the reset cannot be undone.
- **Export/Import:** saves the toolbar settings as *.xml file / opens a file browser to browse for and load exported toolbar settings.

OK or the X button in the upper right corner of the window close the settings window. All changed settings are directly applied.

Custom toolbars are stored in your user profile. They are uploaded from your profile when you open GAFmap® Express and written back when you close it.

Tips and notes:

- Changes to toolbars made directly in the user interface (via drag & drop) are only temporary. When GAFmap® is started, the toolbar order will always be restored according to the settings in this tab.

3.4.1.7 Settings for Credentials

Under **Credentials** you can view, edit, or delete all stored credentials. The list includes all credentials that you have entered yourself and that are stored in your user profile, as well as any additional credentials that are stored in the software itself. The latter are user-independent and cannot be deleted.

If you open a project that contains data that require credentials, e.g. certain web services or linked data from cloud directories, these are requested once and are then stored in your user

profile. All credentials from your user profile are listed for you in the general settings under **Credentials** and, as long as they are not deleted there, are automatically reused when you recall the directory / service.

Please note that incorrect access data is also stored. If you enter, for example, an invalid password, you will not be able to connect to the directory/service until you correct the credentials in the general settings. You will get an error message when trying to connect (e.g. "The remote server returned an error: (401) Unauthorized"); the credentials are not e.g. requested again.

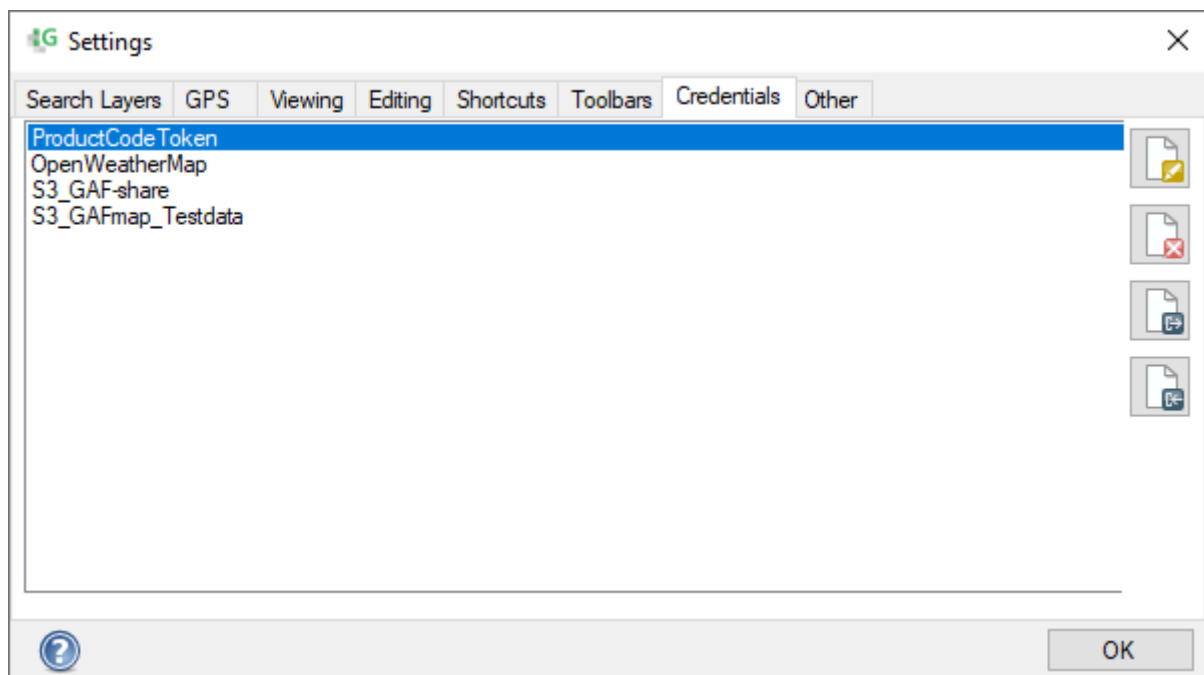






Figure 57: Settings for **Credentials** ("Credential Store")

On the right side of the tab you can find the following buttons:

-  **Edit:** opens the input window for the selected (blue highlighted) credentials; there, the required parameters can be changed/corrected. The access data is then reset accordingly.
-  **Remove/Reset:** deletes all selected credentials from the list (and thus from your user profile) or resets changed credentials stored in the software to default setting.
-  **Export:** exports all selected credentials individually as an encrypted *.crdntl file. A folder browser opens where you can select the target directory.
-  **Import:** allows for loading access exported credentials. A file browser opens. Here you can search and open the required *.crdntl file.

! Please close any other open GAFmap® instances before adding, deleting, or resetting credentials in the tab, as otherwise the changes may not be correctly written back to your user profile and will then not be available when you open the software anew.

OK or the X button in the upper right corner of the window close the settings window. All changed settings are directly applied.

3.4.1.8 Other Settings

In GAFmap Express: Menu Extras > Settings

Within the tab **Other** general (program) settings can be made.


Category General

- **Check for update on program start:** determines whether it is checked for software updates whenever GAFmap® Express is started (**On**) or not (**Off**).
- **Default Open Project Dialog Tab:** determines which tab (**Recent/Local/Central**) is pre-selected in the **Open Project** dialog.

Category Handling


- **Zoom Factor:** determines by which factor the map scale changes when using the zoom buttons (see chapter 4.1.4). A factor of 1.5, for example, changes the scale with each click as follows: 1:6.667, 1:10.000, 1:15.000 etc.
- **Pan Factor:** specifies the factor the map is moved within the map viewer when using the arrow keys. A pan factor of 0.5 for example results in the map being shifted by half the visible extent within the map viewer.
- **Mouse Wheel Up is Zoom In:** if **On**, the map extent is enlarged when rolling the mouse wheel upwards (zoom in) and shrunk when rolling the mouse wheel downwards (zoom out). If **Off**, the rolling direction is inverted.
- **Zoom To Flight Duration [s]** (*only relevant if the project contains a 3D window*): determines the duration of the flight animation that is performed when zooming to a layer in the 3D viewer (see chapter 5.2.1.1 or 5.3.1.1).
- **Include Background in Layer Select** (affects function **Select Layer**; see chapter 4.1.10): if **On**, when you drag a selection rectangle in the map viewer, all layers that lie within the rectangle or are intersected are selected in the TOC. If **Off**, only vector layers and graphics are taken into account. Raster layers can then only be selected with a simple left click in the map viewer.

- **Open Identify for Feature Search Result:** if **On**, features found with **Features Search** (see chapter 4.3) are listed in the Search dialog, which corresponds to the **Identify** window (see chapter 4.1.11). If **Off**, the found features are only selected.
- **Always Keep Scale when Switching Features:** if **Off**, the map is always zoomed to the feature(s) headed for, for example if you jump from feature to feature by using **Show Attributes** (chapter 4.2.1) or by double-clicking rows/features in the **Attribute Table** (chapter 5.3.2.1). The map scale only remains constant if you hold the Alt key while switching features. If **On**, the map scale is always kept when switching features.
- **Specific Map Scale (1 : x):** defines the map scale that is applied when pressing the Z key (shortcut for **Zoom to Specific Map Scale**).
- **Prompt Graphics Name:** if **Off**, newly created graphics are given a default name in the TOC that reflects their type (e.g. AOI, Rectangle, Point etc.). If **On**, you are prompted to enter a name for newly created graphics.
- **Show Column with Number of Selected Features:** Here, you can enable a column on the right side of the TOC showing the number of selected features per vector layer / group.

 opens a drop-down list

For more information on feature selection, see chapter 4.2.3.1.

- **Additional Status Bar Info:** determines, which additional information is displayed in the status bar (see chapter 2.2.1.3). Available are:
 - **Disabled:** if selected, no additional information is displayed.
 - **GPS:** if selected, the GPS status is displayed.
 - **Selected Layers Count:** if selected, the number of layers currently selected (= highlighted in blue) in the TOC is displayed.
 - **Selected Feature Measurement:** if selected, the size of the currently selected feature is displayed. The unit (m²/ha/km² or m/km) depends on the predefined area or length unit (see chapter 3.4.1.4). If multiple features are selected, no size is displayed, i.e. the size is not, for example, added up.

 opens a drop-down list

Category Raster Settings

- **Show Message Dialog on Raster Read/Write Error:** if **On**, you get an error message in the form of a dialog if an error occurs while reading raster data. If **Off**, the error message is only displayed briefly in the status bar (see chapter 2.2.1.3).

- **Only Show Used Bands in Pixel Info and Raster Inspector:** If **On**, only those bands of a raster that are currently in use (i.e. visible in the map viewer) are taken into account when querying pixel values with **Pixel Info** (see chapter 4.1.12). If **Off**, all bands are taken into account; please note that the query may then take a long time for multi-band raster stacks.

If you hold the Ctrl key while clicking into the raster with Pixel Info, the setting is temporarily inverted.

For more information on the band mapping/usage, see chapter 5.3.3.6.

Category **Proxy Settings**

- **Use Proxy:** determines whether a proxy is used for web requests or not (**Disabled**). If the **System Proxy** is used, custom credential (i.e. login and password) can be entered if necessary. If you choose **Custom Proxy**, the address of this proxy has to be entered additionally. You can also decide whether this proxy should be bypassed on local requests.

Category **Cache Settings**

- **Raster Cache (MB):** determines the size of cache for rasters. By default, 10% of the main memory size is entered.
- **Layer Cache (MB):** determines the size of the cache for all drawn layers. By default, 7% of the main memory size is entered.

Please note that performance problems can occur if the set cache size is too small, and an Out of Memory error if the size is too big.

Category **Directories:**

- **TMS Cache Directory:** determines the cache directory for online map services, i.e. the directory where called raster tiles of WMS/WMTS/TMS are (temporarily) stored.
- **Temp Directory:** determines the directory for temporary files created with GAFmap® Express.
- **Local/Central Projects Directory:** determines the default directory for locally/centrally stored projects.

Please note: All directories listed here require rights for reading, the directories for TMS Cache and temporary files also for writing.

At the bottom of the tab / settings window you can find the following buttons:

- **Manage TMS Cache:** lets you empty the **TMS Cache Directory** (see above) completely or partially, i.e. you can delete locally (temporarily) stored raster tiles of WMS, WMTS,

and TMS or 3D tiles. Note that these raster tiles are then no longer available when a service is called again and must therefore be re-downloaded if required. This can significantly increase the loading time, especially with a slow (Internet) connection, and offline use is no longer possible.

A window opens in which all cached raster tiles (*.cache) and 3D tiles (*.3dcache) are listed, separated by online service and including cache size. With the delete button you can delete the saved data for the listed services individually.

- **Restore:** sets all settings within the tab to back to default. The command has to be confirmed before it is executed.

OK or the X button in the upper right corner of the window close the settings window. All changed settings are directly applied.

The settings in this tab are stored in your user profile. They are uploaded from your profile when you open GAFmap® Express and written back when you close it.

3.4.2 Language

In **GAFmap Express: Menu Extras**

Via **Language** you can change the language used for the user interface. GAFmap® Express is available in English and German.

Please note that GAFmap® Express has to be restarted for a language change.

The selected language is stored in your user profile.

3.4.3 Open User Folder

In **GAFmap Express: Menu Extras**

Via the submenu **Open User Folder** you can access your GAFmap® user profile (**Roaming**, **Local** or directly **Log**). If you select one of the three commands, the standard file browser / explorer opens at the corresponding location.

3.5 Menu Help

3.5.1 About GAFmap Express

In GAFmap Express: Menu Help

Here, you can check the following basic software information:

- used software version
- copyright
- product code
- short description of GAFmap® Express

Licenses and Acknowledgments takes you to the directory that holds all (third-party) licenses and acknowledgements that are binding when using the software.

3.5.2 Help

In GAFmap Express: Menu Help

Use **Help** to go to the front page of the software manual.

4 GAFmap Toolbars

4.1 Main Toolbar

4.1.1 Save Project

In GAFmap Express: Main Toolbar



Corresponds to **Save Project** from the Menu **File**. See chapter 3.1.3.

4.1.2 Open Project

In GAFmap Express: Main Toolbar



Corresponds to **Open Project** from the Menu **File**. See chapter 3.1.1.

4.1.3 Pan

In GAFmap Express: Main Toolbar

Only active for (2D) map windows



Pan lets you change the currently visible map extent. Therefore, activate the Hand, grab the map with a left-click on the map viewer, hold the mouse button, move the map to the favored position and release the mouse button.

Shortcuts, Key Commands, etc.:

- Pressed mouse wheel while another tool is active: grab and move map
- Space while another tool is activated: temporarily activate Hand
- Arrow keys: move map by one step in the corresponding direction. You can customize the pan factor in the general settings (see chapter 3.4.1.8).
- Back/Insert: go to last/next extent
- For more shortcuts, see chapter 4.1.4

4.1.4 Zoom In / Zoom Out

In GAFmap Express: Main Toolbar

Only active for (2D) map windows



Zoom In / Zoom Out lets you scale the currently visible extent up / down. Every left-click in the map viewer changes the scale by one step. The step size (zoom factor) can be adjusted in the general settings (see chapter 3.4.1.8).

Using **Zoom In** you also have the possibility to choose the new display extent by dragging a corresponding rectangle within the map viewer.

Shortcuts, Key Commands, etc.:

- Home: zoom to full extent
- Z: zoom to specific map scale
- Mouse wheel: zoom extent
- Ctrl + mouse wheel: zoom extent with 1/5 of the zoom factor
- Alt + left-click on selected layer(s)/group(s) in the TOC: zoom to layer(s)/group(s)
- Back/Insert: go to last/next extent
- For more shortcuts, see chapter 4.1.3

4.1.5 Go to Last/Next Extent

In GAFmap Express: Main Toolbar



Go to Last Extent lets you go back to previous extents step by step while **Go to Next Extent** lets you restore undone extents.

Undone/restored are the **Center** and the **Extent** of the extent visible in the map viewer, e.g. if the extent has been moved or zoomed with the mouse wheel or by using the corresponding buttons in the toolbar, not e.g. (size) changes to the map viewer itself or the activation status of layers in the TOC.

Note that an undone extent can only be restored if it has not been adjusted manually in the meantime.

If multiple map viewers are open, the extent is undone/restored across all windows step by step in the respective order, i.e. regardless of which window is active. Note that the extent in other map viewers is also changed if the center or the extent of the windows is linked (see chapter 3.2.1).

Shortcuts, Key Commands, etc.:

- For shortcuts, see chapter 4.1.3 and 4.1.4

4.1.6 Zoom to Full Extent

In GAFmap Express: Main Toolbar



Zoom to Full Extent zooms the extent visible in the map viewer to the full extent of all loaded datasets, regardless of whether the layers are activated/checked in the TOC or not.

If the project contains multiple map windows, only the extent of the active window is adjusted. Note that the extent in other map viewers is also changed if the center or the extent of the windows is linked (see chapter 3.2.1).

Shortcuts, Key Commands, etc.:

- For shortcuts, see chapter 4.1.3 and 4.1.4

4.1.7 Map Scale

In GAFmap Express: Main Toolbar

Only active for (2D) map windows



In the scale field, the current map scale is displayed. You can always adjust the scale by either selecting one of the predefined scales from the drop-down list or by typing in any scale and confirming with Enter. The map viewer is then zoomed accordingly.

If the project contains multiple map windows, the scale refers to the active (highlighted) map window, and changes only affect this one. Note, however, that the map viewers in the other map windows are also adjusted if the extent is linked (see chapter 3.2.1).

The scale of the map displayed on the screen depends on the size of the screen and its resolution. The calculation in GAFmap® presumes a pixel density of 96 dpi (at 100% DPI scaling in Windows). If your screen has a different resolution, the scale displayed on the screen deviates accordingly from the entered scale.

Shortcuts, Key Commands, etc.:

- For shortcuts, see chapter 4.1.3 and 4.1.4

Tips and notes:

- The desired map scale can also be set via **Set Map Scale** in the map context menu (see chapter 5.1.2).

4.1.8 Go to Coordinate


In GAFmap Express: Main Toolbar

Only active for (2D) map windows


X: —
Y: — **Go to Coordinate** lets you center the map viewer on any entered coordinate. The coordinate can be specified as follows:

Figure 58: Dialog **Go to Coordinate**

- **Geographic:** if selected, the coordinates can be entered in the fields **Lon/Lat** as **Decimal Degree**, **Degree-Minute**, or **Degree-Minute-Second**.
- **Map Spatial Reference X/Y:** if selected, the coordinates can be entered for the current map coordinate system in the fields **X/Y**.
- **Other Spatial Reference X/Y:** if selected, you can browse for another spatial reference the coordinates are to be entered in. The input fields are then adapted to the chosen coordinate system.

 opens a file browser

If you have entered a **Custom Spatial Reference** in the general settings (see chapter 3.4.1.3), this reference system is preselected by default.

- **MGRS** (= Military Grid Reference System): The coordinate can be entered in the **MGRS** field in the respective syntax.
-  **Add Point**: A point is created at the currently entered coordinate. It is added to the TOC as graphic named Ref. Point.

Apply centers the map in the map viewer on the entered position. The coordinate is briefly marked with a red cross. **Close** closes the dialog without further action.

If multiple map viewers are open, only the active window is centered on the entered coordinate. Note that the extent in other map viewers is also changed if the center or the extent of the windows is linked (see chapter 3.2.1).

Shortcuts, Key Commands, etc.:

- For shortcuts, see chapter 4.1.3 and 4.1.4

Tips and notes:

- The display format of the coordinates in the status bar (see chapter 2.2.1.3) can be adjusted in the general settings (see chapter 3.4.1.3).

4.1.9 Undo / Redo

In GAFmap Express: Main Toolbar



Undo lets you gradually undo all actions performed in GAFmap®, while **Redo** lets you gradually redo undone actions. This applies to all actions but the following exceptions:

- Changes to the program window (e.g. changing size, rearranging toolbars, etc.)
- Activation status of buttons in toolbars
- Arranging map viewers
- Changes to general settings (under menu Extras)
- Panning and zooming the map extent. These actions can be undone/redone with **Go to Last/Next Extent** (see chapter 4.1.5).

The tooltip of the Undo/Redo-button tells you which action will be undone/redone next.


Note that undone actions can only be redone if no new action has been performed in the meantime.

Shortcuts, Key Commands, etc.:

- Ctrl+Z/Ctrl+Y: undo/redone changes

4.1.10 Select Layer

In GAFmap Express: Main Toolbar

 **Select Layer** lets you select all layers (incl. graphics) in the TOC that are shown at a certain position in the map viewer, e.g. to deactivate them ("turn them off") with X, or simply to check which layers are located at this position. The latter can be helpful especially if the TOC contains a lot of layers and/or if layers overlap / cover each other in the respective map section.

You can select layers by clicking/activating the button and then

- dragging a selection rectangle in the map viewer. All layers that intersect this rectangle are selected (highlighted in blue) in the TOC.
- clicking into the map viewer. All layers that intersect the mouse pointer are selected in the TOC.
- clicking into the map viewer while holding the Alt key. The topmost layer that intersects the mouse pointer is selected in the TOC.

Note that only activated (i.e. checked/visible) layers are included in the selection.

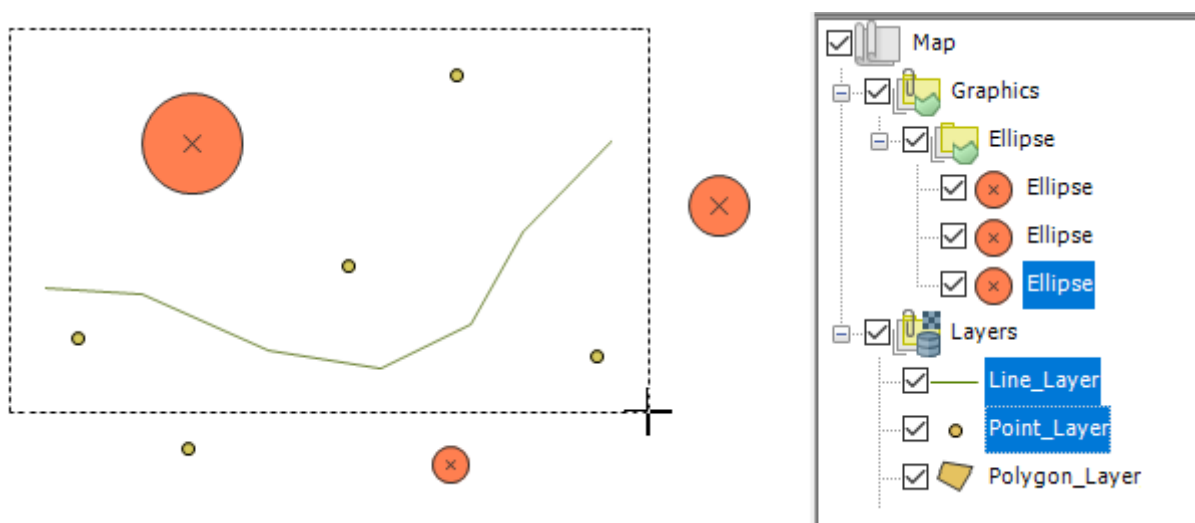


Figure 59: **Select Layer** by a rectangle in the map viewer

Selecting layers in the 3D Viewer

In the 3D Viewer, you can select single graphics or layers by clicking them (or in case of vector layers: by clicking a single feature). Note that only 3D objects/layers can be selected, but not textures (see chapter 2.2.3.2).

Shortcuts, Key Commands, etc.:

- Ctrl when selecting: add selection to current selection. Already selected layers will be deselected when they are selected twice.
- Ctrl + Shift when selecting: add selection to current selection. Already selected features are not deselected when they are selected twice.
- Shift when selecting: Already selected features are deselected when they are selected twice. Other features are not added to the current selection.
- Alt while dragging a selection rectangle: create square
- Alt when selecting by click: select only topmost layer
- Ctrl+A within TOC: select all layers
- X: toggle layer(s) selected in TOC (with multiple map windows only in the active one)
- C: toggle layer(s) selected in TOC globally (with multiple map windows in all windows)

Tips and notes:

- For general information on (selected) layers, see chapter 5.
- You can exclude background layers (i.e. raster) from the selection when dragging a selection rectangle (see chapter 3.4.1.8).
- Special case mosaic layer (see chapter 5.3.6): A collapsed mosaic layer is interpreted as a single raster and accordingly selected as a whole. If the mosaic layer is expanded, individual rasters are identified and selected.

4.1.11 Identify

In GAFmap Express: Main Toolbar



Identify lets you detect all layers and features within a certain extent / on a certain position

- by dragging a rectangle on the map. All layers/features that are within the rectangle or intersect it are listed.
- by a left-click on the map. All layers/features that intersect the pointer are listed.

All active (i.e. checked/visible) layers are taken into account.

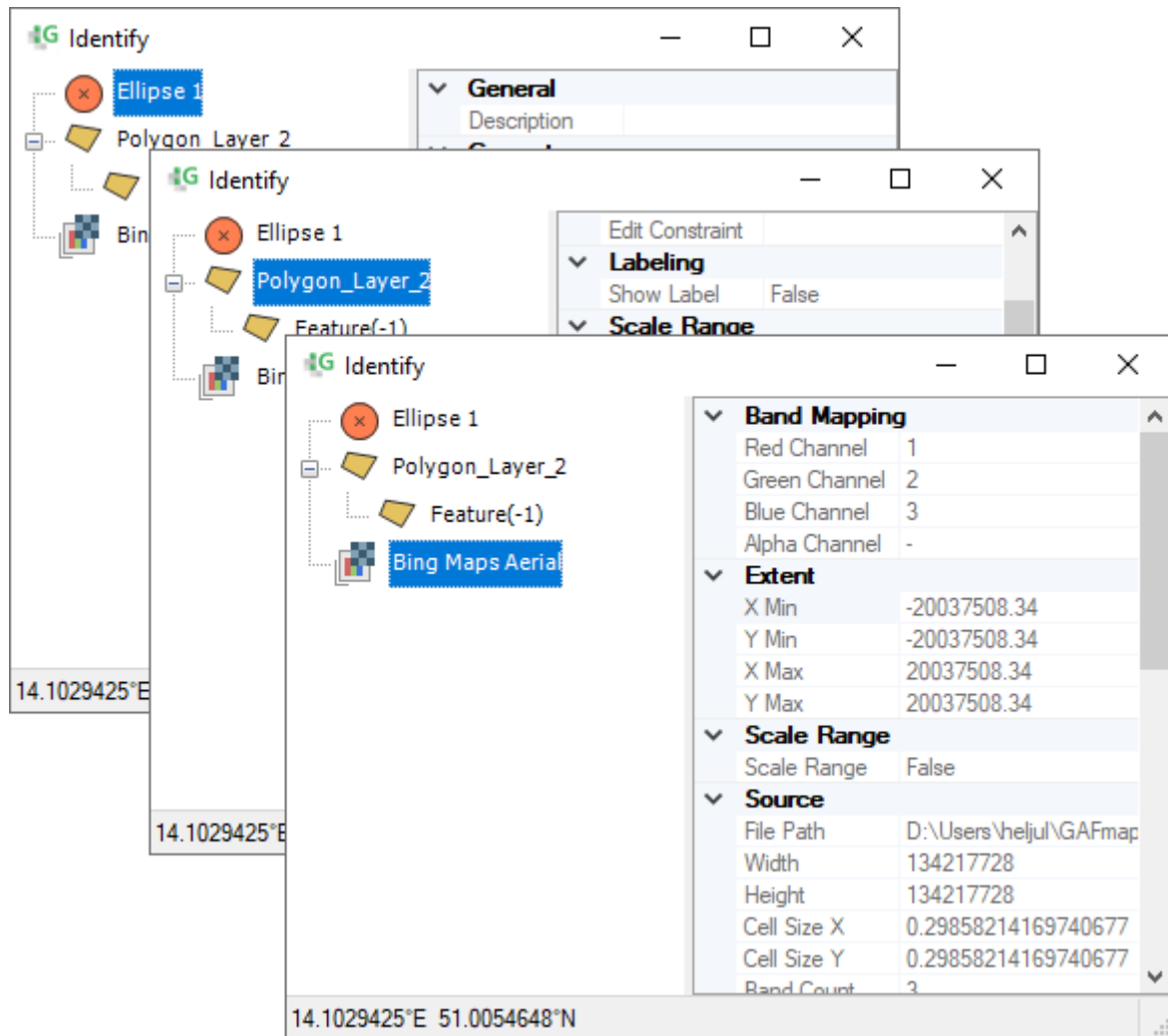


Figure 60: **Identify** window: List of all identified layers and features within a certain extent

To the **left** side of the window, all identified layers and features are listed. The selected layer /feature is highlighted in light green in the map viewer. To the **right side** all layer properties or features attributes of the layer/feature selected on the left are shown.

In the footer of the Identify window, the X/Y-coordinates of the clicked location and, if enabled, the terrain height there are displayed. The display corresponds to that in the footer of the main window (see chapter 2.2.1.3). It can be specified in the general settings under menu Extras > Settings > Viewing (see chapter 3.4.1.3).

By clicking on the footer of the Identify window, you can copy the X/Y/(Z) coordinates to the (Windows) clipboard:

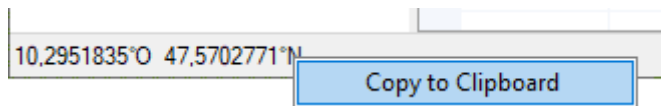


Figure 61: **Identify** window: Copy coordinates to Clipboard

If you use **Identify** in the 3D window, additionally the distance of the clicked point to the viewer is displayed in the footer.

Tips and notes:

- The **Identify** window is dockable. For more information, see chapter 2.2.4.
- Special case mosaic layer (see chapter 5.3.6): A collapsed mosaic layer is interpreted as a single raster and accordingly listed in the Identify window. If the mosaic layer is expanded, individual rasters are identified and listed.

4.1.12 Pixel Info

In GAFmap Express: Main Toolbar

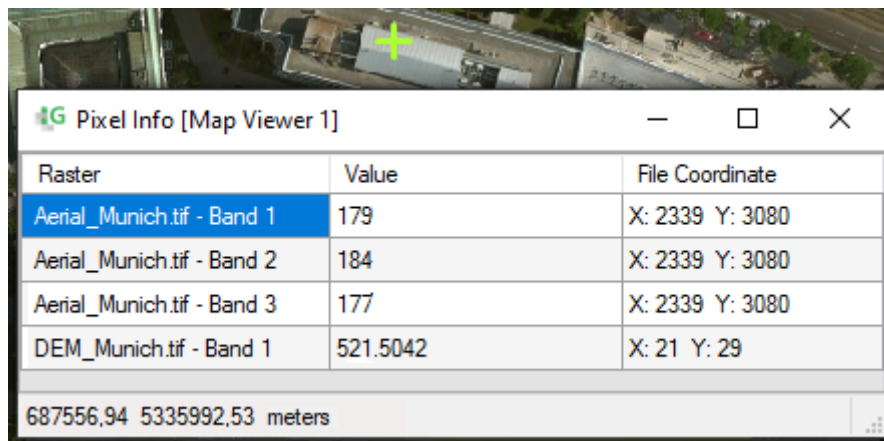


Pixel Info lets you query gray-scale values of single pixels by selecting them within the map viewer with the cursor. The Pixel Info window lists the following information about the hit pixel(s):

- name of the source raster and band
- gray-scale value of the pixel
- if applicable: the stretched value in brackets (see below)
- pixel coordinate (as file coordinate)

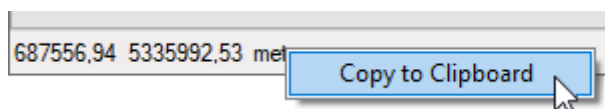
For multi-channel rasters, the value of the pixel hit is listed individually for each band. By default, only bands used / displayed in the map viewer are taken into account (see chapter 5.3.3.6). However, all bands can be included by changing the corresponding general setting under Other (see chapter 3.4.1.8) or pressing the Ctrl key when querying the pixel.

If raster layers overlap, the values of all hit pixels are listed.

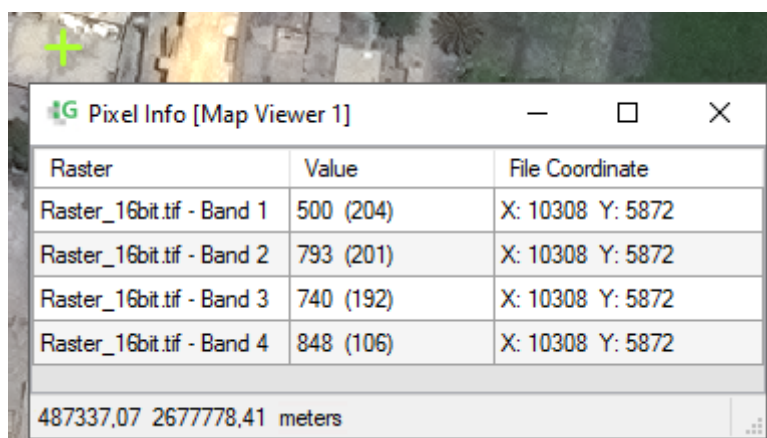
Figure 62: **Pixel Info** window

The clicked location is marked in the map viewer with a green cross. In the footer of the Pixel Info window, the corresponding X/Y coordinates are displayed. The display format corresponds to that in the status bar of the program window (see chapter 2.2.1.3). It can be specified in the general settings (see chapter 3.4.1.3).

By clicking on the footer of the Pixel Info window, you can copy the X/Y coordinates to the (Windows) clipboard:

Figure 63: **Pixel Info** window: Copy coordinates to Clipboard

If rasters are stretched with a custom transfer function (see chapter 5.3.3.6), the stretched value (i.e. the value as visible on screen) is shown in brackets in addition to the original gray-scale value.

Figure 64: **Pixel Info** window - Example with stretched values (only for Custom Transfer)

Shortcuts, Key Commands, etc.:

- Ctrl when querying the pixel: include all / only used bands for multi-channel rasters (depending on the general setting; see chapter 3.4.1.8).

4.1.13 Split Button Measure

4.1.13.1 Measure

In GAFmap Express: Main Toolbar > Split Button Measure



Measure lets you retrieve lengths/distances and area sizes from the map

- by drawing a **measuring sketch** freehand in the map viewer; the length or area of the sketch is then returned.

To do this, simply activate the button and then draw a measuring line (for distance measurement) or a measuring polygon (for area measurement) with any number of vertices in the map viewer. As soon as the first/second vertex is set, the length/area of the sketch is determined on-the-fly and displayed at Distance/Area.

The sketch can be completed with a double-click or F2. Up to this point, set vertices can be undone step by step with the right mouse button. A completed measuring sketch remains until you start a new sketch or the Measure button is deactivated.

- by **selecting** one or multiple line or polygon **features**; their length or area is then returned. If multiple features are selected, their length or area is summed up.

To do this, simply select one or multiple line or polygon features (e.g. with **Select Feature**; see chapter 4.2.3.1) and then check the **For selected features** option in the Measure dialog. The (summed) length or area of the selected features is then displayed at Distance/Area.

The length or area unit to be shown can be selected via the adjoining drop-down list.

Measuring Distances

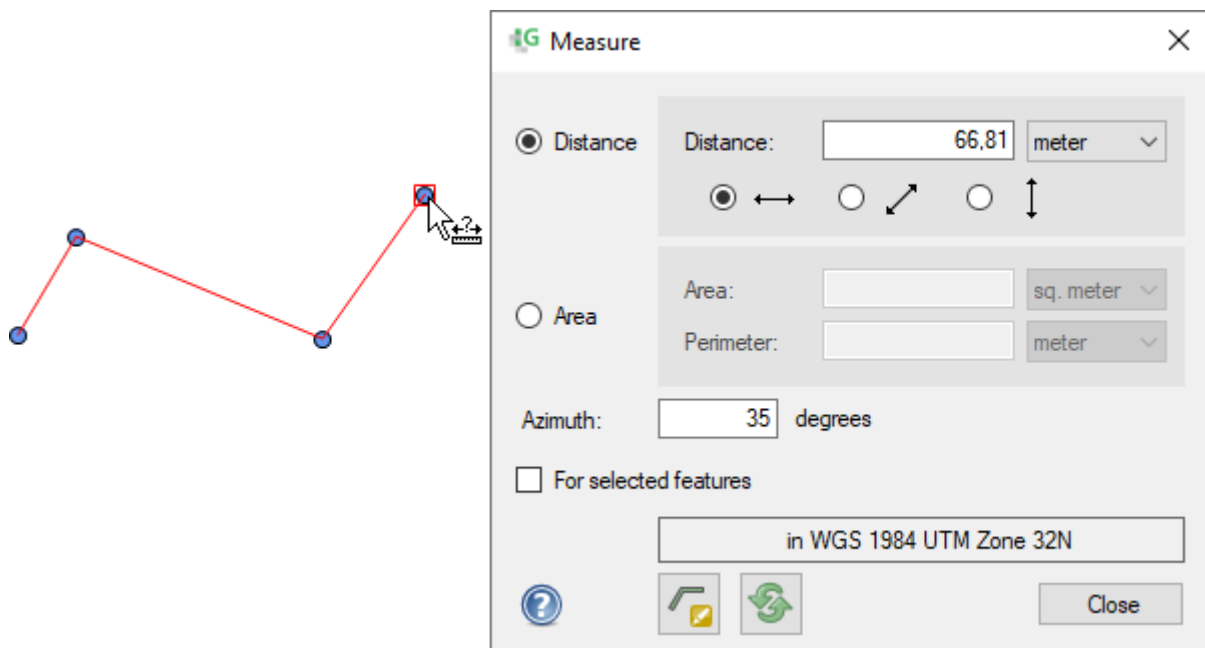





Figure 65: Measure window if measuring a distance


If you choose **Distance**, you can measure distances/lengths by drawing a measuring line in the map viewer or by selecting one or multiple (line) features. The (summed) length is then displayed at **Distance**.


You can choose from these three measurement options:

-  **Measure horizontally:** the length of the (measuring) line is determined on a horizontal plane; height differences are not taken into account in any case.
-  **Measure directly** (*please consider the notes on the height below!*): the length of the (measuring) line is determined, height differences at the vertices are taken into account. (I.e. the direct connection between the vertices in 3D space is measured).
-  **Measure vertically** (*please consider the notes on the height below!*): the height difference between the highest and the lowest vertex of the (measuring) line is determined; the length of the line is irrelevant.

- **Azimuth [°]:** shows the angle of the last drawn line segment in degrees from true north.
- **For selected features:** the summed length of all selected features is displayed.

Note that selected polygons are also included in the length calculation; the decisive factor is their perimeter, i.e. the length of the ring(s).

-  **Create Graphic:** adds the measuring line as graphic to the TOC.

-  **Reset:** deletes the measuring line and clears all measurements in the dialog.

Note for direct and vertical measurement with regard to the **height**:

- If you measure with a **measuring line**, the height component needed for direct and vertical measurement is interpolated for each vertex based on the **base DEM** (see chapter 5.3.4). If a vertex of the measuring line is not covered by the DEM, a height of 0 is assumed for it.

Also note that the height is not always determined based on the full DEM resolution, but on the pyramid level displayed in the active map viewer; thus, the full resolution is only used if pyramid level 0 is actually visible there. This means that the calculation of the length for direct or vertical measurements is usually more accurate the closer you zoom into the dataset.

- If you measure **selected features**, the Z-coordinate of the feature vertices is used as height component. If vertices do not have a Z coordinate, a height of 0 is assumed.

Note that the lengths of multiple selected features are always summed up, also when measuring vertically. I.e. in the case of vertical measurement, the height difference is not, for example, determined between all vertices, but per feature; these height differences are then added up.

Measure areas

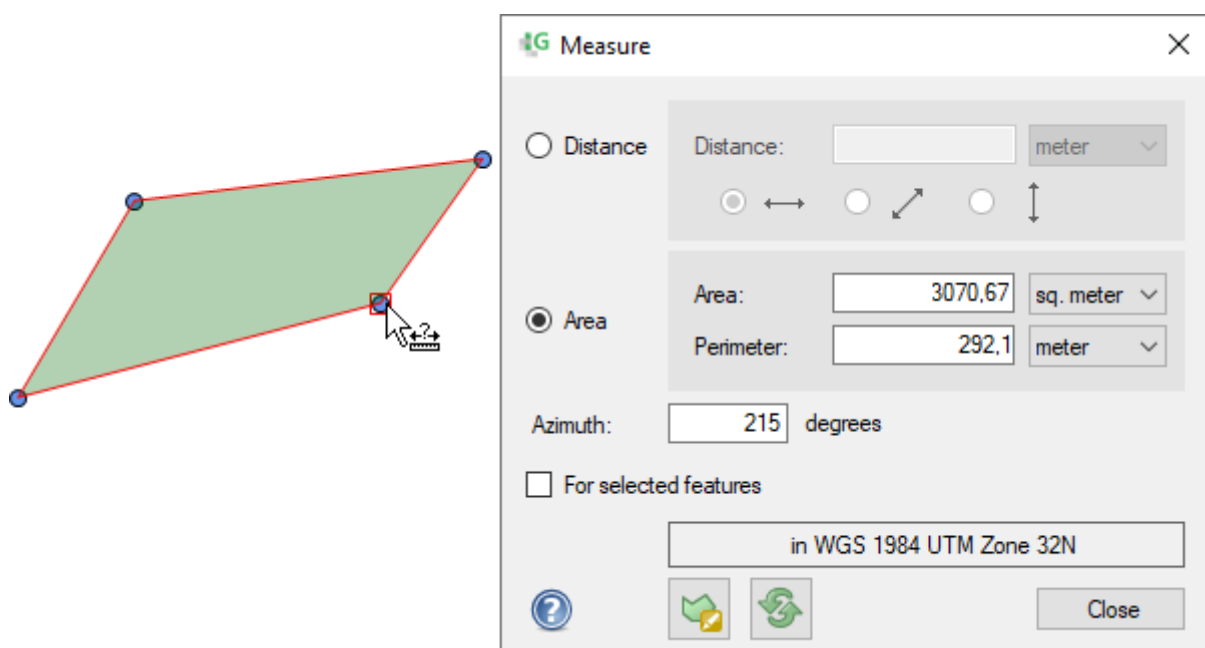




Figure 66: Measure window if measuring an area

If you choose **Area**, you can measure area sizes by drawing a measuring polygon in the map viewer or by selecting one or multiple (polygon) features. The (summed) area is then displayed at **Area**, and the (summed) length of the ring(s) is displayed at **Perimeter**.

- **Azimuth [°]:** shows the angle of the last drawn line segment in degrees from true north.
- **For selected features:** the summed area or perimeter of all selected features is displayed.

Note that selected lines are also included in the calculation of the perimeter; the decisive factor is their length. Lines are not included in the area calculation.

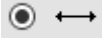
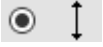

-  **Create Graphic:** adds the measure polygon as graphic to the TOC.
-  **Reset:** deletes the measure polygon and clears all measurements in the dialog.

Measuring in the 3D Viewer

Only relevant if the project contains a 3D window

When measuring **distances** in the 3D viewer, you receive the same result as in 2D. When creating the measuring line, the height for each set vertex is taken from the base terrain (see chapter 5.3.4) and is used for the measurement as well as for the display of the measuring line.

Regarding the three measurement options:

-  **Measure horizontally:** the horizontal measure line is placed on the height level of the highest vertex.
-  **Measure vertically:** the vertical measure line is always based on the lower vertex and is perpendicular to the terrain.
-  **Measure directly:** the direct measure line always shows the distance between two vertices (i.e. shortest connection).

When measuring **areas** in the 3D viewer, you also receive the same result as in 2D, since areas are also measured on a horizontal plane. Height values are only used for the visualization of the measure polygon.

Note that in 3D the vertices of the measuring sketch can only be placed on a surface, i.e. on DEMs, 3D models, three-dimensional graphic elements, or (extruded) features etc., and not into "empty space". If there is no 3D dataset on the screen at the clicked position, no vertex is created.

Method / Spatial Reference

The spatial reference for the measurement is always the defined or currently applicable UTM zone. If you work in a geographic reference system or a non-equidistant projection, the data is projected to UTM when measuring (in background!); for this, the vertices are densified to 0.1° or 10000m. If you measure distances or areas that exceed two UTM zones, the measurement is ellipsoidal. If a selected multipart feature is measured, each geometry part is first regarded individually and the measurement result is then summed up.

in WGS 1984 UTM Zone 32N

The used reference system is displayed in an info field at the bottom of the Measure dialog. If the reference system is unknown, e.g. because no spatial reference is defined for the map, the info field remains empty.

If the projection is not Transverse Mercator or Lambert Azimuthal, the measurement is made in UTM because e.g. Web Mercator has too much distortion.

Shortcuts, Key Commands, etc.:

- Right-click while drawing the measuring sketch: undo last vertex
- Esc while drawing the measuring sketch: cancel
- F2 while drawing the measuring sketch: finish sketch
- F4 while drawing the measuring sketch: enable/disable tracing

Tips and notes:

- You can adjust the symbology of the measurement line in the general settings (**Sketch Line/Fill Symbol**; see chapter 3.4.1.4).

4.1.13.2 Measure Length

In GAFmap Express: Main Toolbar > Split Button Measure

Only active for (2D) map viewers



Measure Length lets you measure distances directly in the map. To do this, simply activate the button and then draw a line with any number of vertices in the map. After the first vertex is set, the resulting length is displayed directly at the mouse pointer and updated on-the-fly. A double click, F2, or Esc ends the measuring and the sketch disappears.

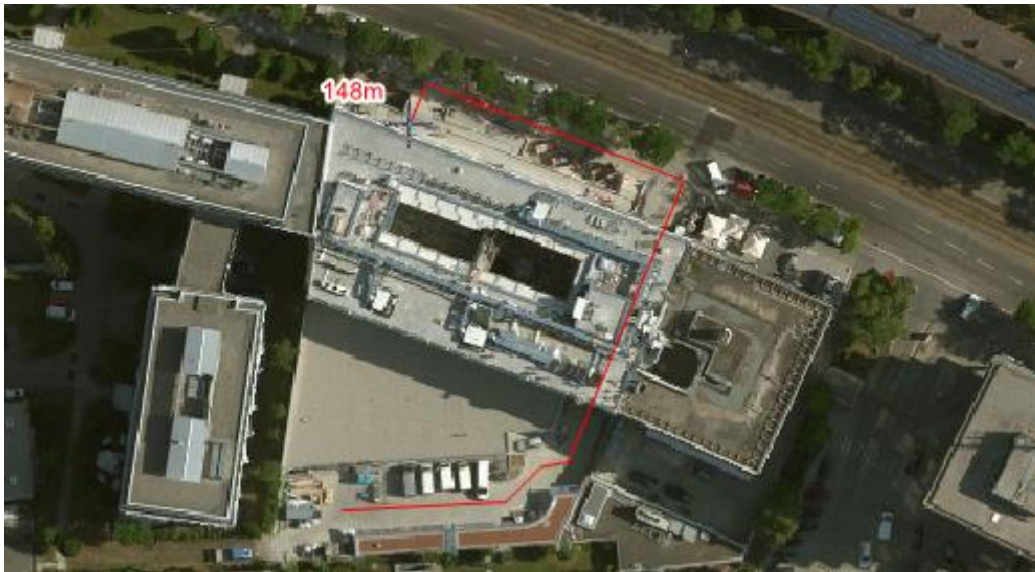


Figure 67: **Measure Length**, Example

The displayed unit can be changed in the general settings (see chapter 3.4.1). The measuring method corresponds to that of the **Measure** tool (see chapter 4.1.13.1).

Shortcuts, Key Commands, etc.:

- Right-click while drawing the measuring sketch: undo last vertex
- Esc or F2 while drawing the measuring sketch: end/cancel measuring

Tips and notes:

- Activate **Show Measurement** in the general settings if you want the length of line features to be displayed directly while capturing (see chapter 3.4.1.4).
- You can adjust the symbology of the measurement line in the general settings (**Sketch Line Symbol**; see chapter 3.4.1.4).

4.1.13.3 Measure Area

In GAFmap Express: Main Toolbar > Split Button Measure

Only active for (2D) map viewers



Measure Area lets you measure areas directly in the map. To do this, simply activate the button and then draw a polygon with any number of vertices in the map. After the second vertex is set, the resulting area is displayed directly at the mouse pointer and updated on-the-fly. A double click, F2, or Esc ends the measuring and the sketch disappears.



Figure 68: **Measure Area**, Example

The displayed unit can be changed in the general settings (see chapter 3.4.1). The measuring method corresponds to that of the **Measure** tool (see chapter 4.1.13.1).

Shortcuts, Key Commands, etc.:

- Right-click while drawing the measuring sketch: undo last vertex
- Esc or F2 while drawing the measuring sketch: end/cancel measuring

Tips and notes:

- Activate **Show Measurement** in the general settings if you want the area of polygon features to be displayed directly while editing (see chapter 3.4.1.4).
- You can adjust the symbology of the measurement line in the general settings (**Sketch Line/Fill Symbol**; see chapter 3.4.1.4).

4.1.13.4 Measure Distance to Selected Features

In GAFmap Express: Main Toolbar > Split Button Measure

Only active for (2D) map viewers



Measure Distance to Selected Features lets you measure the shortest distance from a certain point to one or multiple selected features. To do this, first select the feature(s) to which the distance is to be measured (see chapter 4.2.3) and then press the button to open the

measure window and/or activate the measure tool. If you now click into the map viewer, the shortest distance from the mouse pointer to each selected features is displayed:

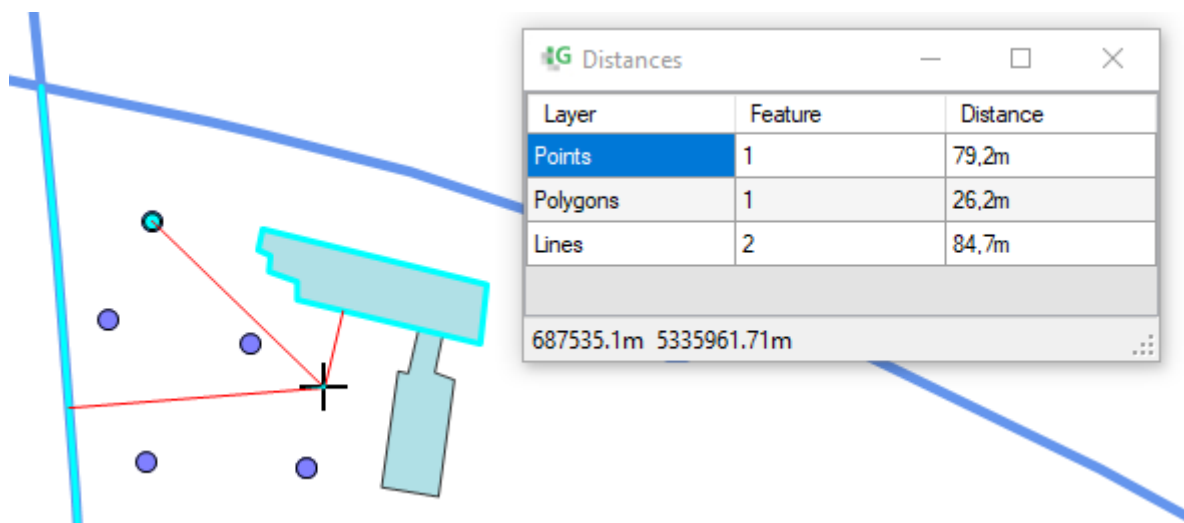


Figure 69: **Measure Distance to Selected Features**, Example

As long as you press the mouse button, the distance to the mouse pointer is updated on-the-fly, if you release the mouse button, the measured values are fixed.

The following information is displayed in the measure window for each measured feature:

- **Layer:** the name of the layer from which the feature originates.
- **Features:** the FID of the feature.
- **Distance:** the shortest distance from the mouse pointer to the feature.

In addition, in the status bar of the measure window: the mouse pointer position on which the measurement is based (in map coordinates)

Method

For the measurement, it is first determined which point of the feature is closest to the mouse pointer ("Closest Point"). This closest point is determined in the current map projection. Note that the closest point may differ slightly from the actual closest point, depending on the projection distortion. The measuring method for the distance measurement then corresponds to that of the **Measure** tool (see chapter 4.1.13.1).

Tips and notes:

- You can adjust the symbology of the measurement line in the general settings (**Sketch Line Symbol**; see chapter 3.4.1.4).

4.1.13.5 Measure Angle

In GAFmap Express: Main Toolbar > Split Button Measure


 **Measure Angle** lets you measure angles directly in the map. To do this, simply activate the button and then define a line segment in the map with two points/vertices. If you now move the mouse, the resulting angle between the set and the next line segment is displayed and updated on-the-fly. A third click, F2, or Esc ends the measuring and the sketch disappears.



Figure 70: **Measure Angle**, Example

Always the smaller angle is displayed. The measuring method corresponds to that of the **Measure** tool (see chapter 4.1.13.1).

Shortcuts, Key Commands, etc.:

- Right-click while drawing the measuring sketch: undo last vertex
- Esc or F2 while drawing the measuring sketch: end/cancel measuring

Tips and notes:

- You can adjust the symbology of the measurement line in the general settings (**Sketch Line Symbol**; see chapter 3.4.1.4).

4.1.14 Create Profile

In GAFmap Express: Main Toolbar



Create Profile lets you quickly and easily visualize a height profile, i.e. a terrain section, based on a digital elevation model (DEM) and a (profile) line. For this, the height values under the (profile) line are captured, interpolated, and transferred to an height diagram:

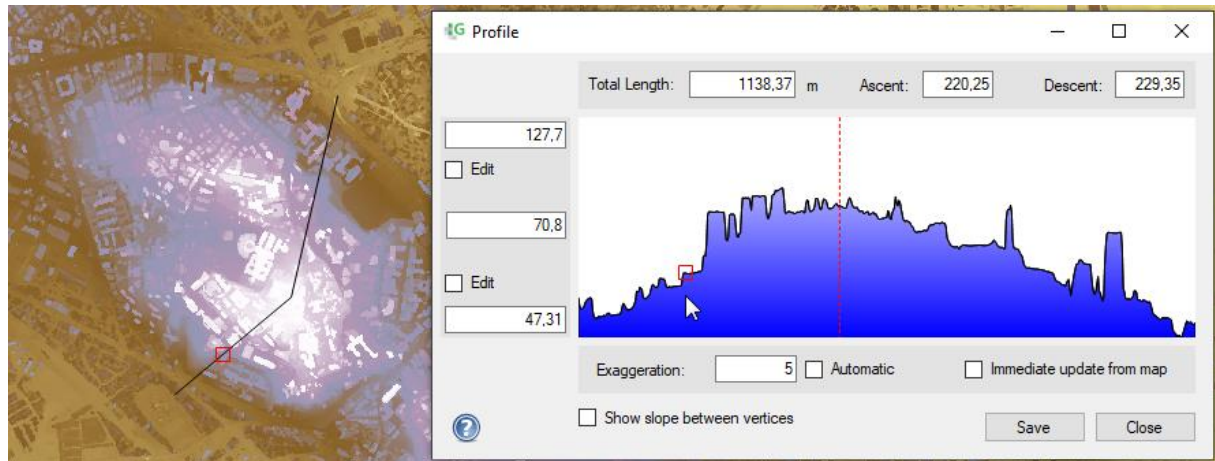


Figure 71: **Create Profile**, Example: (profile) line in the map viewer and resulting height profile

The calculation of the profile is based on the background DEM (see chapter 5.3.4). If no DEM lies under the profile line, all fields in the profile dialog remain empty; if only sections of the line are covered by the DEM, the profile is only created for the covered areas.

Proceed as follows to create a height profile:

- Activate the **Create Profile** button. The dialog opens.
- Draw a (profile) line with any number of vertices at the desired position in the map viewer. As soon as you set the second vertex, the height profile under (scetch) line is displayed. The display is constantly updated while drawing. Vertices are displayed as vertically dashed, red lines.
- Complete the (profile) line with a double-click. It is then added to the TOC under Graphics as a simple line graphic.
- As long as the Profile dialog remains open or the **Create Profile** button is activ, you can draw further (profile) lines at any time. The display in the dialog is always adapted to the current (profile) line.

Alternatively, you can create a height profile by using any existing line graphic. To do this, simply start the command **Create Height Profile** in the context menu of the graphic (see chapter 5.2.5.3). The Profile dialog then opens directly:

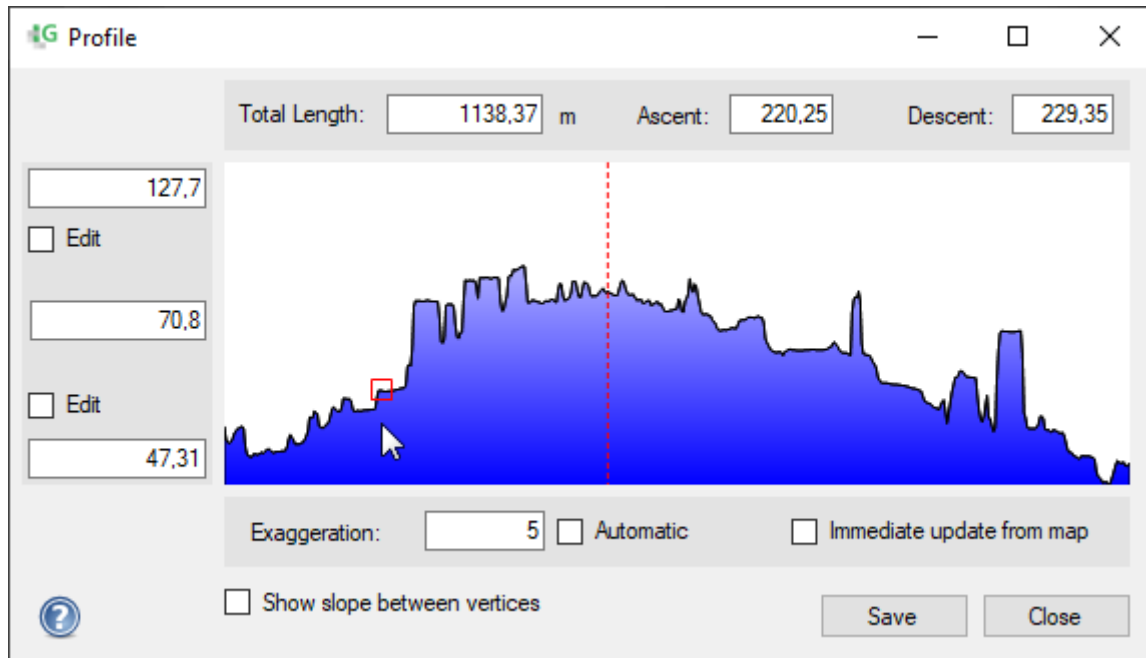


Figure 72: **Create Profile** dialog

Diagram Field

In the **Diagram Field** the height profile/terrain section is displayed graphically. If you move the mouse cursor across the profile, the current mouse position is displayed on the height curve as well as in the map viewer. This makes it easier to e.g. find a certain position in the height profile on the map.

The height at the current mouse position is displayed in the middle field in the bar to the left of the diagram field (see below).

A right-click in the diagram field opens the context menu. If you select **Transfer to Map**, a point graphic is created at the currently marked position on the (profile) line in the map viewer and added to the TOC under Graphics:

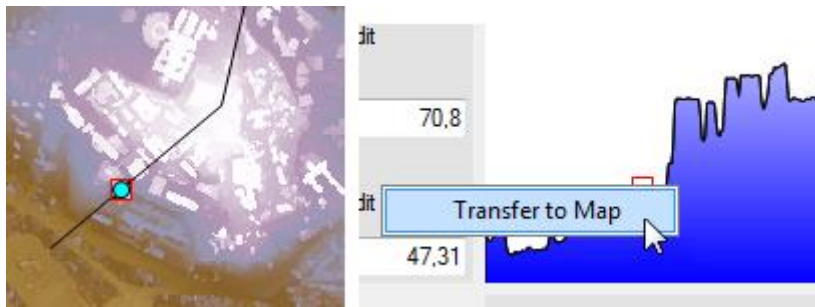


Figure 73: **Create Profile** - current position: **Transfer to Map**

Profile Dialog, Top Bar

- **Total Length [m]**: shows the total length of the (profile) line (measured horizontally).
- **Ascent [m] / Descent [m]**: shows the number of vertical meters the terrain below the (profile) line ascends/descends in total.

The profile is always displayed in full length in the diagram field. You can adjust the vertical position and extent with **Maximum/Minimum Height** or **Exaggeration**:

Profile Dialog, Left Bar

- **Maximum Height** (top field) / **Minimum Height** (bottom field): determines the absolute height of the top/bottom edge of the diagram field and therefore how the profile is vertically positioned in the field and/or shrunk or stretched.

By default, the profile is displayed so that the maximum height corresponds to the highest derived height value and the minimum height to the lowest. Consequently, the pre-entered values correspond to the highest/lowest height below the (profile) line.

Edit: if checked, you can manually change the **Maximum/Minimum Height**. The height of the top/bottom edge in the diagram field is then adjusted and the profile in the field shifted vertically and/or shrunk/stretched accordingly (also depending on whether the **Exaggeration** is automatically determined or fixed; see below).

Note that the profile is not or not completely visible in the diagram field if the entered **Maximum/Minimum Height** is smaller/larger than the highest/lowest height.

- **Height at current mouse position** (middle field): displays the height at the current mouse position in the profile.

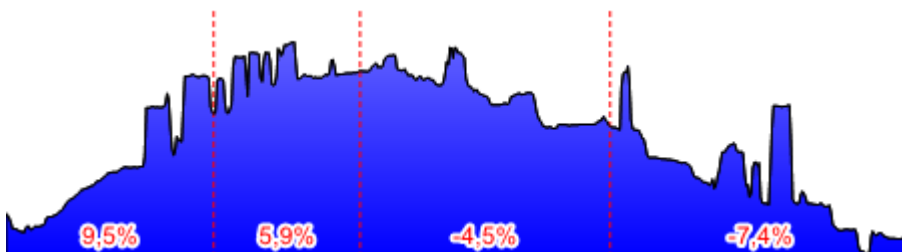
Profile Dialog, Bottom Bar

- **Exaggeration:** determines the factor the derived heights are multiplied with and therefore whether and to what extent the profile is stretched or shrunk ("exaggerated").

Automatic: if checked, the exaggeration is determined automatically so that the profile is displayed with the highest possible vertical extent in the diagram field. The corresponding factor is displayed in the adjacent field. It is adjusted continuously, e.g. while you are creating the profile line or when changing the **Maximum/Minimum Height** or the aspect ratio of the dialog.

If unchecked, you can manually enter a fixed exaggeration. The profile is then enlarged or reduced in the diagram field with a constant aspect ratio if e.g. the line length or the field size changes.

- **Immediate update from map** (*not available if the height profile has been opened via the context menu of a line graphic*): the terrain section is already displayed while you create the (profile) line in the map viewer. If this option is unchecked, the profile is updated as soon as a vertex is set, i.e. as soon as a line segment is "fixed". If checked, it is updated on-the-fly, i.e. while you are positioning a line segment.
- **Show slope between vertices:** if checked, the average slope per section is displayed in % in the **diagram field**. Both, gradients (positive values) and slopes (negative values) are displayed.



Save lets you save the height profile including all data displayed in the dialog as *.jpg.

Close closes the dialog. (Profile) lines not completed by double-click are then deleted. Note that the dialog is also closed when the **Create Profile** button is deactivated (e.g. because you click it again or activate another button).

If you want to visualize the Profile of a closed (profile) line again, you can reopen it at any time via **Create Height Profile** in the context menu of the line (see chapter 5.2.5.3).

Shortcuts, Key Commands, etc.:

- Right-click while drawing: undo last vertex

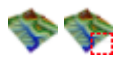
Tips and notes

- The symbol used to display the current mouse position within the diagram in the Map Viewer can be adjusted in the general settings (see chapter 3.4.1.4). The display of the point symbol in the 3D Viewer (size/color) also depends on this setting.
- You can see/check the **base DEM** if you uncheck the **Map** in the TOC and then enable the on-the-fly lighting/shading (see chapter 4.5.4 and 5.3.4).

4.1.15 Start 3D Viewer / Start 3D Viewer with current Map Extent

In GAFmap Express: Main Toolbar

Only available if the project contains a 3D window



Start 3D Viewer lets you extend a reduced map extent visible in the 3D viewer to the total extent of all data contained in the project and reduce/update the total/map extent visible in the 3D viewer to the map section currently visible in the (2D) map viewer with **Start 3D Viewer with current Map Extent**. With both buttons you can reopen/maximize a minimized 3D viewer.

Note that the button **Start 3D Viewer with current Map Extent** is only available if a (2D) map viewer is active (= highlighted); for multiple map viewer, it always refers to the active one. If the 3D Viewer is active or if the project does not contain a map viewer, the button is grayed out.

Alternatively, you can reduce/update the map extent visible in the 3D viewer to that of an **AOI** graphic. Therefore, use the command **Start 3D Viewer** in the AOI context menu (see chapter 5.2.2.1).

Loading a Reduced Map Extent

If the 3D viewer is started for a map extent only, data outside this extent are not only not displayed in the 3D viewer, but are not loaded into the 3D viewer at all. Depending on data quantity/size and hardware, this can significantly increase the performance in the 3D viewer, i.e. the rendering and the frame rate.

Raster layers are then (virtually) clipped, i.e. cut to the extent, vector data/features and 3D models are only taken over if they lie completely or partially within or intersect the loaded map extent. If a complete layer is outside the loaded area, this layer is not available in the 3D viewer and therefore grayed out in the 3D TOC:

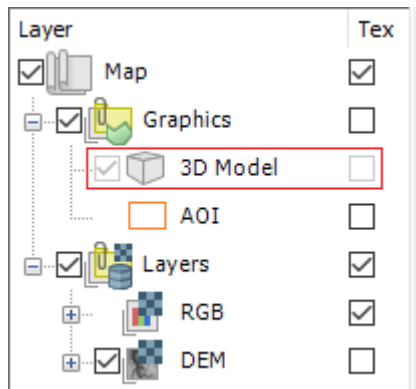


Figure 74: Grayed out layer/graphics in the 3D TOC are outside the loaded area

If the map extent is adjusted/updated so that it contains a previously grayed out layer again, this layer is available again in the 3D TOC.

4.2 Toolbar for Features

4.2.1 Show Attributes

In **GAFmap Express: Toolbar for Features**

Show Attributes lets you check the attributes of (selected) vector features, or browse (selected) features within a vector layer using the arrow buttons.

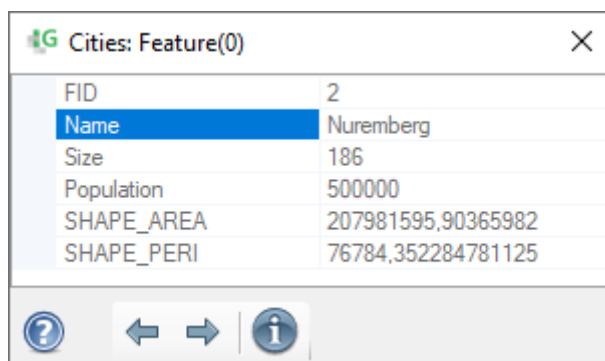



Figure 75: **Attributes** window

Show attributes


If you want to check feature attributes, select at least one feature (see chapter 4.2.3.1) and click **Show Attributes** (in this order). In the opening Attributes window all attributes of the (first) selected feature are listed.

If features from different vector layers are selected, a separate window opens for each layer.

-  **Previous/Next Feature:** switches between features one by one as follows:
 - If at least two features are selected before clicking Show Attributes, the attributes of all selected features are shown in turn. While browsing, the initial selection does not change.
 - If a single feature is selected, the attributes of all features within the layer are shown in turn. While browsing, the selection changes to the currently shown feature. This way you can browse all features within the layer.

After the last feature in the queue, the display automatically jumps back to the first feature. The order in which the features are browsed corresponds to the order of the features in the attribute table in the current sorting (see chapter 5.3.2.1) or with selected features to the selection order.

Within the map viewer, the map is always zoomed to the extent of the currently shown feature. In the general settings, you can determine whether the map is to be centered only on the feature geometry (see chapter 3.4.1.8). If you hold down the Alt key while changing features, the map is also just centered instead of zoomed.

-  **Highlight this feature:** highlights the geometry of the currently shown feature within the map viewer in light green.

Shortcuts, Key Commands, etc.:

- Alt when switching features: center map on feature geometry (instead of zoom to)

Tips and notes:

- The **Attributes** window is dockable. For more information, chapter 2.2.4.
- You can also check feature attributes directly via the attribute table. For this and for general information on features attributes, see chapter 5.3.2.1.

4.2.2 Show Coordinates

In **GAFmap Express: Toolbar for Features**

X: Y: **Show Coordinates** lets you display a list of all vertices and their coordinates for a single selected feature:

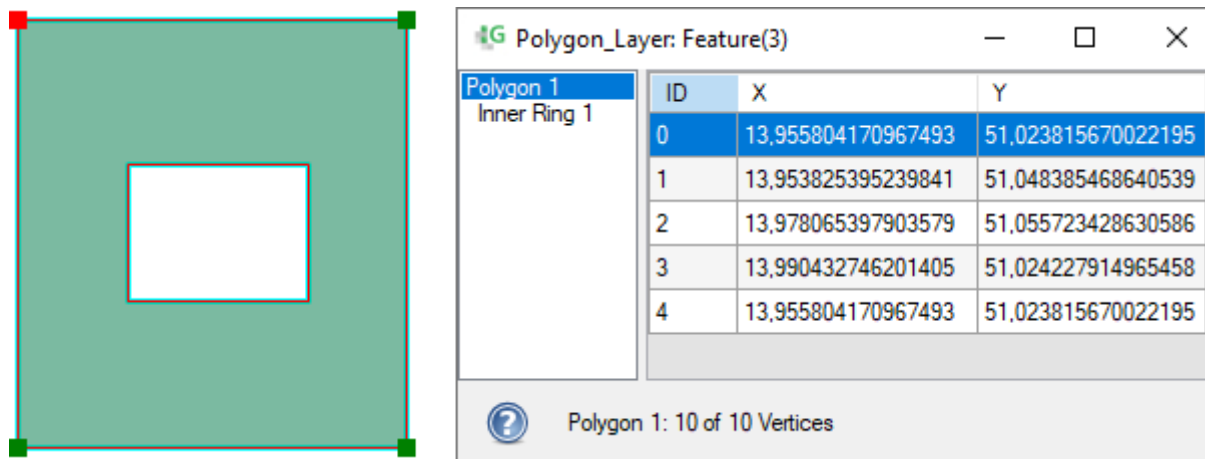


Figure 76: List of all feature vertices and their coordinates (Example: polygon feature without Z-coordinates)

The **left box** holds a list of all geometry parts (in case of multipart features) and all inner rings (in case of polygons with holes). A double-click on a list item zooms or centers the map extent to/on the respective geometry part / ring.

In the **footer** of the window, the vertex count of the geometry part selected in the left box above (including all its inner rings) or of the selected inner ring as well as the feature's total vertex count are displayed.

The table on the **right** lists all vertices of the chosen (i.e. highlighted in blue) list item, including their ID and coordinates, and in the following order:

- **Line:** starting at the start point (ID=0) and listing each vertex consecutively to the end point (ID=max), depending on the drawing direction.
- **Polygon:** start and end point are always coincident. The numbering for the outer ring is always clockwise, for the inner ring counterclockwise, regardless of the direction of digitization.

The vertex selected in the list (highlighted in blue) is highlight in red within the map viewer.

Shortcuts, Key Commands, etc.:

- Alt when double-clicking a list item in the Coordinates window: Pan to geometry part / ring (instead of zoom to)

4.2.3 Split Button Selection

4.2.3.1 Select Feature

In GAFmap Express: Toolbar for Features > Split Button Selection



Select Feature lets you select vector features

- by dragging a selection rectangle in the map viewer. All features that are within the rectangle or intersect it are selected.
- by clicking in the map viewer. All features that are hit by the mouse pointer are selected.
- by holding down the Alt key and clicking in the map viewer or dragging a selection rectangle. In this case, only the topmost* feature is selected (e.g. if features overlap).

* The drawing order in the map viewer is decisive here. The following applies: Features that higher up in attribute table in the current sorting are drawn first and are therefore at the bottom in the map viewer (see also chapter 5.3.2.1).

Selected features are bold-framed in the given selection color (cyan by default) in the map viewer, and highlighted in blue in the attribute table (see chapter 5.3.2.1).

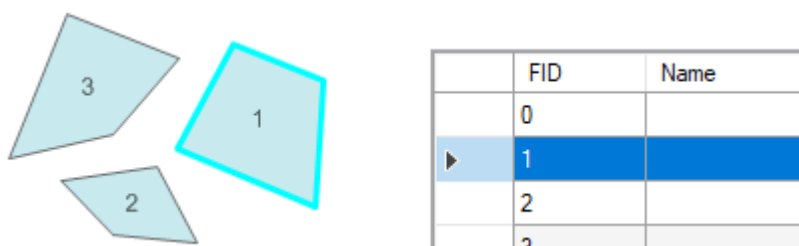


Figure 77: Selected feature (FID=1) highlighted in map viewer and Attribute Table

If desired, you can always change the selection color in the general settings (see chapter 3.4.1.3).

Please note that by default an existing selection is discarded / replaced by the new one, if you select features.

Add to / Reduce Selection

If you hold down the Ctrl key while selecting features, you can add features to an existing selection or reduce it by re-selecting already selected features. This applies regardless of how the selection is made (i.e. by clicking or using a selection rectangle). If you additionally hold down the Shift key, the selection is only extended but not reduced (if features are re-selected), if you only hold the Shift key, the selection is only reduced:

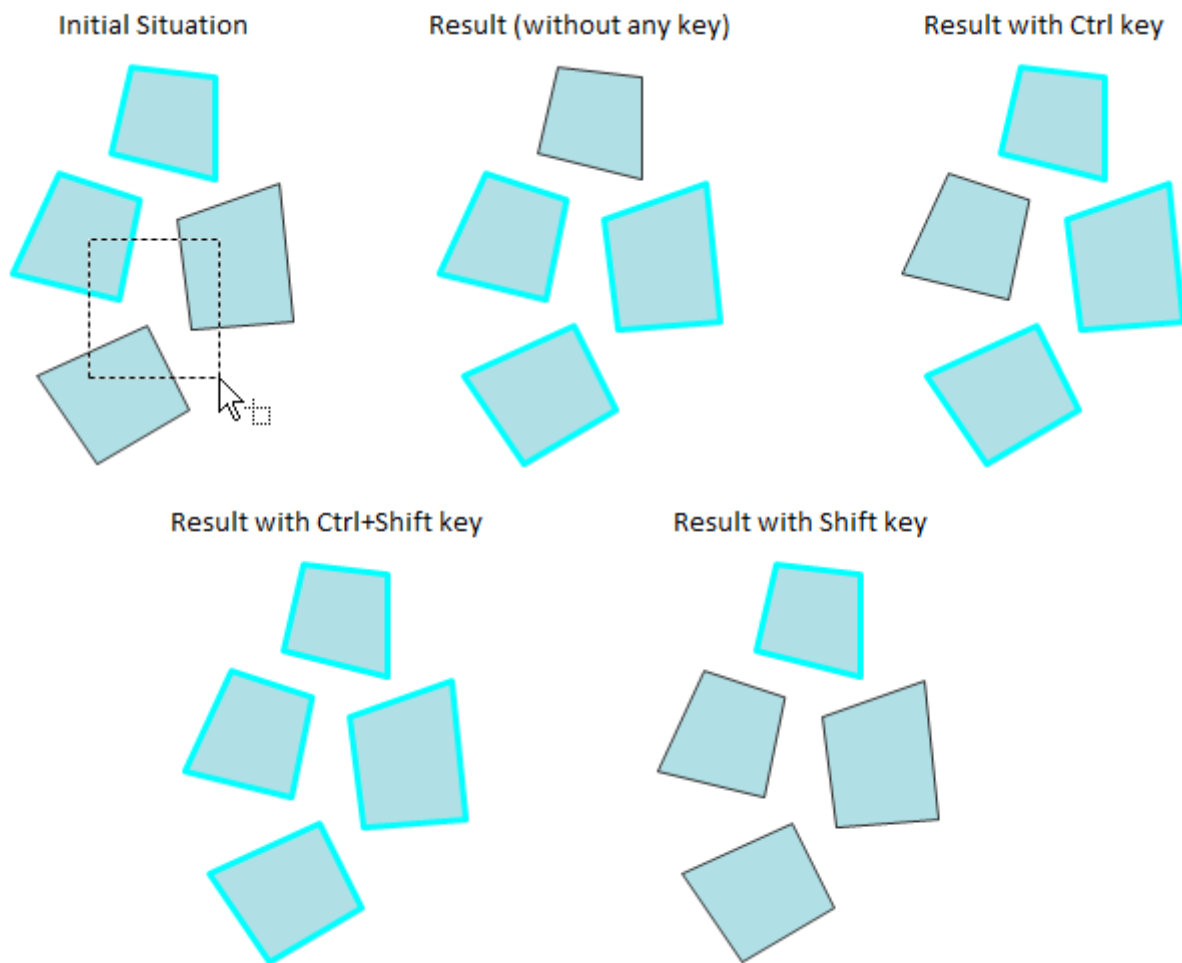


Figure 78: Add to / reduce selection (key commands)

Clear Feature Selection

You can clear a feature selection by

- clicking **Clear Selection** (see chapter 4.2.4) in the toolbar for Feature Editing,
- another left-click in the map viewer next to the selected feature(s),
- "reselecting" selected features while pressing Ctrl or Shift, or
- executing the respective command in the layer context menu (see below).

Selectable Features / Layers

Select Feature always selects all intersected features in all vector layers if

- the layer is visible, i.e. checked in the TOC and
- the layer is set selectable (see chapter 5.3.2.5).

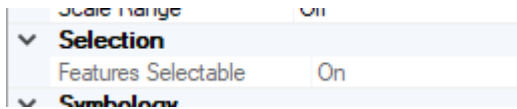


Figure 79: Layer property **Features Selectable** = On

Features in not activated or non-selectable layers are not selected.

If the property **Features Selectable** is turned **Off** for a vector layer, then this is indicated with the **non-selectable** icon next to the layer icon:

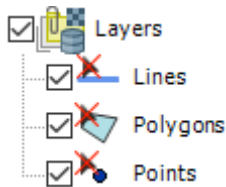


Figure 80: **non-selectable** icon in the TOC

Submenu Selection in the Vector Layer Context Menu

The submenu **Selection** in the vector layer context menu contains several commands with which you can, for example, select or deselect all features of the source layer, or clear the selection of all layers but the source layer (see chapter 5.3.2.3).

Selected Features in the Attribute Table

Within a single layer, you can also select or deselect features via their attribute table, or manage the feature selection. For more information on this, see chapter 5.3.2.1.

Number of Selected Features

The total number of all selected features is shown in the Status Bar:

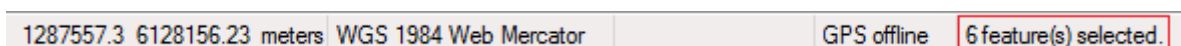


Figure 81: Message in the status bar after clicking **Select Features**

Via the general settings, you can add the column **Selected Features** to the TOC that shows the number of selected features per layer. For more information, see chapter 3.4.1.8. The number of currently selected features per layer will then be displayed.

Layer	Selected Features
<input checked="" type="checkbox"/> Map	
<input checked="" type="checkbox"/> Graphics	
<input checked="" type="checkbox"/> Layers	10
<input checked="" type="checkbox"/> Layer1	3
<input checked="" type="checkbox"/> Layer2	1
<input checked="" type="checkbox"/> Layer3	6

Figure 82: Column **Selected Features** in the TOC (only visible if enabled in the general settings)

Shortcuts, Key Commands, etc.:

- Ctrl when selecting: add selection to current selection. Already selected features are deselected when they are selected twice.
- Ctrl + Shift when selecting: add selection to current selection. Already selected features are not deselected when they are selected twice.
- Shift when selecting: Already selected features are deselected when they are selected twice. Other features are not added to the current selection.
- Alt when selecting: select only topmost feature in the map viewer

4.2.3.2 Select with Polygon (Intersects)

In GAFmap Express: Toolbar for Features > Split Button Selection

Only active for (2D) map windows



Select with Polygon lets you select vector features by drawing a sketch polygon in the map viewer. All features are then selected that lie within the selection polygon, are cut, or touch it (= spatial relation "intersect"; see chapter 5.3.2.1.3).

Right-clicking on an existing polygon uses this polygon as selection polygon. If multiple polygons overlap at the clicked position, the polygon lying on top in the map viewer is used as selection polygon (i.e. across layers the polygon from the topmost layer in the TOC, and within a layer the feature listed last in the attribute table in the current sorting). By default, only selectable layers are considered (see chapter 5.3.2.5); with Alt + right-click, all activated/visible layers are considered.

Shortcuts, Key Commands, etc.:

- Right-click on existing polygon: use polygon as selection polygon (and ignore non-selectable layers)
- Alt+right-click on existing polygon: use polygon as selection polygon (and consider non-selectable layers)
- Ctrl when selecting: add selection to current selection. Already selected features are deselected when they are selected twice.
- Shift when selecting: Already selected features are deselected when they are selected twice. Other features are not added to the current selection.
- Ctrl+Shift when selecting: add selection to current selection. Already selected features are not deselected when they are selected twice.

Tips and notes:

- Use the function **Select by Location** for more complex spatial selections and/or other relations (see chapter 5.3.2.1.3).
- For general information on feature selection, see chapter 4.2.3.1.

4.2.3.3 Select with Polygon (Completely Within)

In GAFmap Express: *Toolbar for Features > Split Button Selection*

Only active for (2D) map windows



The functionality of **Select with Polygon (Completely Within)** corresponds to that of **Select with Polygon (Intersects)**, with the only difference that here only features are selected that lie within the selection polygon (i.e. the spatial relation "completely within" is used instead of "intersect").

For more information on the **Select with Polygon** function see chapter 4.2.3.2, for information on the different spatial relations see chapter 5.3.2.1.3.

4.2.4 Clear Selection

In GAFmap Express: *Toolbar for Features*



Clear selection lets you deselect all selected features at once.

Tips and notes:

- For general information on feature selection, see chapter 4.2.3.1.

4.2.5 Zoom to Selection

In GAFmap Express: Toolbar for Features



Zoom to Selection automatically adjusts the display extent so that all selected features are visible in the map viewer as close as possible. This also applies if features are selected but currently not visible, because the layer is deactivated in the TOC.

Shortcuts, Key Commands, etc.:

- For shortcuts to adjust the display extent, see chapter 4.1.3.

Tips and notes:

- For general information on the topic feature selection, see chapter 4.2.3.1.
- For general information on zooming, see chapter 4.1.4 et seqq.

4.3 Toolbar for Feature Search



Figure 83: Toolbar for Layer Effects

Feature Search lets you search selected vector layers, tables, and/or geocoding services for a specific search expression, more precisely a specific alphanumeric character string. Simply type the search string into the text field and confirm with Enter. All features whose attributes contain the search string are then returned.

In the **Search Layer** tab in the general settings, you can specify which vector layers / tables and (attribute) fields and which geocoding services are to be searched for the string (see chapter 3.4.1.1).



directly opens the tab **Search Layer** of the general settings

Via **Open Identify for Feature Search Result** in the **Other** tab of the general setting (see chapter 3.4.1.8), you can control how the features containing the search string are returned:

- if **On**, the found features are listed in the **Identify** window (see chapter 4.1.11).
- If **Off**, the found features are selected.

In both cases, the map extent is zoomed to the found features. If the search is unsuccessful, a corresponding message appears.

If the search expression is found in a geocoding service (e.g. in the OSM or GeoNames database), the relevant features are automatically downloaded and also listed or selected.

General Notes on The Search

The search is always carried out across the entire attribute set of a feature or, more precisely, across all fields that are selected as **Search Fields** in the general settings (see chapter 3.4.1.1). For this purpose, the attribute values in all search fields are combined (in the background) to form a text line. If the search expression is found in this text line, the feature is returned as a "match".

When forming the text line, the individual attribute values are "framed" with #. Example:

[Field1] contains the attribute value *Value1*, [Field2] the attribute value *Value2*, and [Field3] the attribute value *Value3*. Provided that all three fields are selected as search fields, the text line used for the search is formed as follows: #Value1##Value2##Value3#.

Please note when searching:

- The search is independent of individual (attribute) fields; it is always performed across the entire attribute set of a feature (i.e. across all search fields; see above).
- The search is case-insensitive, i.e. upper/lower case is not taken into account.
- Numbers and dates are not recognized as such, but are interpreted as simple alphanumeric characters, i.e. as individual digits from 0-9, including the formatting with which they are currently displayed in the table. If, for example, *1,000.1* is displayed, then only *1,000.1* results in a match and not, for example, *1000,1* etc.
- If in the attribute table display names are shown (see chapter 5.3.2.1), what is currently visible in the attribute table is also decisive.
- A | between characters/strings means "or"; i.e. with e.g. *ab|cd* all features containing the character string *ab* or *cd* are returned.
- * serves as wildcard/placeholder; i.e. *a*c* finds e.g. *ac*, *abc*, *Acre*, or *Arch*, but also, for example, features with the value *A* in [field1] and the value *C* in [field2].
- The # cross sign, with which the individual attribute values are framed when forming the text line (see above), can be integrated into the search. For example, if you want

to find features with the attribute value *Crop* and exclude those with *Cropland*, you can enter `#Crop#` as search string. (Only `Crop` would also return a match for *cropland*).

- Empty fields can be found with e.g. `###`

Using Regex

By default, the search is performed as described above. Alternatively, you can search with **regex** ("regular expression"). You can then perform a somewhat more complex (text) search, e.g. to find all values starting with an upper case letter and ending with a digit. For this, activate the setting **Use Regex** under menu Extras > Settings > **Search Layers** (see chapter 3.4.1.1).

Information on Regex can be found e.g. under the following links:

- [Regular expression - Wikipedia](#)
- [RegexOne - Learn Regular Expressions - Lesson 1: An Introduction, and the ABCs](#)
- [GitHub - ziishaned/learn-regex: Learn regex the easy way](#)

Please note in particular when searching with regex:

- Unlike the search without regex, the search with regex is case-sensitive.
- When searching with regex, `.*` serves as wildcard/placeholder instead of `*`
(`.` means "any character" in regex, `*` means "zero or more repetitions"; i.e. `a*c` finds e.g. *c*, *ac*, *aac*, *aaac* etc.; `a.*c` finds e.g. *ac*, *abc*, *acre*, or *arch*; `[aA].*c` finds e.g. *ac*, *abc*, *Acre*, or *Arch*).
- In regex, `.` is a reserved character (see above). If you search for numbers with decimal separator `.` (e.g. *1.2*), the escape character `\` must be added before the `.`. To find exactly *1.2*, you must therefore search for `1\.2`
(As the `.` means "any character" in regex and the `.` in *1.2* is in fact any character, *1.2* is found with the search expression `1.2`, but also *132*, *1,2*, or *1n2* etc.)

! Please note that an online search is not possible with regex. If regex is activated, the **geo-coding services** are deactivated and the corresponding area in the tab cannot be operated.

Tips and Notes:

- Use the **Find** command in the attribute table to find cells containing a specific value / character string (see chapter 5.3.2.1.1).
- Alternatively, you can use **Select by Attribute** to find/select features with specific attributes or attribute combinations within a layer. There, you can explicitly address the

individual attribute fields, i.e. you can, for example, find features for which the character string *Arch* appears specifically in the field [BuildType]. For more information, see chapter 5.3.2.1.2.

4.4 Toolbar for Layer Effects



Figure 84: Toolbar for Layer Effects

Via the **Toolbar for Layer Effects** you can (temporarily) hide specific graphics, layers, or groups in the map viewer in various ways, so that the underlying layers become visible. This allows you to compare overlapping data more easily, for example.

Layer effects are always applied to the graphics, layers, and/or groups that are selected in the **drop-down list** on the left:

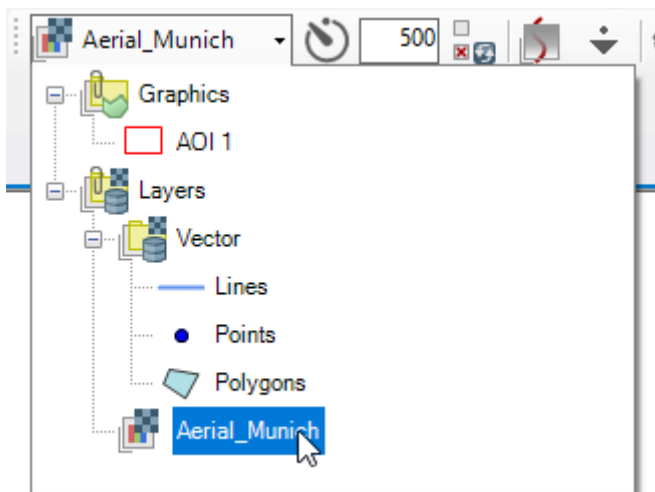


Figure 85: Drop-down list for Layer Effects

Use the Ctrl key to select multiple list items.

4.4.1 Flicker

In *GAFmap Express: Toolbar for Layer Effects*



If you click the **Flicker** button, the layer(s)/element(s) selected in the drop-down list is/are automatically switched between on and off (shown/hidden) in the current map viewer until the button is clicked again. The time (measured in milliseconds) for which the layer(s) is/are visible can be set in the box to the right of the **Flicker** button.

Shortcuts, Key Commands, etc.:

- Ctrl+A within TOC: select all layers
- X: toggle layer(s) selected in TOC (with multiple map windows only in the active one)
- C: toggle layer(s) selected in TOC globally (with multiple map windows in all windows)

Tips and notes:

- Alternatively, you can toggle between individual and/or grouped layers or graphics selected in the TOC by pressing the X or C key. In this case, the layers do not constantly switch, but are shown/hidden each time you press the button. If necessary, this shortcut can be edited in the general settings (see chapter 3.4.1.5).

4.4.2 Toggle

In GAFmap Express: Toolbar for Layer Effects



Toggle lets you toggle the layer selection in the drop-down list, i.e. elements activated in the TOC are deactivated and deactivated elements are activated. If multiple map viewers are open, the function Toggle refers to the currently active map viewer.

Shortcuts, Key Commands, etc.:

- Ctrl+A within TOC: select all layers
- X: toggle layer(s) selected in TOC (with multiple map windows only in the active one)
- C: toggle layer(s) selected in TOC globally (with multiple map windows in all windows)

4.4.3 Transparency

In GAFmap Express: Toolbar for Layer Effects

Only active for (2D) map windows

Transparency lets you change the degree of transparency of the selected layer(s)/element(s). Just move the slider up or down to set a value between 0 (opaque) and 100 (transparent / not visible).



Figure 86: Adjusting the transparency of a selected vector layer group.

Tips and notes:

- The **Transparency** effect can be combined with the **Flicker** or **Swipe** effects.

4.4.4 Swipe

In GAFmap Express: Toolbar for Layer Effects

Only active for (2D) map windows

▼ **Swipe** lets you briefly "swipe away" the selected layer(s)/element(s). To do so, click the **Swipe** button, click anywhere in the map viewer, and then swipe away the layer(s)/ element(s) by holding the mouse button and dragging the mouse-pointer in the desired direction. As soon as the mouse button is released, the layer(s)/element(s) jump back to their original extent.

The direction the layer(s)/element(s) are swiped to (horizontally from right/left or vertically from top/bottom) is indicated by an arrow as soon as the mouse pointer hovers over the map viewer.

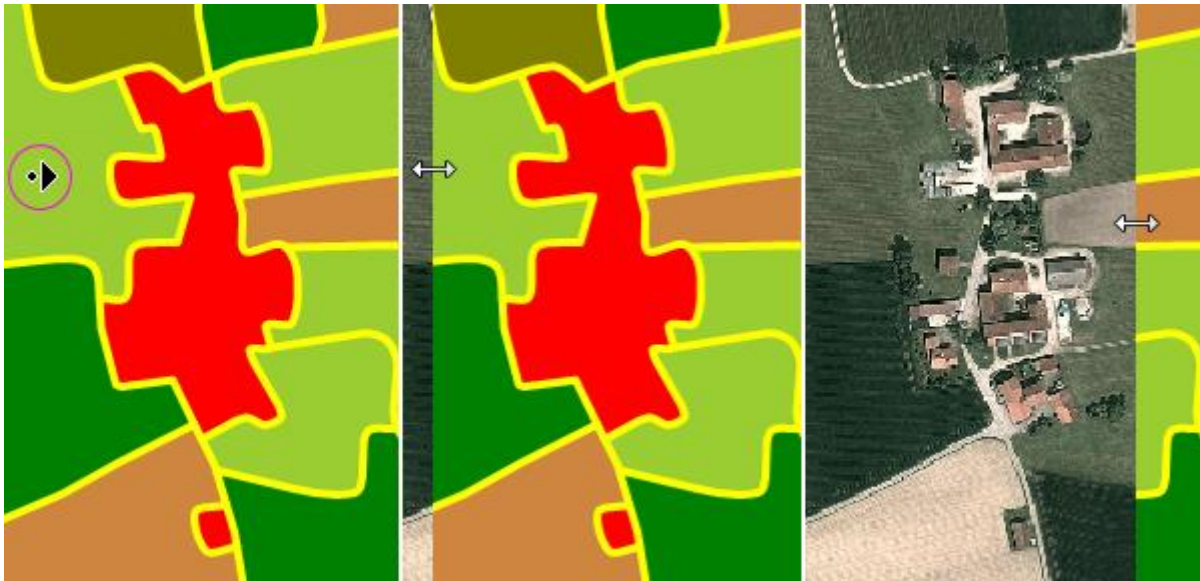


Figure 87: Selected vector layer group is temporarily "swiped away"

4.4.5 Timeline

In GAFmap Express: Toolbar for Layer Effects

Only available if the project contains a layer with time stamp



Time Line lets you display vector and/or raster layers animated with regard to a time stamp, i.e. show and hide them successively and in chronological order in the map viewer. So, depending on the data basis, you can simulate various events that have taken place or are expected over a longer observation period in the map viewer, e.g. the growth of cities or infrastructure over several years (e.g. with vector data) or the expected weather conditions (e.g. with raster stacks).

Additionally or alternatively, you can simulate the lighting situation "on site" over a certain period of time in the map viewer, e.g. over the course of a day or year. When the time line is operated, the position of the virtual light source is then automatically set so that it corresponds to the position of the sun at the time currently displayed, and the lighting or shadows cast in the visible map extent are adjusted accordingly.

If the project contains a 3D window, the animation can also be executed in 3D.

Prerequisite / Requirement for Layers (not) to be Animated

The time line is only available for layers with a **Time Stamp(s)**. A time stamp can either be assigned to the layer as a whole or to individual features (for vector layers) or bands (for raster

layers). When operating the time line, the layers, vector features, and/or raster bands are then shown/hidden in the map viewer one after the other in the order of their time stamps.

If a layer is enabled for the time line, and, if so, how the time stamps are stored can be viewed in the layer properties under **Time Line** ((see chapter 5.3.2.5 for vector layers or chapter 5.3.3.6 for raster layers).

Layers that are not enabled for the time line or that are not in the **Layer Group** to be animated (see below) are not affected by the time line. Their activation status remains unchanged during the animation, i.e. they remain shown/hidden if they are checked/unchecked in the TOC.

Time Line Control



A click on the **Time Line** button opens the Time Line dialog:

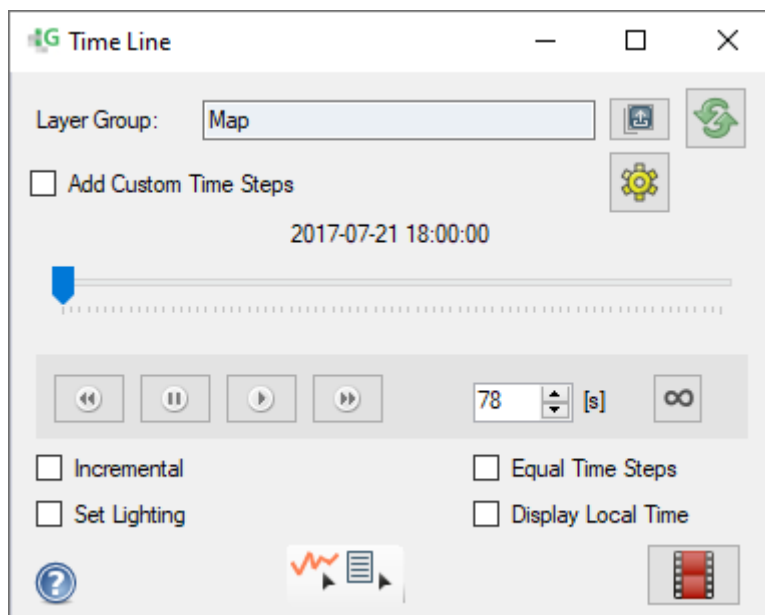


Figure 88: Dialog **Timeline Control**

! Please note: As long as the dialog is open, the elements of the selected **Layer Group** that are enabled for the time line are "filtered" in all existing map viewers according to their time stamp, i.e. they are only displayed if their time stamp corresponds to the **currently displayed time** or is older (depending on the **Incremental** option, see below). This also applies if no animation is running!

The time line / animation can be controlled via the dialog as follows:

- **Layer Group:** Here, you can select the layer group to be animated. All layers within the selected group, including those in sub-groups, are affected by the time line, but only if they are enabled for the time line (see above).



opens a layer selection panel



refreshes the selected layer group, e.g. if layers under the have been changed subsequently

As soon as a group is selected or refreshed, all the time stamps of all the layers it contains are read out, and the time steps on the time line are set accordingly.

- **Add Custom Time Steps:** By default, i.e. if unchecked, the time steps on the time line correspond to the time stamps provided by the selected layer group (see above).

If checked, custom time steps are inserted, either in addition to those read from the group or instead of them



opens a properties window. Here, you can define the custom time steps as follows:

- **Start/End Date:** specifies the time at which the custom time steps begin/end. Enter the desired date in the format *dd.MM.yyyy hh:mm:ss* or select it from the calendar



opens a calendar

- **Interval (Unit):** specifies the time interval in which the custom time steps are set between the start and end date.



opens a drop-down list

Tip: If start date = 31.01. and interval unit = month, always the last day of the month is inserted.

- **Exclusive:** If **On**, the time line only contains the custom time steps. If **Off**, the custom time steps are inserted in addition to the time steps read from the layer group.




Tip: You can also insert and use custom time steps if the project does not contain any layers with a time stamp. This lets you **Set Lighting** independently of layers (see below).

- **Time Line:** The time line contains all accessible time steps. The **slider** marks the **currently displayed time**; the label above the time line shows the exact time.

! Please note that all times are interpreted as UTC as long as no other information is stored in the dataset itself!

The currently displayed time can be changed manually by dragging the slider with the mouse to any time step. A click on the time line moves the slider five steps forwards or backwards.


Additionally, the following buttons are available:

-  starts the animation; all time steps are then run through in sequence, starting at the currently displayed time.
-  pauses the animation.
-  skips to the previous or next time step.

The elements of the selected layer group are only displayed if their time stamp corresponds to the currently displayed time or is older (depending on the **Incremental** option, see below).

- **Runtime [s]**: determines the runtime of the animation in seconds. The events are distributed over this time span according to their time markers (proportional or constant, depending on the **Equal time steps** option, see below).

Please note: When playing the animation, the map viewer is refreshed at each time step, which takes a few milliseconds (visible in the status bar, see chapter 2.2.1.3). If many time steps are displayed in a short time and/or if the map viewer is very complex, e.g. if it contains many layers or features, the rendering time can exceed the time interval between successive events. In this case, the actual runtime exceeds the entered runtime.

-  : if checked, the animation is repeated until it is manually paused or stopped.
- **Incremental** (*only relevant with Time Stamp Type = Layer or Attribute*): if unchecked, when a time stamp is reached, only those layers or features are displayed that have been assigned exactly this time stamp. Layers or features with other time stamps, also older ones, are hidden.

If checked, layers or features are shown when reaching their time stamp and are not hidden again until the end of the animation. Thus, the displayed data grows over time until all layers or features are visible at the end of the animation.

- **Equal time steps**: if unchecked, the distance between the time steps is calculated based on the time stamps, i.e. the events are displayed with realistic time distance (scaled to the runtime).


If checked, the events are displayed with a constant time interval, independent of the time stamps. The time stamps then only influence the order of the events. This can be useful, for example, if some events are close together (e.g. a few days), while others have a large time distance (e.g. a year). The events are then distributed evenly over the runtime and overlong pauses are avoided.

- **Set Lighting** (*only relevant in association with on-the-fly lighting or shadows*): if checked, you can use the time line to simulate the lighting or shading situation "on site" over a certain period of time, e.g. over the course of a day or year. The time line then influences the lighting settings in the map properties, more precisely the **Lighting Direction** (i.e. the position of the virtual light source, see chapter 5.1.7). If you check the box, the **From Date/Time** property is switched on and the currently displayed time is adopted as **Date [UTC]** and **Time [UTC]**. When operating the time line, the lighting direction is then updated with each time step.

In 2D, the lighting settings only affect the on-the-fly **lighting** and **shadows** (see chapter 4.5.4 et seq.). If they are enabled, they are recalculated with each time step.

The changes to the lighting properties are temporary. If you close the time line dialog, they are reset to the previously valid values.

If **Set Lighting** is unchecked, the time line does not affect the lighting properties.

- **Display Local Time**: if checked, the UTC or stored time is converted to your local time, i.e. the system time. If unchecked the UTC / stored time shown.
-  **Show Diagram for Map Position** (*only for raster layers*): activates the diagram tool. If you now click in the map viewer in (a) raster(s) with a time stamp, the course of the pixel values over the entire event period is displayed graphically for this position. For this purpose, a separate diagram window opens:

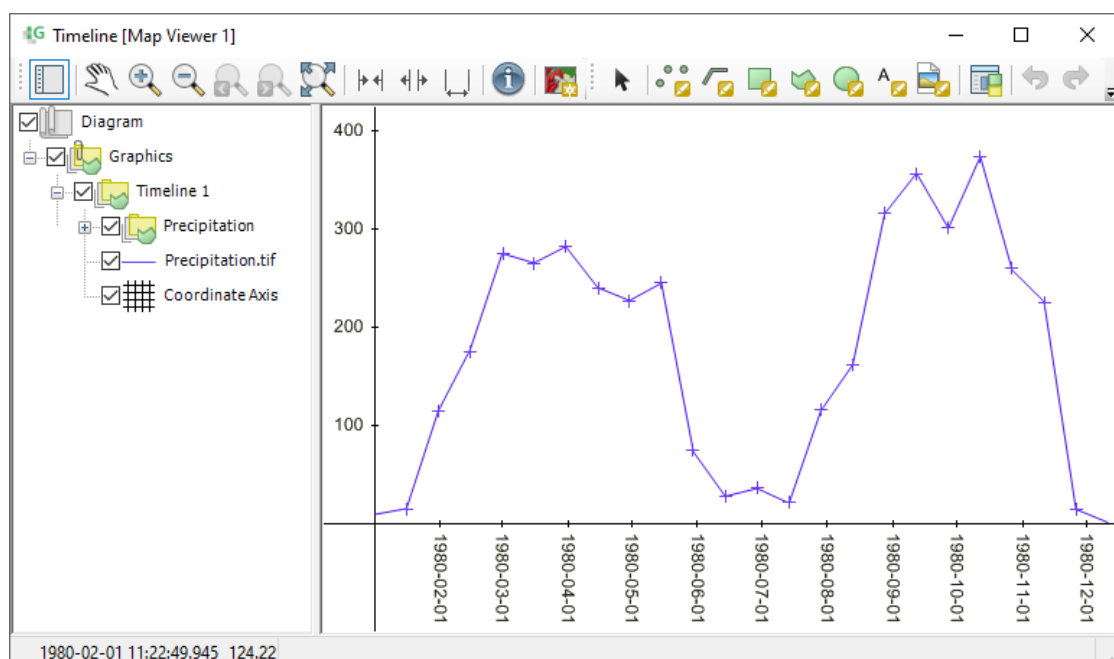



Figure 89: Graphic representation of the pixel values at the selected position over time

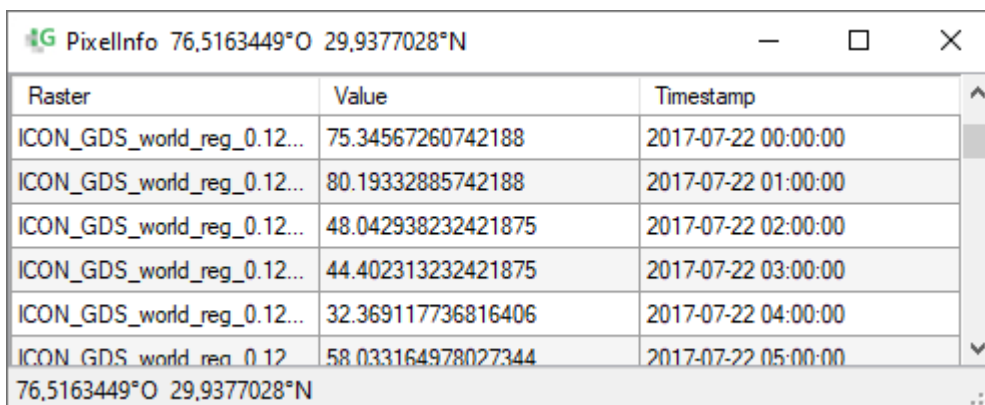
The Y-axis shows the pixel values, the X-axis the time. The vertices of the curve, i.e. the individuals pixel values by time stamp, can be shown/hidden separately.

With each additional click in the raster(s), a new curve is added to the diagram and numbered in ascending order. All clicked positions are marked in the map viewer with a point and a corresponding number. These points are temporary and will be deleted again when the diagram window is closed.

For more information on the diagram window, see chapter 5.3.2.1.7.

Tips and notes:

- Note that the X-axis (just like the Y-axis) is labeled regularly, i.e. the labeling usually does not correspond to the time stamps
 - For multi-channel rasters with Time Stamp Type = Band, the values from band 1 are output.
 - If you need a tabular list of all the curve vertices (= i.e. the individuals pixel values by time stamp at the sampled point), then click with the Pixel Info tool (see below) on the same point in the map viewer. The coordinates list, which can be called up via the context menu of the line, is not suitable for this purpose.
-  **Show Values for Map Position** (*only for raster layers*): activates the Pixel Info tool. If you now click in the map viewer in (a) raster(s) with a time stamp, the values of all raster pixels located at this position are listed in tabular form including their time stamp:



The screenshot shows a window titled 'PixelInfo 76,5163449°O 29,9377028°N'. It contains a table with three columns: 'Raster', 'Value', and 'Timestamp'. The table lists six data points for the raster 'ICON_GDS_world_reg_0.12...' at the specified coordinates, with timestamps ranging from 2017-07-22 00:00:00 to 2017-07-22 05:00:00. The coordinates are repeated at the bottom of the window.

Raster	Value	Timestamp
ICON_GDS_world_reg_0.12...	75.34567260742188	2017-07-22 00:00:00
ICON_GDS_world_reg_0.12...	80.19332885742188	2017-07-22 01:00:00
ICON_GDS_world_reg_0.12...	48.042938232421875	2017-07-22 02:00:00
ICON_GDS_world_reg_0.12...	44.402313232421875	2017-07-22 03:00:00
ICON_GDS_world_reg_0.12...	32.369117736816406	2017-07-22 04:00:00
ICON_GDS_world_reg_0.12...	58.033164978027344	2017-07-22 05:00:00

76,5163449°O 29,9377028°N

Figure 90: List of raster values at the selected position for all times

Rasters without a time stamp are ignored.

For more information about the Pixel Info window see chapter 4.1.12.

Timeline Animation in the 3D Viewer


Only relevant if the project contains a 3D window

For 3D-capable data (incl. DEMs), a time line animation can also be executed in the 3D viewer; for raster textures, this is not possible. The **Set Lighting** also affects the 3D viewer.

For more information on the difference between 3D-capable data <> raster texture and lighting in 3D, see GAFmap® 3D Viewer manual, chapter 2.2.3.2 and chapter 5.1.7.

Tips and notes:

- During the animation you can freely navigate in the map viewer and use almost all functions, tools, etc. without affecting the animation and vice versa.

! Note for vector layers with **Time Stamp Type = Attribute** in particular: During the time line animation, the features are temporarily **filtered** according to their time stamps. Like with a definition query (chapter 5.3.2.5), filtered features are not only hidden in the map viewer, but they are also missing in the attribute table. You can identify filtered layers (in the TOC) by the  filter icon above the layer icon and in the attribute table by the additional information "number of unfiltered features" in the footer.
- If multiple map windows are opened, the animation runs in all windows (incl. 3D window).
- The **Time Line** dialog is dockable. For more information, see chapter 2.2.4.

4.5 Map Viewer Toolbar (2D)

Only available if the project contains a (2D) map window

The **Map Viewer toolbar** is located on the left edge of each (2D) map viewer; all contained functions refer exclusively to the map viewer to which it is attached.



Figure 91: Buttons in the **Map Viewer** toolbar

All contained analysing functions are on-the-fly functions, which means that

- they apply only to the map extent currently visible in der map viewer,
- they apply to all data currently visible in der map viewer, and
- they directly and exclusively affect the output on the screen.


All data remains unchanged and no new data is produced. A preprocessing ist not necessary.

If you activate e.g. lighting (see chapter 4.5.4), it is calculated directly for the map extent currently visible in the corresponding map viewer. All data within the map viewer are then shaded on the screen. If the visible map extent changes, the shading is recalculated accordingly. In all other possibly open map viewers the data is not shaded (unless the button is activated there as well).

4.5.1 Separate/Embed TOC

In GAFmap Express: Map Viewer Toolbar (2D)

Only available if the project contains a (2D) map window and only if the TOC is not hidden (see chapter 4.5.2)

 **Separate/Embed TOC** lets you detach the TOC (table of content, see chapter 2.2.2.2) from its map window or attach it again.

If you activate the button, the TOC is separated from its map window and opened in a separate, initially floating, dockable window. The title of the TOC window always corresponds to that of the associated map window:

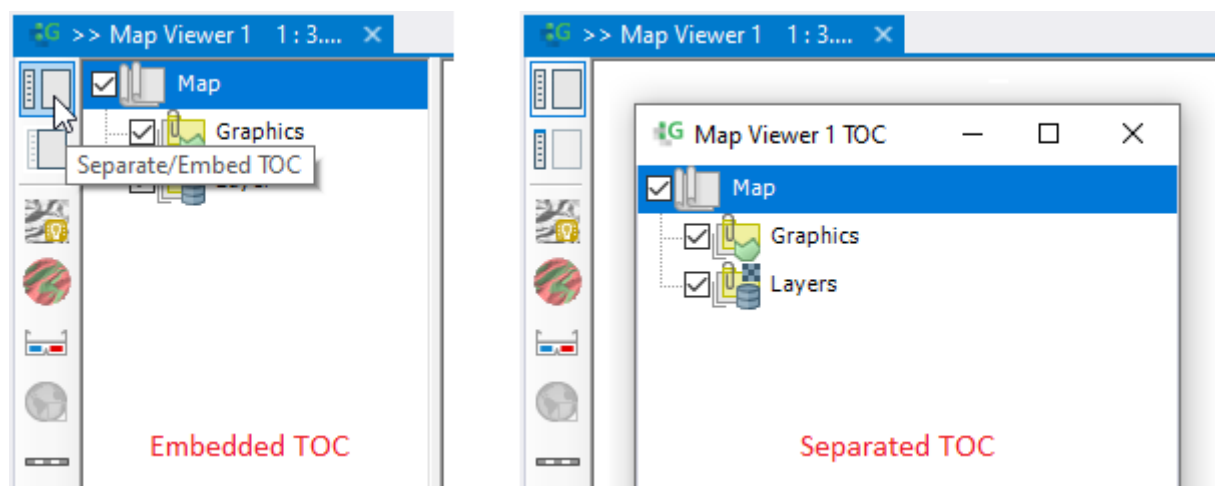


Figure 92: TOC, embedded in its map window (left) and separated from its map window (right)

As long as the button is activated (framed in blue), the TOC remains separated from its map window. Like any dockable window, it can then be anchored in the main window or in other dockable windows (see chapter 2.2.4.2 et seq.)

By another click, the button can always be deactivated and the TOC can be embedded in its map window again.

For more information and examples see chapter 2.2.4.4.

Tips and notes:

- You can always activate/call up a separated TOC with **Activate TOC** in the associated map window (see chapter 4.5.3), e.g. if it has been forced into the background, minimized, or hidden while working. The TOC is then brought up and highlighted in blue.

4.5.2 Show/Hide TOC

In GAFmap Express: Map Viewer Toolbar (2D)

Only available if the project contains a (2D) map window and only if the TOC is embedded (see chapter 4.5.1)



Show/Hide TOC lets you show or hide the TOC (table of content; see chapter 2.2.2.2) if it is embedded in its map window (see chapter 4.5.1).

As long as the button is deactivated, the TOC is shown at the left edge of the map window. If you activate the button by clicking it, the TOC is hidden; the button is then framed in blue. The TOC remains hidden until the button is deactivated again by another click.

4.5.3 Activate TOC

In GAFmap Express: Map Viewer Toolbar (2D)

Only available if the project contains a (2D) map window and only if the TOC is separated from its map window (see chapter 4.5.1)



Activate TOC lets you call up the TOC (table of content; see chapter 2.2.2.2) if it is separated from its map window (see chapter 4.5.1). This can be necessary if, for example, it has been forced into the background, minimized, or hidden while working. If called up, the TOC is brought up and highlighted in blue.

4.5.4 Enable/Disable Lighting

In GAFmap Express: Map Viewer Toolbar (2D)

Only available if the project contains a (2D) map window



Enable/Disable Lighting lets you display the current map view with shading. The shading causes surfaces facing the light to appear lighter and those facing away from the light to appear darker, which creates a better three-dimensional impression and helps to identify relative differences in height more easily.

The calculation of the lighting/shading is performed on-the-fly, i.e. in the background for the map extent currently visible in the map viewer.

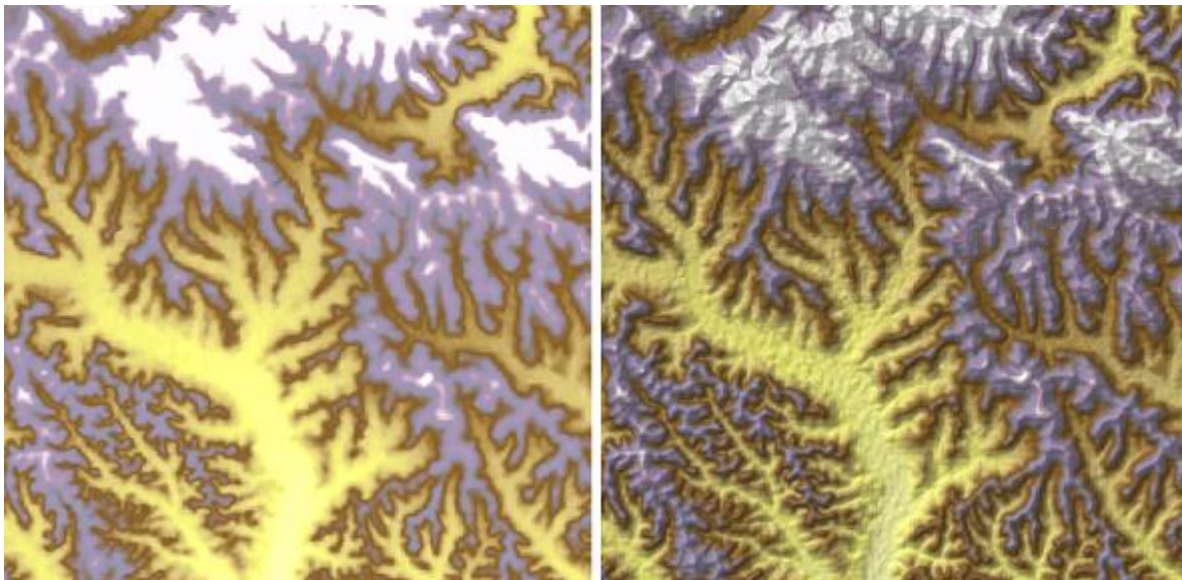


Figure 93: Map section with disabled Lighting (left) and enabled Lighting (right)

The calculation of the on-the-fly lighting / shading is based on

- the **base DEM** / DEM mosaic (see chapter 5.3.4) and
- a **virtual light source**. The position and intensity of this light source can be defined/adjusted in the map properties under **Lighting Direction** and **Lighting** (see chapter 5.1.7).

For areas in the map for which no DEM is available, no shading can be calculated.

Shortcuts, Key Commands, etc.:

- L: Enable/Disable Lighting

Tips and Notes:

- You can see/check the **base DEM** if you uncheck the **Map** in the TOC and then enable the on-the-fly lighting/shading (see also chapter 5.3.4):

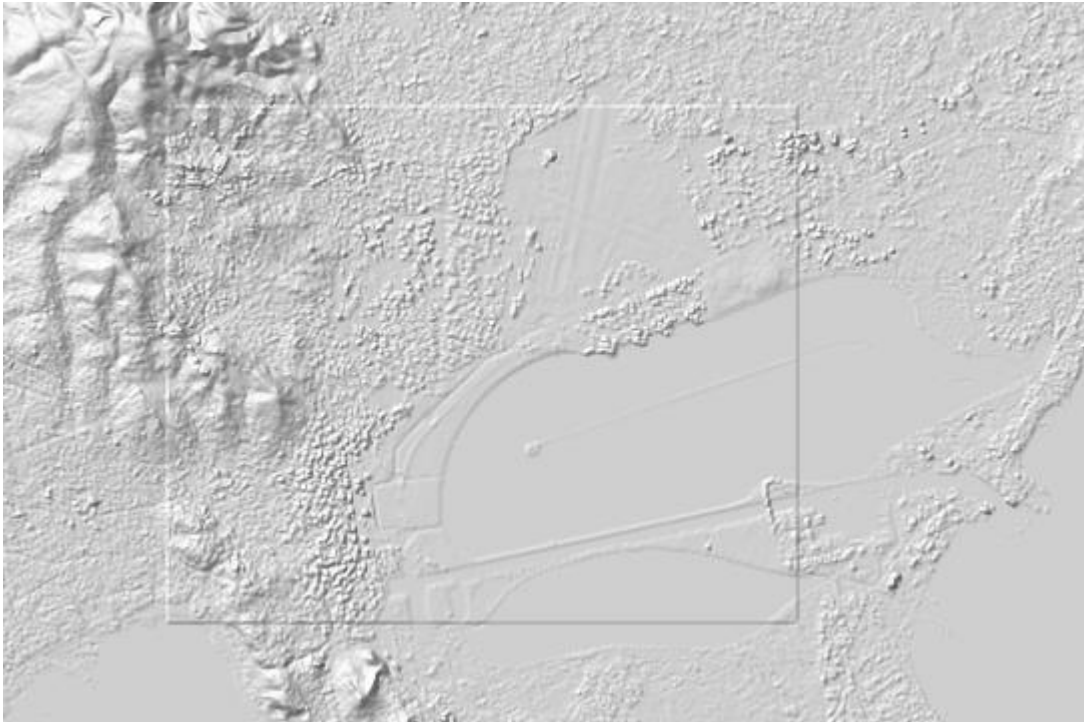


Figure 94: Display of the base terrain / DEM mosaic on which the calculation is based

- With the **Time Line**, you can simulate the change in lighting over a certain period of time, e.g. over the course of a day or year. When the time line is operated, the position of the virtual light source is then automatically set so that it corresponds to the position of the sun at the time currently displayed, and the lighting in the map viewer is adjusted accordingly. For more information, see chapter 4.4.5.

4.5.5 Enable/Disable Shadows

In GAFmap Express: Map Viewer Toolbar (2D)

Only available if the project contains a (2D) map window



Enable/Disable Shadows lets you display the current map view with shadows. This enhances the three-dimensional impression of the captured terrain or surface, and allows you to analyze the shadows cast, e.g. to determine whether or when a specific target object is shadowed by other objects.

The calculation of the shadows is performed on-the-fly, i.e. in the background for the map extent currently visible in the map viewer.

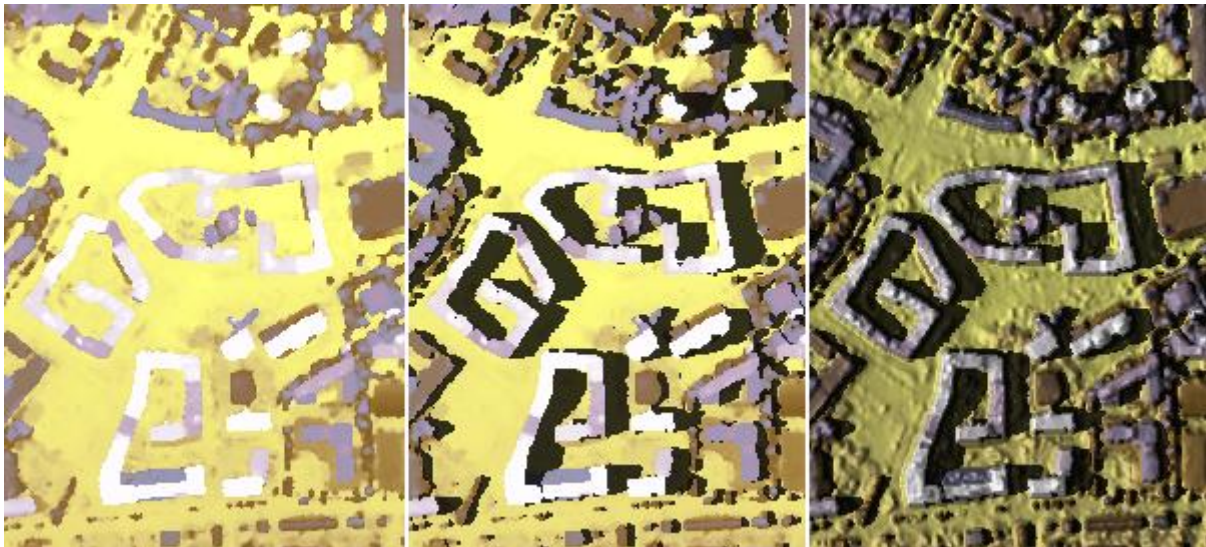


Figure 95: Map section with disabled Shadows and Lighting (left), with enabled Shadows (center), and with enabled Shadows and Lighting (right)

The calculation of the on-the-fly shadows is based on

- the **base DEM** / DEM mosaic (see chapter 5.3.4) and
- a **virtual light source**. The position and intensity of this light source can be defined/adjusted in the map properties under **Lighting Direction** and **Lighting** (see chapter 5.1.7).

For areas in the map for which no DEM is available, no shadows can be calculated.

Shortcuts, Key Commands, etc.:

- Ctrl+L: Enable/Disable Shadows


Tips and Notes:

- You can see/check the **base DEM** if you uncheck the **Map** in the TOC and then enable the on-the-fly lighting/shading (see chapter 4.5.4 and 5.3.4).
- With the **Time Line**, you can simulate the change in shadows over a certain period of time, e.g. over the course of a day or year. When the time line is operated, the position of the virtual light source is then automatically set so that it corresponds to the position of the sun at the time currently displayed, and the shadows in the map viewer are adjusted accordingly. For more information, see chapter 4.4.5.

4.5.6 Enable/Disable Viewshed

In GAFmap Express: Map Viewer Toolbar (2D)

Only available if the project contains a (2D) map window

 **Enable/Disable Viewshed** lets you display the visibility of the terrain from one or more locations in the map viewer. The calculation/analysis is performed on-the-fly, i.e. in the background for the map extent currently displayed in the map viewer.

The calculation of the on-the-fly viewshed is based on

- the **base DEM** / DEM mosaic (see chapter 5.3.4) and
- at least one **viewshed point (VSP)**, which defines the location of the virtual observer and thus forms the starting point for the analysis.

The on-the-fly viewshed can always be enabled by activating the corresponding button. All areas visible from the VSP are then colored in green in the map viewer, non-visible areas are colored in red:

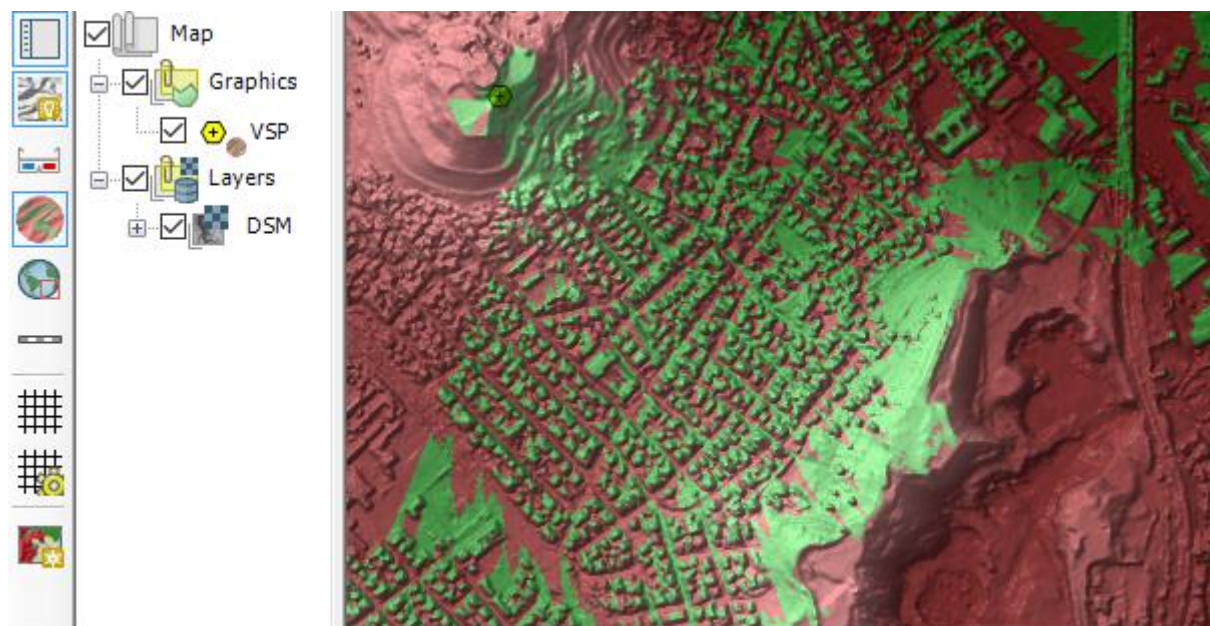


Figure 96: Example of enabled viewshed rendering, based on a single VSP: green = visible, red = non-visible

As long as no VSP is set and activated, the entire visible map extent is displayed as "non-visible" (red). The same applies to areas within the map extent for which no DEM is available.

Another click on the button deactivates the viewshed again.

Viewshed Points (VSPs) and their Properties

A VSP defines the location of a virtual observer and thus forms the starting point for the on-the-fly viewshed. The analysis can be carried out with any number of VSPs (limiting factor here is only the performance; see below). If multiple VSPs are set and activated, the union set is displayed, i.e. all areas that are visible from one of the VSPs are displayed as "visible" (in green) (not, for example, the areas that are visible from all points). Areas colored in red are not visible from any of the VSPs.

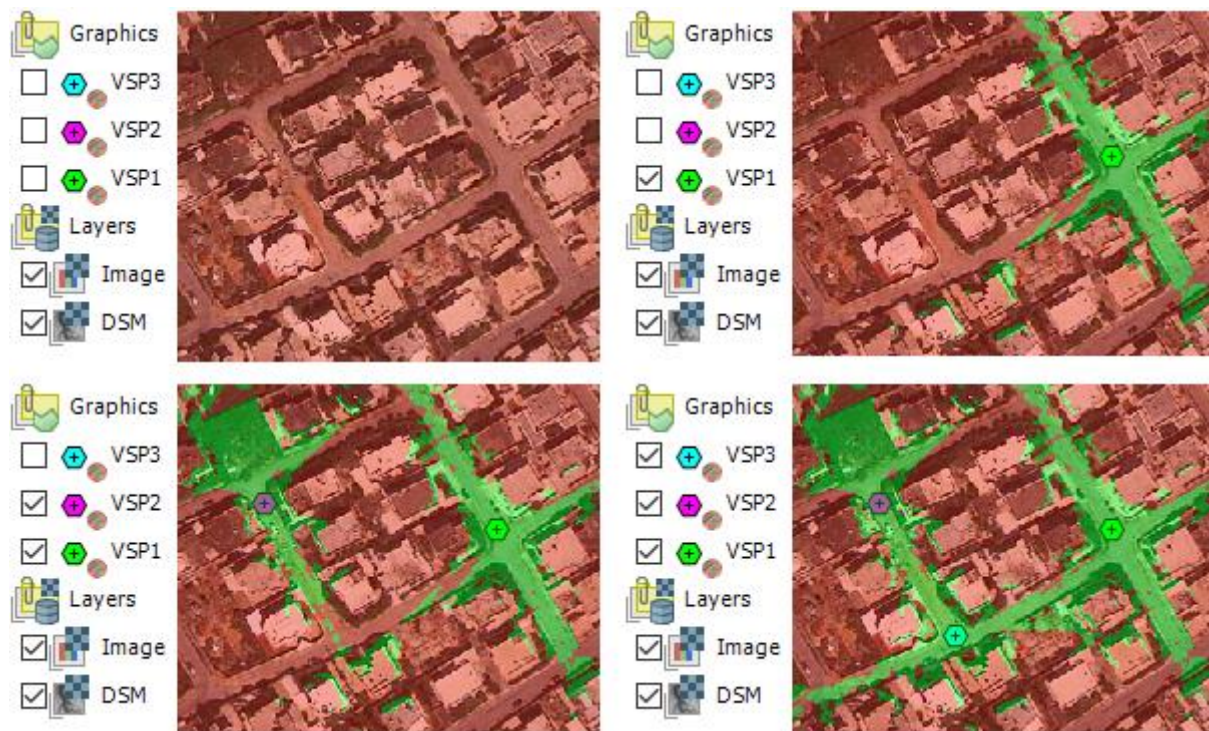


Figure 97: Example of enabled viewshed rendering (green = visible, red = non-visible)

VSPs can be set via the Graphics toolbar (see chapter 4.7.14). Always all VSPs that are activated, i.e. checked in the TOC, are considered. VSPs that are not activated are ignored.

A self-created VSP can alternatively be deactivated by switching **Use for Viewshed** in its properties to **Off**. (see chapter 5.2.12.1 and 5.2.17). In the TOC, the viewshed icon (📍) next to the point symbol is then hidden. Such a point is no longer used as VSP, even if it is checked in the TOC.

In addition to the location of a VSPs, the following VSP properties are also significant for the on-the-fly viewshed (see also chapter 5.2.12.1 and 5.2.17):

- **Height [m]:** specifies the eye height of the virtual observer (= starting height for the analysis). As default, the height defined as **Eye Height** in the general settings under menu Extras > Settings > Viewing > Viewshed (see chapter 3.4.1.3) is entered. If you

enter a value higher than the average eye height of 1.75m, you can analyze the visibility of the terrain from an elevated position (e.g. a tower or even a satellite).

- **Relative to Ground:** if **On**, the (eye) **height** is measured relative to the ground (i.e. above the base DEM). If **Off**, it is measured in absolute terms.
- **Minimum/Maximum Sector Angle [°]** (*only available if Use for Viewshed = On*): delimits the sector angle to be analyzed for the viewshed, e.g. to simulate a certain viewing direction and angle. For this, the min/max geographical angle has to be entered (meaning North = 0°, East = 90° etc.). You can also enter negative angles or angles $\geq 360^\circ$; they are directly converted to the valid value range. If the angles entered match, the entire circle is analyzed.

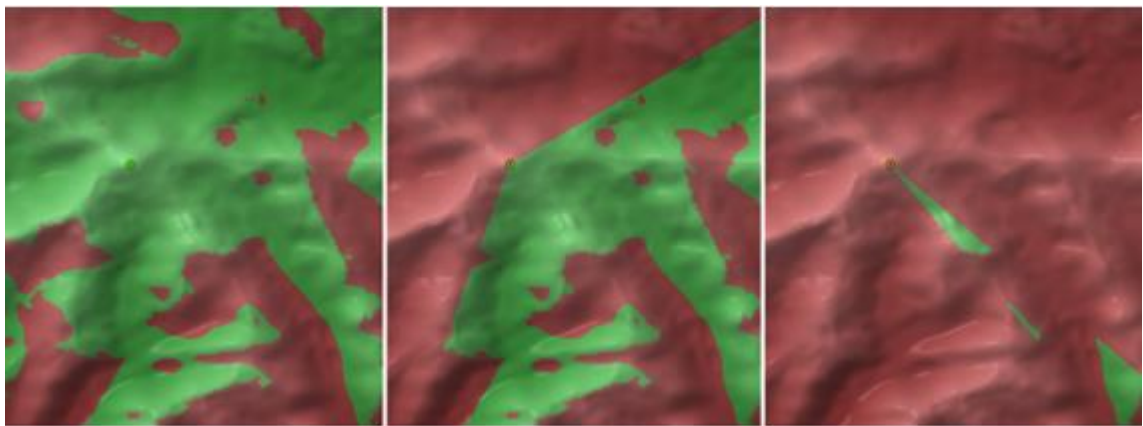


Figure 98: Example of viewshed with different Sector Angles (green = visible, red = non-visible)

- **Maximum Viewing Distance** (*only available if Use for Viewshed = On*): delimits the radius of the area to be analyzed. If the field is left empty, the analysis is performed without distance limitation.

In addition to the VSP properties mentioned above, the general setting **Target Height** under menu Extras > Settings > Viewing > Viewshed has influence on the on-the-fly viewshed (see chapter 3.4.1.3). 0 corresponds to the ground surface, values > 0 to the corresponding area above the ground surface. With values > 0 , you can, for example, check whether objects with a certain height are visible from the viewer's point of view.

A VSP can also be located anywhere outside the visible map extent and outside the area covered by the base DEM. However, please note in this case, that no height information is available for areas not covered by the DEM. Depending on the situation, this can make the result of the analysis useless, e.g. if the terrain between the VSP and the map extent not covered by the DEM is elevated and the vertical viewing angle is flat.

The **curvature of the earth** is precisely taken into account for the calculation of the viewshed; it is based on the WGS84 ellipsoid.

Viewshed Quality / Performace

The on-the-fly viewshed is always calculated for the map extent currently visible in the map viewer. Alongside the initial accuracy of the DEM, the accuracy of the viewshed depends largely on the following factors:

- how closely meshed and at what resolution the DEM is sampled within the map viewer.

The resolution is higher the further you zoom into the map, as then a higher resolution DEM pyramid level is displayed and used. It is then also decisive how closely meshed the pyramid level used is sampled: the finer the mesh, the more accurate its reconstruction.

- for VSPs outside the map viewer: how closely meshed and at what resolution the DEM between the SAP and the visible map extent is sampled.

The DEM is sampled along the "visual rays" from the VSP to the visible map extent in a certain number of steps, at a DEM pyramid level that matches the length of the visual rays and the number of steps. I.e. the closer the VSP is to the visible map extent and the higher the number of sampling steps, the more detailed the measurement.

You can control the accuracy of the viewshed via the general setting **Viewshed Quality** under menu Extras > Settings > Viewing > Viewshed (see chapter 3.4.1.3). The higher the selected quality, the better the pyramid level used and its reconstruction within the map viewer and the more sampling steps are carried out outside the visible map extent.

! Note that the calculation of the viewshed is very demanding, especially if you work with many VSPs and/or high quality. The image build-up in the map viewer then takes a correspondingly long time. So, an appropriate compromise must be found between accuracy and performance. Usually, the default setting (Quality = Normal) produces good results. Increase the quality, for example, if the result changes significantly in areas that are far away from the VSP when you move the maps (at a large scale). In this case, too few sampling steps are carried out between the VSP and the visible map extent and view obstructions are therefore not "hit" reliably enough.

Regardless of the used viewshed quality, it is always advisable to deactivate VSPs that are not required in order to improve performance!

Tips and Notes:

- If you only want to analyze whether a certain target point is visible from an observer's position, use **Add Sight Line** (see chapter 4.7.15).
- Regarding the curvature of the earth: The calculation of viewshed is based on the WGS84 ellipsoid. However, if your DEM has geoidal heights, this makes hardly a difference in terms of accuracy. Since the analysis is about relative heights, the quality of the DEM has a much (!) greater influence on the result than an earth radius that deviates by a few meters due to undulation.
- You can see/check the **base DEM** if you uncheck the **Map** in the TOC and then enable the on-the-fly lighting/shading (see chapter 4.5.4 and 5.3.4).

4.5.7 Enable/Disable Anaglyph Rendering

In GAFmap Express: Map Viewer Toolbar (2D)

Only available if the project contains a (2D) map window



Enable/Disable Anaglyph Rendering lets you display the current map view as an anaglyph image (= red-green image). With suitable red-green glasses, you will then get a three-dimensional impression of the data.

The calculation is performed on-the-fly, i.e. in the background for the map extent currently visible in the map viewer.

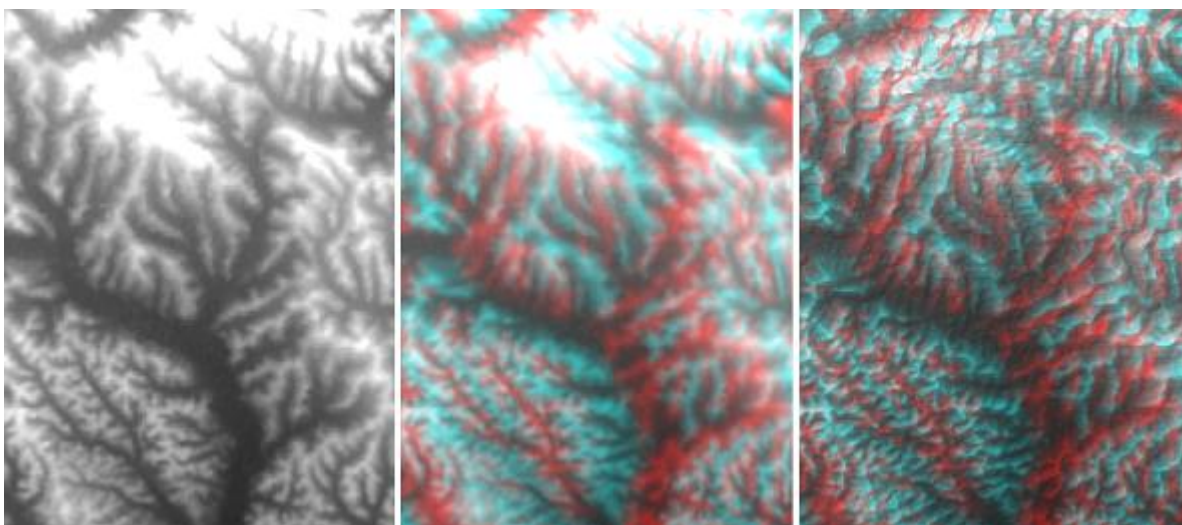


Figure 99: Map section with disabled Anaglyph Rendering (left), enabled Anaglyph Rendering (middle), and enabled Anaglyph Rendering plus Lighting (right)

The calculation of the on-the-fly anaglyph rendering is based on the **base DEM** / DEM mosaic (see chapter 5.3.4) only. For areas in the map for which no DEM is available, no anaglyph rendering can be calculated.

Anaglyph shift and depth, which influence the 3D perception, can be adjusted in the general settings (see chapter 3.4.1.3).

Shortcuts, Key Commands, etc.:

- K: Enable/Disable Anaglyph Rendering

Tips and Notes:

- You can see/check the **base DEM** if you uncheck the **Map** in the TOC and then enable the on-the-fly lighting/shading (see chapter 4.5.4 and 5.3.4):

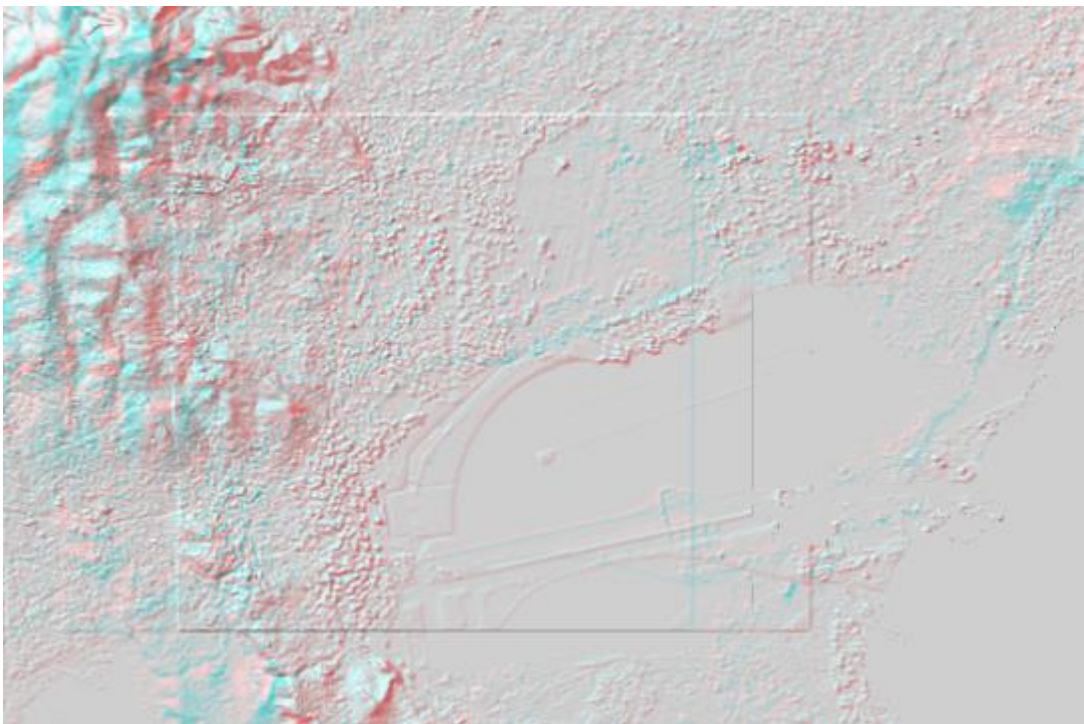


Figure 100: Display of the **base DEM** (here with anaglyph rendering)

4.5.8 Enable/Disable Overview

In GAFmap Express: Map Viewer Toolbar (2D)

Only relevant if the project contains multiple map windows



Based on the always grayed out button **Enable/Disable Overview** in GAFmap® Express you can see whether a map windows is an Overview or not.

For an **Overview**, the button is activated, i.e. framed in blue. The map viewer then shows the visible extents of all other map windows. These extents are displayed as black-yellow dashed frames (according to the settings under Viewing, see chapter 3.4.1.3) and labeled with the name of the corresponding map windows.

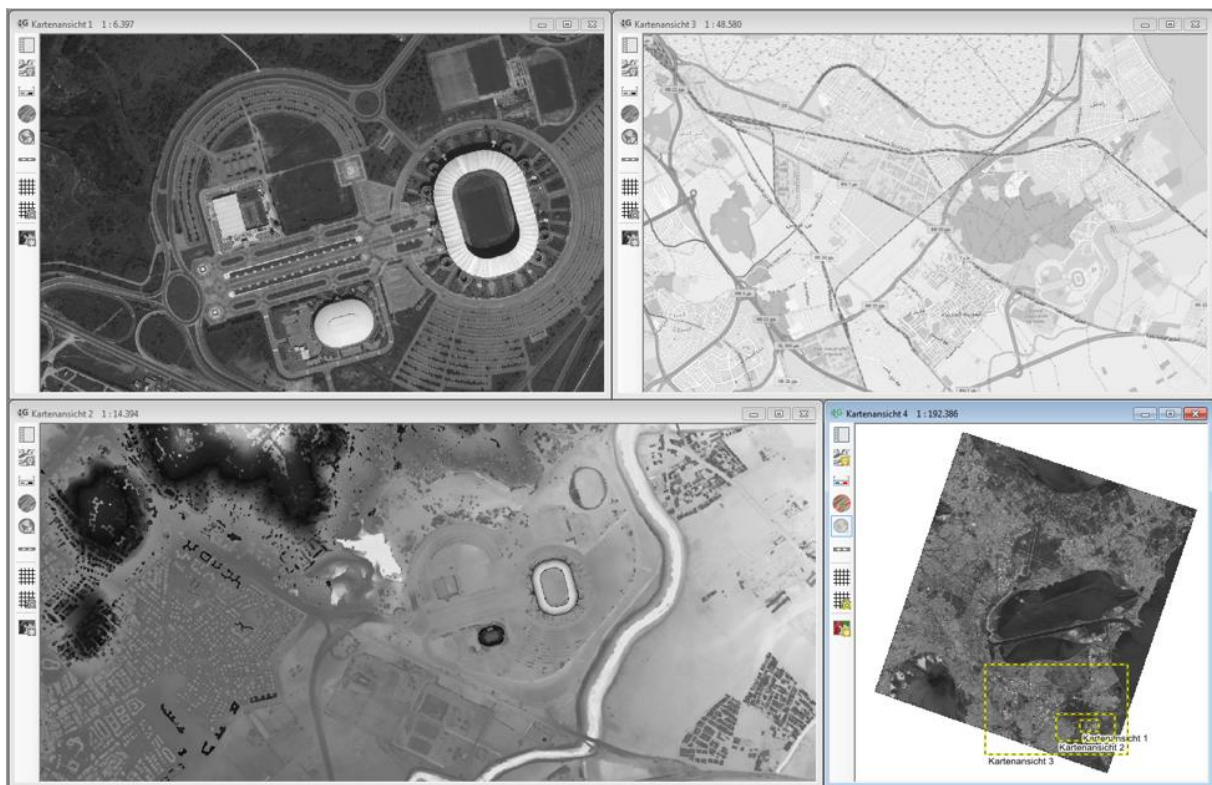


Figure 101: Example for Enable/Disable Overview: active Overview Window is bottom right

An overview is never linked to the other map windows, regardless of the settings in the menu Window (see chapter 3.2), i.e. the visible extent in the overview never changes unless you zoom/move it consciously.

If the button is not activated (does not have a blue frame), the map window is not an overview.

4.5.9 Show/Hide Scalebar

In GAFmap Express: Map Viewer Toolbar (2D)

Only available if the project contains a (2D) map window



If you activate the button **Show/Hide Scalebar**, a scalebar is shown at the lower edge of the map viewer. The length unit (in m or km) is automatically adapted to the current map scale; it is always metric, independent of the map coordinate system.

You can adjust the appearance of the scalebar (as bar or line, color and background) in the general settings (see chapter 3.4.1.3).

If you deactivate the button, the scale bar is hidden again.

Shortcuts, Key Commands, etc.:

- B: Show/Hide Scalebar

4.5.10 Show/Hide Grid

In GAFmap Express: Map Viewer Toolbar (2D)

Only available if the project contains a (2D) map window



Show/Hide Grid lets you activate or deactivate an on-the-fly coordinate grid for the map viewer. The appearance of the grid depends on the settings in the **Grid Properties** (see chapter 4.5.11).

On-the-fly means that the grid is calculated in the background for the currently visible map extent and is only displayed on the screen; thus, no "object" such as a graphic element is created.

Shortcuts, Key Commands, etc.:

- G: Show/Hide Grid

4.5.11 Grid Properties



In GAFmap Express: Map Viewer Toolbar (2D)

Only available if the project contains a (2D) map window



Via **Grid Properties** you reach the Properties window where all essential properties of the on-the-fly coordinate grid (see chapter 4.5.10) are listed:

Symbologie

- **Line Pen:** specifies the symbol used to display the grid lines.
 opens the Line Pen dialog (see chapter 6.2)
- **Show Label:** determines whether the coordinate grid is labeled (**On**) or not (**Off**). If **On**, the following properties are available for the labeling:
 - **Labeling:** here, the label style can be customized.
 opens the Labeling dialog (see chapter 6.4)
 - **Vertical Labeling:** if **On**, parallels are labeled vertically; if **Off**, they are labeled horizontally.

Note: The grid can only be labeled horizontally or vertically. The **Rotation** property in the Labeling dialog (see chapter 6.4) has no effect here.
 - **Labels on X/Y-Axis:** determines whether the medians/parallels are labeled on **Both** sides of the map viewer or only on the **Top** or **Bottom** / the **Left** or **Right**.
- **Grid mode:** determines whether continuous grid lines (**Lines**) or only **Ticks** are displayed in the map viewer, or whether the coordinates are only displayed on the edge of the map viewer (**On Edge**). If you select **Ticks** or **On Edge**, you can specify the size of the markers at **Tick Size**.
- **Tick Size [px]** (*only available for Grid Mode = Ticks / On Edge*): determines the size of the (grid line) markers. Enter negative values if you want the markers to be drawn inwards for **On Edge**.

Coordinate Grid

- **Use Map Spatial Reference:** if **On**, the map coordinate system is used for the coordinate grid; if **Off**, you can specify a different **Spatial Reference**.
- **Automatic Step Size:** if **On**, depending on the map scale, a suitable step size for the coordinate grid is automatically identified and applied. If **Off**, you can specify a fixed **Step Size in X/Y** direction. The unit depends on the coordinate system set for the coordinate grid.

The above-mentioned display options always and only refer to the corresponding map viewer, i.e. you can display different grids in different map viewers.

4.5.12 Export Map

In GAFmap Express: Map Viewer Toolbar (2D)

Only available if the project contains a (2D) map window



Export Map lets you export a defined map extent as image file, including all currently activated (= visible) layers and graphics. So in a broader sense you create a (localized) screenshot of the currently visible map extent.

The function **Export Diagram**, with which you can export field statistics or a scatter plot, uses the same dialog (see chapter 5.3.2.1.7 or 5.3.2.1.8).

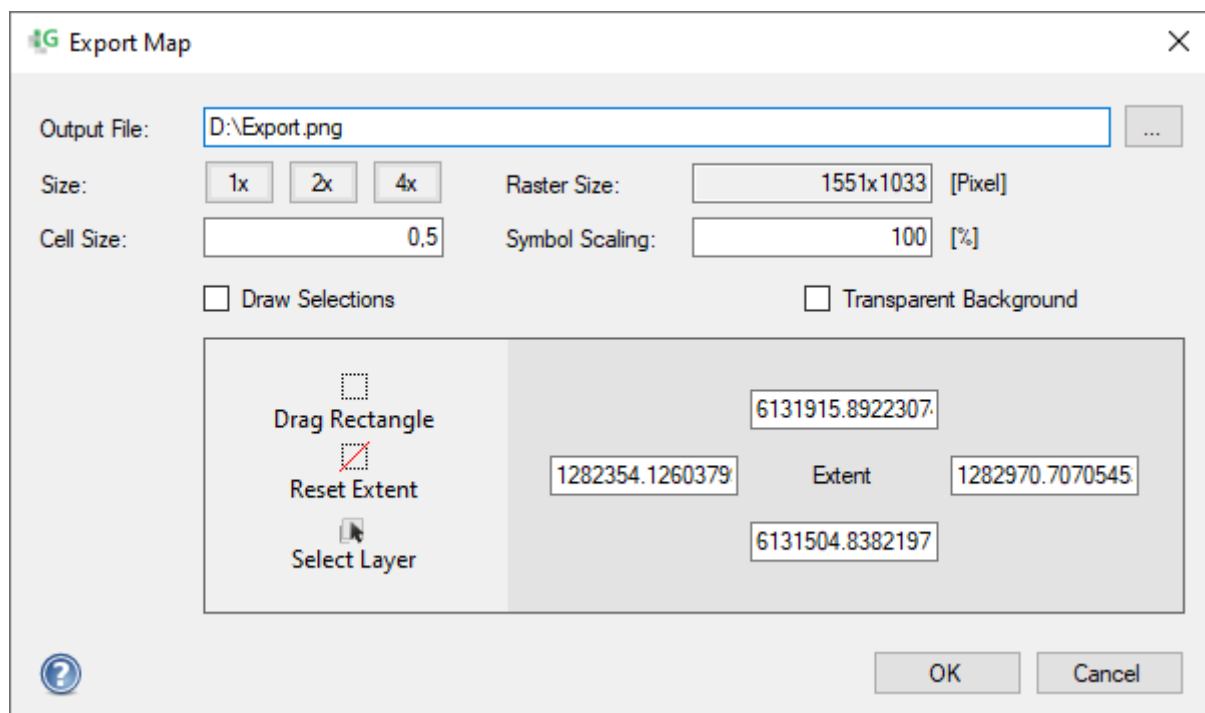


Figure 102: Dialog **Export Map**

- **Output File:** specifies storage location, name, and file type for the output image. The following output formats are supported: PNG, JPG and EMF.

... opens a file browser

- **Size:** determines the resolution of the output file. **1x** corresponds to the current display of the map on the screen. If you want to export the currently visible map extent in a

higher resolution, select **2x** or **4x**. The display for **Pixel Size** and **Raster Size** is updated accordingly.

- **Cell Size:** determines the pixel size of the output raster. If you want to export the current map extent in a higher resolution, for example the full resolution of a raster, you can specify it directly.
- **Raster Size [Pixel]:** shows the size of the output image in pixels. It is automatically calculated from **Pixel Size** and **Extension**.
- **Symbol Scaling [%]:** determines how strongly symbols such as vector data, labels, and graphics are scaled. If you use a higher resolution (= **Pixel Size**), increase the value to > 100% if necessary. This prevents the symbols from becoming too small.
- **Draw Selections:** if checked, any existing feature selection is also visible in the output image. Otherwise, no selection is displayed in the output file.
- **Transparent Background** (*only available if the output file type supports transparencies, e.g. for *.png*): if checked, the map viewer is exported with a transparent background, regardless of the **Background Color** selected in the general settings (see chapter 3.4.1.3). If unchecked, the map viewer is exported with the selected background color.
- **Extent:** determines the map extent to be exported. The exported area always corresponds to that of the entered rectangle. Preentered is the currently visible extent. However, you can define any other extent by **Drag Rectangle**, manually entering the edge coordinates, or **Select Layer** (= extent of a selected layer).

Click **OK** to export the specified map extent or **Cancel** to close the dialog without further action.

4.6 3D Viewer Toolbar

Only available if the project contains a 3D window

The **3D Viewer Toolbar** is located at the left edge of the 3D window; all functions contained there exclusively refer to 3D viewers.


It includes

- various on-the-fly analyse functions (see also chapter 4.5),
- functions to save views and to display views and movements ("flights") in the 3D viewer,
- the basic settings for the 3D viewer ("configuration"), and
- buttons to start stereoscopic views, VR, and the Multi User mode.

4.6.1 Separate/Embed TOC

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window and if the 3D TOC is not hidden (see chapter 4.6.2)

 **Separate/Embed TOC** lets you detach the 3D TOC (see chapter 2.2.3.2) from the 3D window or attach it again.

If you activate the button, the TOC is separated from the 3D window and opened in a separate, initially floating, dockable window:

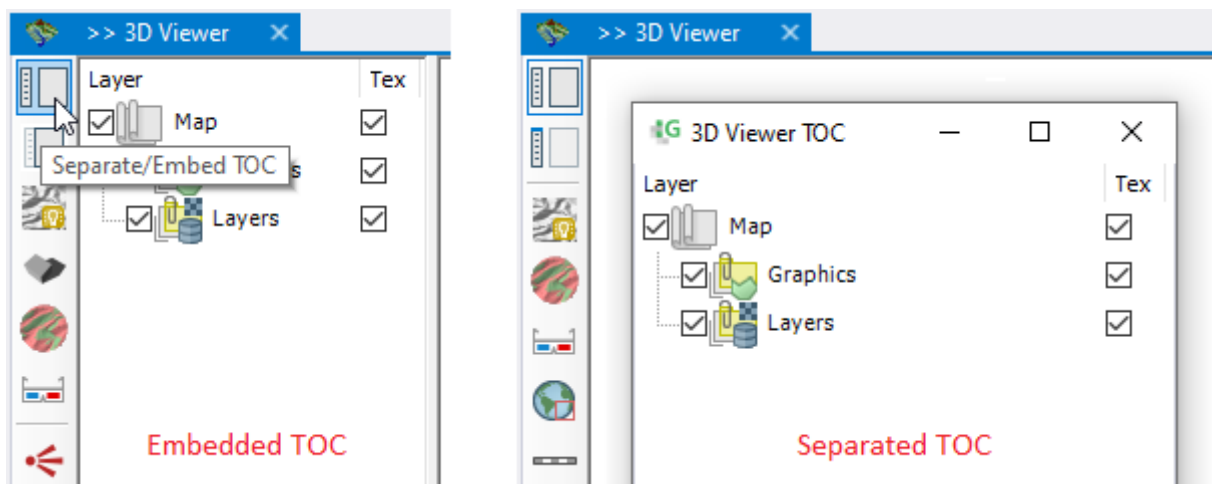


Figure 103: 3D TOC, embedded in the 3D window (left) and separated from the 3D window (right)

As long as the button is activated (framed in blue), the TOC remains separated from the 3D window. Like any dockable window, it can then be anchored in the main window or in other dockable windows (see chapter 2.2.4.2 et seq.)

By another click, the button can always be deactivated and the TOC can be embedded in the 3D window again.

For more information and examples see chapter 2.2.4.4.

Tips and notes:

- You can always activate/call up a separated 3D TOC with **Activate TOC** in the 3D window (see chapter 4.6.3), e.g. if it has been forced into the background, minimized, or hidden while working. The TOC is then brought up and highlighted in blue.

4.6.2 Show/Hide TOC

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window and only if the 3D TOC is embedded in the 3D window (see chapter 4.6.1)



Show/Hide TOC lets you show or hide the 3D TOC (see chapter 2.2.3.2) if it is embedded in the 3D window (see chapter 4.6.1).

As long as the button is deactivated, the TOC is shown at the left edge of the 3D window. If you activate the button by clicking it, the TOC is hidden; the button is then framed in blue. The TOC remains hidden until the button is deactivated again by another click.

4.6.3 Activate TOC

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window and only if the 3D TOC is separated from the 3D window (see chapter 4.6.1)



Activate TOC lets you call up the 3D TOC (see chapter 2.2.3.2) if it is separated from the 3D window (see chapter 4.6.1). This can be necessary if, for example, it has been forced into the background, minimized, or hidden while working. If called up, the TOC is brought up and highlighted in blue.

4.6.4 Enable/Disable DEM Shading

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window



Enable/Disable DEM Shading lets you activate/deactivate an on-the-fly shading for the DEM mosaik / base terrain (see chapter 5.3.4) in the 3D viewer. Shading causes all surfaces facing the light source to appear lighter, and all surfaces turned away from the light source to appear darker. This enhances the spatial impression and the perceptibility of smaller differences in heights.

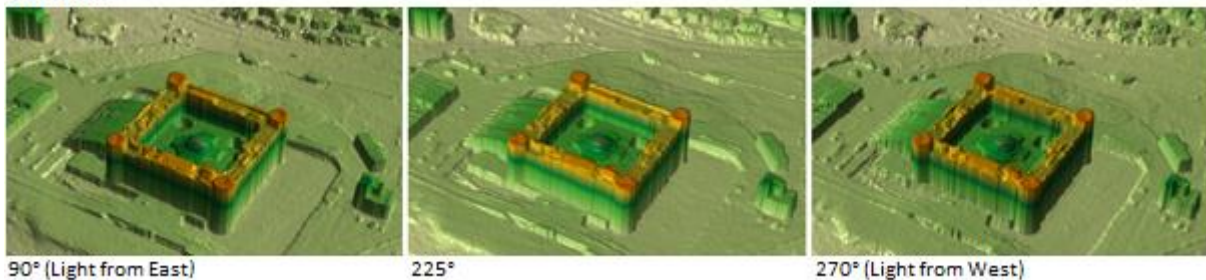
The terrain is also shaded when it is overlayed with textures.

The virtual light source is specified for the entire scene in the map properties (see chapter 5.1.7).

Influence of Azimuth and Elevation

If you change the position of the virtual light source ("sun") via **Azimuth** and **Elevation** or **From date and time** in the properties of the Map (see chapter 5.1.7), you can simulate and analyze e.g. the lighting situation "on site" at different sun positions:

Azimuth:



Elevation:

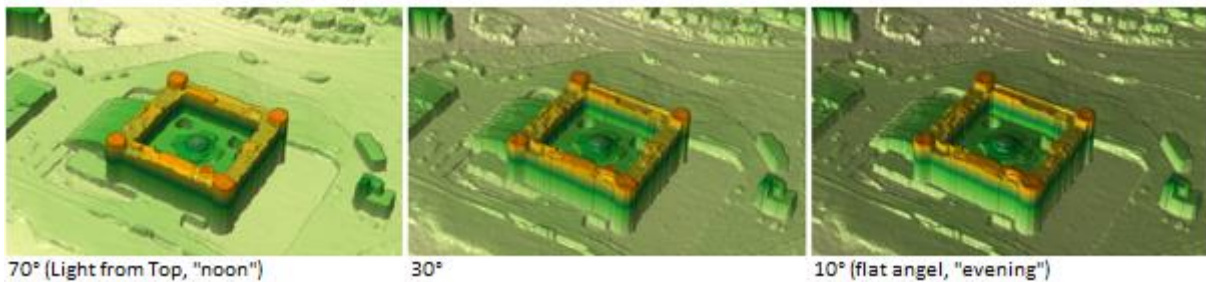


Figure 104: Same DEM extent under different lighting conditions (Map properties Azimuth and Elevation)

If you use the Background Mode **SkyBox Textures** (see chapter 5.1.7), the virtual light source is displayed as "sun in the sky" at the right position.

Shortcuts, Key Commands, etc.:

- L: Enable/Disable DEM Shading

4.6.5 Enable/Disable Shadows

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window



Enable/Disable Shadows lets you activate/deactivate on-the-fly shadows for all three-dimensional objects, 3D models, point clouds, and digital elevation models. The direction and

length of the shadows depends on the direction from which the virtual light source ("sun") shines, i.e. on **Azimuth** and **Elevation**.

The virtual light source is specified for the entire scene in the map properties (see chapter 5.1.7).

Shadows lets you analyze the shadow cast by the terrain and all three-dimensionally displayed layers and graphics at different "sun positions", e.g. to find out if and when certain areas or objects are shaded by others:

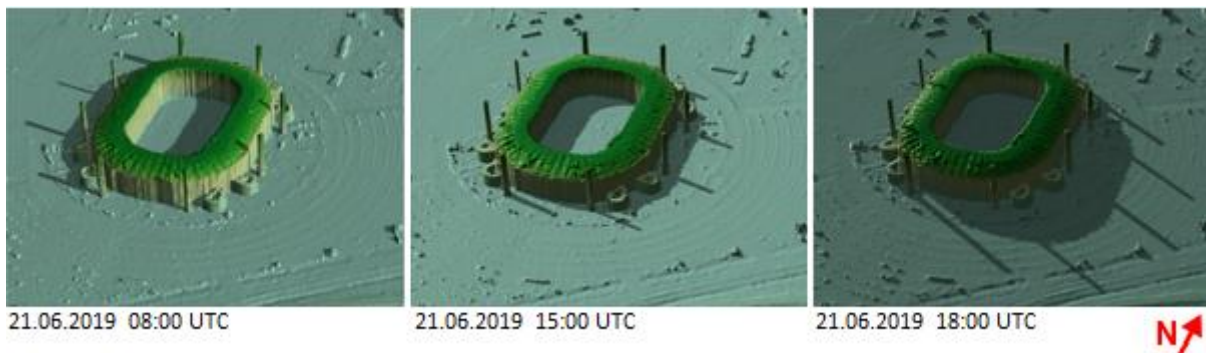


Figure 105: Same DEM extent, **Shadow** at different times (Map property **From date and time**)

Note that objects only cast a shadow

- if **Shadows/View Obstruction** is activated in their properties (see e.g. chapter 5.2.1.10, 5.3.2.5, or 5.3.4.1).
- if they appear as bodies in the 3D Viewer. This excludes e.g. point clouds that are visualized with the point symbols **Point**, **Cross**, or **Quad** (see chapter 5.3.7.1).
- if they are not visualized with the Symbol Size Unit **Pixel** or **Scene**.
- The (auxiliary) geometries **View Point**, **Flight Line**, and **Sight Line** never cast shadows.

Note also that the calculation of shadows involves a large computing effort and places high demands on the graphics card. If the performance in the 3D Viewer decreases significantly when activating Shadows, you can reduce their quality step by step in the **Edit Configuration** dialog (see chapter 4.6.19). The shadows are then accordingly displayed with a lower resolution.

Shortcuts, Key Commands, etc.:

- Ctrl + L: Enable/Disable Shadows

4.6.6 Enable/Disable Viewshed

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window



Enable/Disable Viewshed lets you display the visibility of the terrain from one or more locations in the 3D viewer. The calculation/analysis is performed on-the-fly, i.e. in the background for the data extent currently displayed in the 3D viewer ("on-the-fly viewshed").

The calculation of the 3D viewshed is based on

- the base terrain (see chapter 5.3.4) and/or any other 3D capable data (see chapter 2.2.3.2)
- at least one **viewshed point (VSP)**, which defines the location of the virtual observer and thus forms the starting point for the analysis (see chapter 4.5.6).

The 3D viewshed can always be enabled by activating the corresponding button. All areas visible from the VSP are then colored in green in the map viewer, non-visible areas are colored in red.

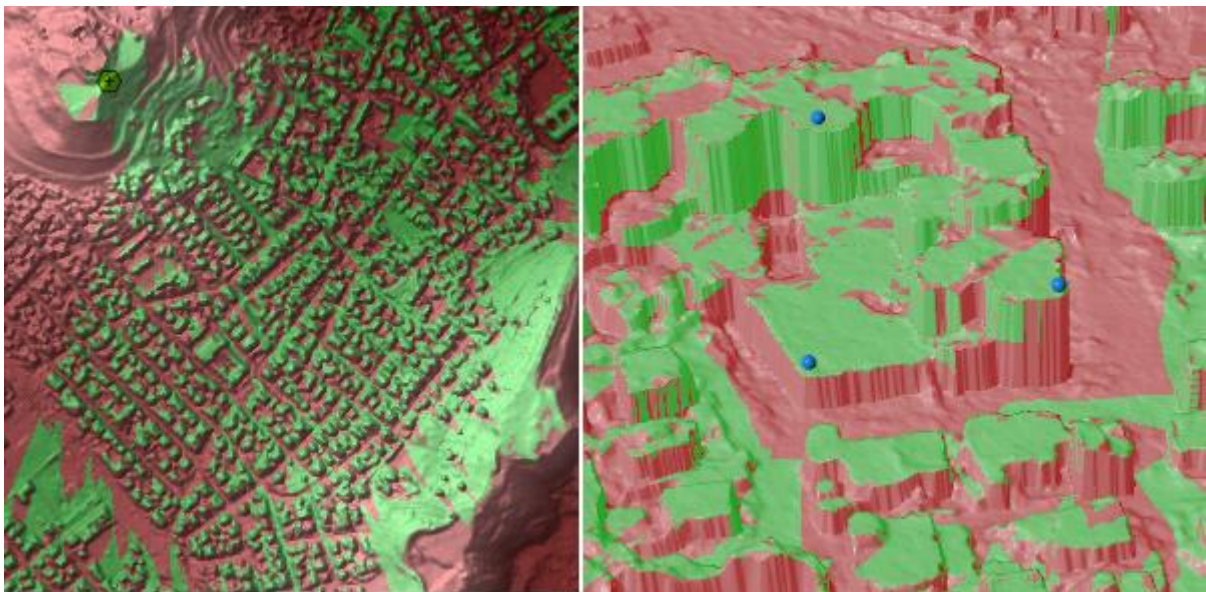


Figure 106: Result of an on-the-fly viewshed in 2D (with activated Shading; left) and of an on-the-fly viewshed in 3D (right)

For more information on viewshed and viewshed points (VSPs), see chapter 4.5.6.

Special Features for Viewshed in 3D

While the viewshed in 2D is performed exclusively based on DEMs, all 3D capable data are considered as "view obstructions" in 3D. This includes DEMs as well as 3D surfaces, 3D models, point clouds, extruded vector layers (polygons, lines, points), and 3D capable graphics. Prerequisite is,

- that the property **Shadows/View Obstruction** is enabled on the layer level (see e.g. chapter 5.2.1.10, 5.3.2.5, or 5.3.4.1) and
- that the objects are not displayed with the Symbol Size Unit **Pixel** or **Scene**, but a "real" size in meters is given (see e.g. chapter 5.2.1.10 or 6.6.1).

Layers and graphics for which **Shadows/View Obstruction** is disabled or which do not have this property (e.g. view points or 3D text labels), and those that are displayed with the Symbol Size Unit **Pixel** or **Scene**, are ignored when applying the 3D viewshed.

Note that the result of the viewshed is also only displayed on the surface of elevation models and objects for which **Shadows/View Obstruction** is enabled.

You can activate up to eight VSPs in the 3D TOC and thus use for 3D viewshed. When attempting to activate a ninth VSP, the VSP that is bottommost in the TOC is automatically deactivated.

The 3D viewshed is very calculation-intensive and places high demands on the hardware, especially on the graphics card. Depending on what data and hardware you are using, there can be a significant decrease in performance when viewshed is activated. Usually, it a reasonable compromise has to be found between a result that is as exact as possible and a result with the highest performance possible:

- The setting **Shadow Map and Viewshed Quality** in the dialog **Edit Configuration** (see chapter 4.6.19) lets you influence the quality of the viewshed. The following applies: The higher the quality, the more accurate the viewshed, but the worse the performance.

! The setting **Viewshed Quality** under menu Extras > Setting > Viewing > Viewshed has no affect an the 3D viewshed!

- Activate as few VSPs as possible to obtain a viewshed with the highest possible resolution. The graphics memory intended for 3D viewshed is split between activated VSPs, i.e. the resolution per VSP is automatically reduced when activating additional VSPs.
- Reduce the area for the viewshed by loading only a section of the entire data extent into the 3D viewer (see chapter 4.1.15), for example, or by reducing the **Maximum Viewing Distance** or the **Sector Angle** to be analyzed (see chapter 5.2.12.1)

The quality of the 3D viewshed depends significantly on the DEM properties **Mesh Simplification** and **Level of Detail** (see chapter 5.3.4.1). The following applies: the less the DEM is simplified and the higher the level of detail, the more accurate the viewshed, but the worse the performance.

Usually, **Dynamic LOD** is selected at **Level of Detail**, since this setting leads to a good compromise between performance and recognizable details and is therefore generally recommended. Especially with regard to the viewshed, a fixed LOD should be set, as **Dynamic LOD** (automatically) leads to different and, when moving, constantly changing LODs.

Shortcuts, Key Commands, etc.:

- Alt+click on the layer name of a VSP in the 3D TOC: zoom to layer

4.6.7 Enable/Disable Anaglyph Rendering

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window



Enable/Disable Anaglyph Rendering lets you start or stop an on-the-fly anaglyph rendering (red-green display) for the 3D viewer. With a suitable pair of red-green glasses you will then get a better three-dimensional impression of the data.

The anaglyph rendering can be configured in the Map properties under **Stereoscopic View** (see chapter 5.1.7).

4.6.8 Enable/Disable Direct X Stereo

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window and if Direct X Stereo support is enabled (see chapter 4.6.19)



Enable/Disable DirectX Stereo lets you start/end the 3D visualization for DirectX Stereo. The display can be configured in the Map properties under **Stereoscopic View** (see chapter 5.1.7).

4.6.9 Enable/Disable Oculus Rift

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window, if Oculus Rift support is enabled (see chapter 4.6.19), and if a suitable VR headset is connected and ready for operation



If you have a virtual reality headset connected and ready for operation that is addressed via the Oculus Rift interface, e.g. an Oculus Rift S headset, you can always switch to VR mode via the **Enable/Disable Oculus Rift** button or Map Properties > Stereoscopic View > Technique **Oculus Rift** (see chapter 5.1.7). The 3D viewer is then output on the displays of the headset until you disable the button or stereoscopic technique again.

The VR display can be adjusted in the Map Properties under Stereoscopic View (see chapter 5.1.7), and you can define whether and in which way the headset displays are mirrored on the screen in the configuration dialog under **Monitor Mirror Mode** (see chapter 4.6.19).

For more information on Virtual Reality mode (general notes, controls, possible actions, etc.), see chapter 8.

4.6.10 Enable/Disable SteamVR

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window, if SteamVR support is enabled (see chapter 4.6.19), and if a suitable VR headset is connected and ready for operation



If you have a virtual reality headset connected and ready for operation that is addressed via the SteamVR interface, e.g. a HTC Vive (Pro) headset, you can always switch to VR mode via the **Enable/Disable SteamVR** button or Map Properties > Stereoscopic View > Technique **SteamVR** (see chapter 5.1.7). The 3D viewer is then output on the displays of the headset until you disable the button or stereoscopic technique again.

The VR display can be adjusted in the Map Properties under Stereoscopic View (see chapter 5.1.7).

For more information on Virtual Reality mode (general notes, controls, possible actions, etc.), see chapter 8.

4.6.11 Enable/Disable OpenXR

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window, if OpenXR support is enabled (see chapter 4.6.19), and if a suitable VR headset is connected and ready for operation

XR If you have a virtual reality headset connected and ready for operation that is addressed via the OpenXR interface, e.g. Windows Mixed Reality headset, you can always switch to VR mode via the **Enable/Disable OpenXR** button or Map Properties > Stereoscopic View > Technique **OpenXR** (see chapter 5.1.7). The 3D viewer is then output on the displays of the headset until you disable the button or stereoscopic technique again.


The VR display can be adjusted in the Map properties under Stereoscopic View (see chapter 5.1.7).

For more information on Virtual Reality mode (general notes, controls, possible actions, etc.), see chapter 8.

4.6.12 Save Current View Point

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window


 **Save Current View Point** lets you save your current view in the 3D window, e.g. to recall it at a later time. A view point is then created automatically whose height and viewing angle exactly match your current viewing position and direction.

For more information on view points, see chapter 5.2.15.

4.6.13 Start/Pause Animation

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window and only if a single flight line or view point is selected in the 3D TOC


 **Start Animation** starts the flight along a selected flight line or the flight from your current view to a selected view point. To start the flight, simply select a flight line or a view point in the 3D TOC and press the button.

- If a **flight line** is selected, the view jumps to the start point of the flight line and the flight is then executed according to the flight line properties.

For more information on flight lines, see chapter 5.2.16.

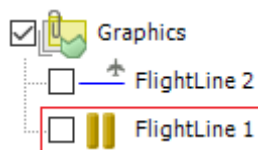
- If a **view point** is selected, a flight starts that leads you directly from your current view to the view stored in the view point.

For more information on view points, see chapter 5.2.15.

 You can always pause a running flight animation with **Pause Animation** and resume a paused animation with **Start Animation**.

Note that once a flight animation has been started, it remains active until it has been completed, it is stopped (see chapter 4.6.15), or the project is closed. As long as an animation is active, no other animation can be started.

You can tell that an animation is active by the fact that the **Stop Animation** button in the 3D Viewer toolbar is active, or by the play or pause icon in front of the affected flight line / view point in the 3D TOC:



Shortcuts, Key Commands, etc.:

- Alt + click on a View Point's or Flight Line's layer name in the 3D TOC: start animation
- Key 1-9 while the 3D Viewer is aktiv: fly to 1st-9th View Point in the TOC
- Ctrl + Key 1-9 while the 3D Viewer is aktiv: start 1st-9th Flight in the TOC
- Esc while animation: stop animation

4.6.14 Jump Forward/Backward

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window




Jump Forward/Backward let you jump forward or back in a started flight animation, regardless of whether it is currently running or paused (see chapter 4.6.13). The size of the jumps depends on the total duration of the animation, i.e. the flight time.

4.6.15 Stop Animation

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window and if a flight animation is active

 **Stop Animation** ends a running or paused flight animation (see chapter 4.6.13). The pause or play icon in front of the affected flight line / view point is then replaced by the regular layer icon again and the **Stop Animation** button is grayed out.

If an animation is completed, it is automatically ended.


Shortcuts, Key Commands, etc.:

- Esc while animation: stop animation

4.6.16 Create Screenshot

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window

 **Create Screenshot** lets you create a screenshot of the 3D viewer / current 3D view:

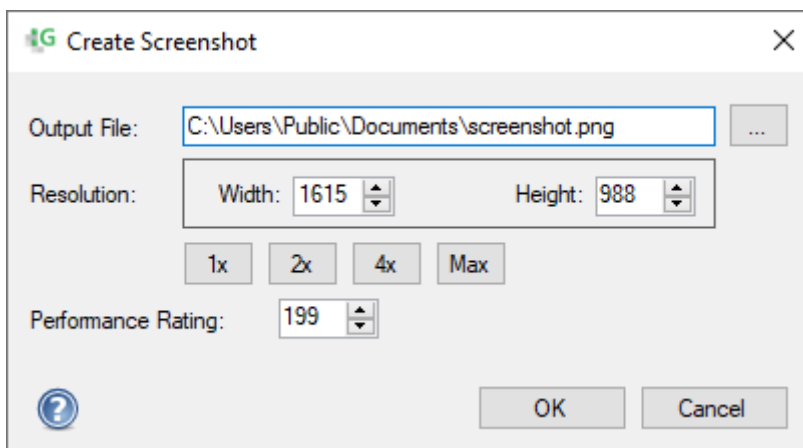



Figure 107: Dialog **Create Screenshot** in the 3D Viewer

- **Output File:** determines storage location, name and file type for the output raster. Available output formats are PNG and JPG.

 opens a file browser

- **Resolution:** determines the resolution of the output file in pixel width x pixel height. Enter the values manually for **Width** and **Height** or use one of the following buttons. At **1x** the resolution corresponds to the current display of the 3D Viewer on the screen, at **2x**, **4x** and **Max** it is scaled accordingly.

Please note that the aspect ratio is not automatically maintained when you manually adjust the **Width** or **Height**. If the aspect ratio of the output file does not match the one of the map viewer, the vertical field of view stays the same and the horizontal field of view is reduced or increased accordingly.

- **Performance Rating:** Specifies the number of DEM blocks shown at once (see chapter 5.3.4.1). Increase the value, for example, to ensure a higher level of detail in the screenshot. If the values differ, the performance rating specified in the configuration dialog (see chapter 4.6.19) is overridden for the screenshot.

4.6.17 Show Controls

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window



Show Controls opens an information window listing all shortcuts and controls available to move within the 3D viewer when using keyboard or mouse. This window automatically updates if you customize shortcuts in the general settings (see chapter 3.4.1.5).

For general information on 3D viewer controls, see chapter 7.

4.6.18 Edit Input Configuration

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window



Edit Input Configuration opens a dialog with setting options for the 3D viewer controls:

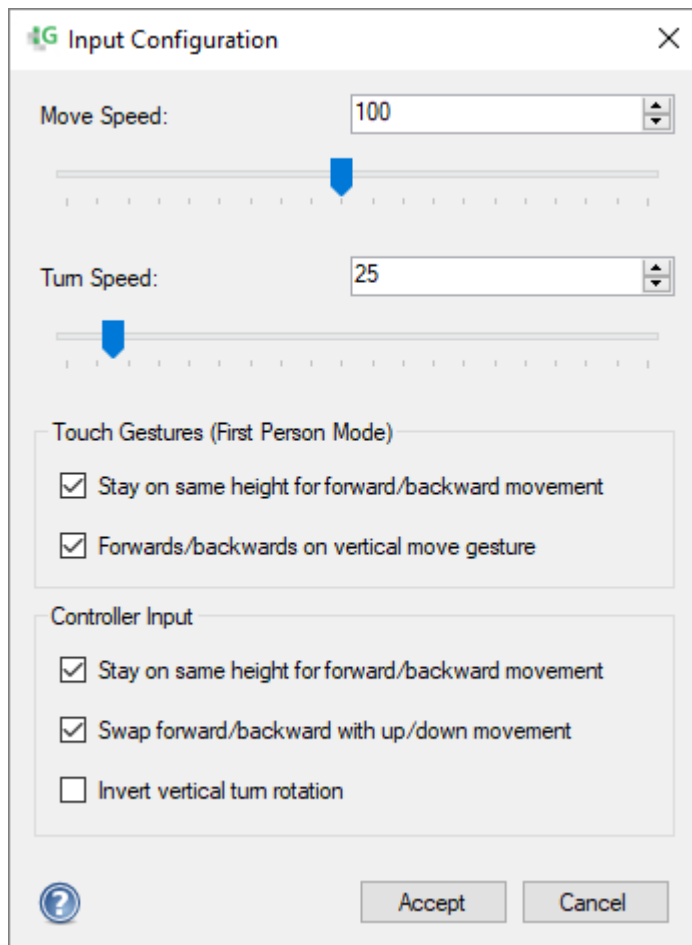


Figure 108: Dialog **Input Configuration**.

- **Move Speed:** defines the speed used when moving linearly within the 3D viewer. The higher the value, the higher the speed. You can also adjust the move speed by scrolling the mouse wheel while navigating within the 3D viewer (see chapter 7.1).
- **Turn Speed:** defines the speed used when rotating within the 3D viewer. The higher the value, the higher the speed. You can also adjust the rotation speed by pressing Ctrl and scrolling the mouse wheel while navigating within the 3D viewer (see chapter 7.1).

Touch Gestures (First Person Mode)

The following settings are only relevant if **First Person Mode** is activated (see chapter 4.6.20). For more information, also see chapter 7.6.

- **Stay on same height for forward/backward movement:** if disabled, you can use the pinch/spread-gesture (see chapter 7.5) to move the camera's position forward or backward along its viewing direction. Enable this option if you want to move the camera's position horizontally forwards or backwards instead.
- **Forwards/backwards on vertical move gesture:** if disabled, you can use the drag-gesture (see chapter 7.5) to move the camera's position vertically up and down. Enable this option if you want to move the camera's position forwards or backwards along its viewing direction instead.

If you enable both **Horizontal Touch Movement** and **Two Finger Pan Up is Forward**, you can use the drag-gesture to move the camera's position horizontally forwards or backwards.

Controller Input

The following settings apply if you use an X-Input Controller (see chapter 7.4) in order to move within the 3D Viewer.

- **Stay on same height for forward/backward movement:** This option affects the left stick and both triggers. If enabled, the camera's position only moves horizontally without changing its height. If disabled, the camera's position moves forward or backward along the camera's viewing direction.
- **Swap forward/backward with up/down movement:** This option affects the left stick and both triggers. If enabled, forward/backward movements swap with upward/downward movements.
- **Invert vertical turn rotation:** This option affects the right stick. If disabled, the camera's viewing direction turns upwards/downwards if you press the stick forward/backward. If enabled, the camera's viewing direction turns the other way round, i.e. downwards/upwards instead.

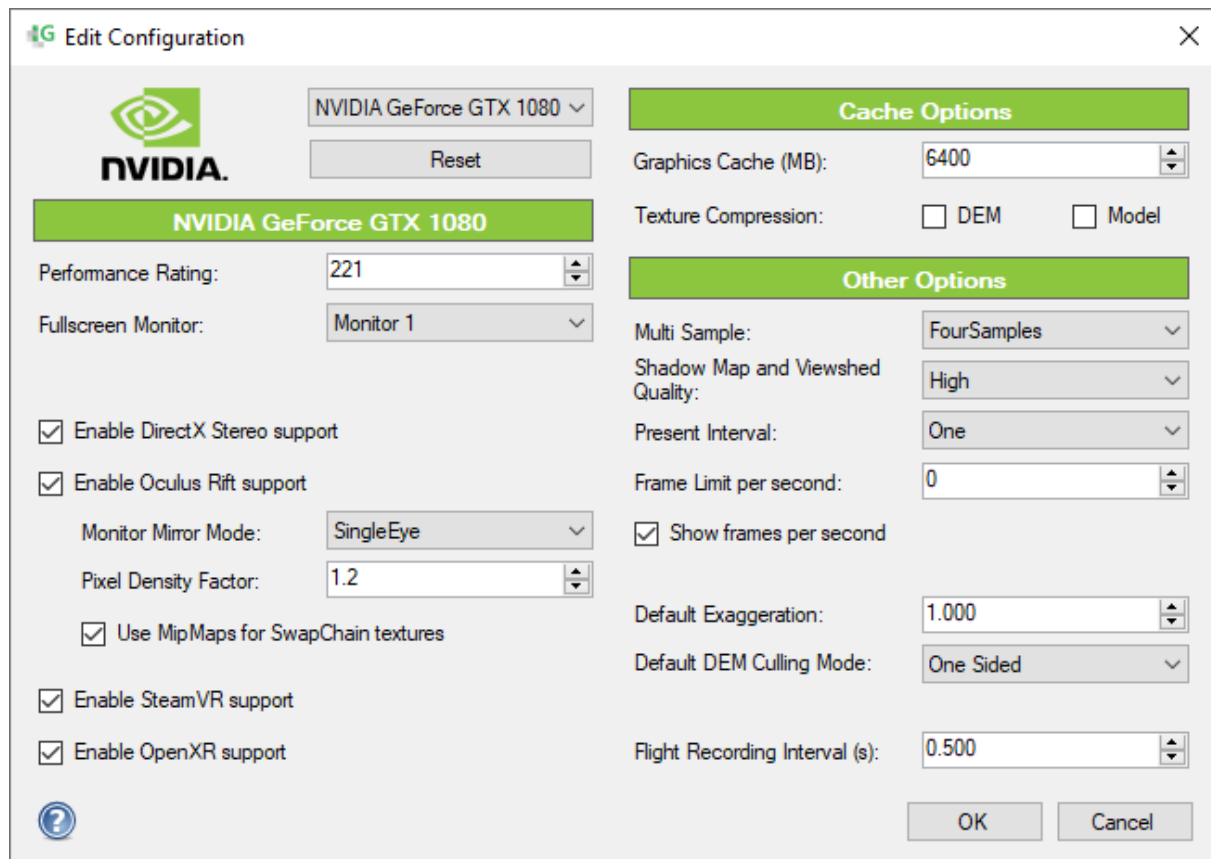
4.6.19 Edit Configuration

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window



Edit Configuration opens the 3D viewer configuration dialog. Most settings directly depend on the used graphics card. Usually, you can work with the default settings automatically detected for each graphics card.

Figure 109: Dialog **Edit Configuration**.

- **Drop-down list** for selecting the graphics card (*only visible if more than one graphics card is available*): determines the graphics card used for the 3D Viewer.
- **Reset**: resets the settings in the dialog to the automatically determined default values for the used graphics card.
- **Performance Rating**: specifies the number of DEM blocks that are displayed at once (see chapter 5.3.4.1). The value can be increased, for example, to achieve a higher level of detail for 3D visualization. How high the value can be set depends mainly on the speed of the graphics card. The preentered reference value is determined automatically (for the selected graphics card) when you start the 3D viewer on a computer for the first time or when you **Reset** the settings in the dialog (see above).
- **Fullscreen Monitor**: determines on which monitor the 3D viewer is displayed in full screen display.
- **Enable Direct X Stereo support**: if checked, the data output for DirectX Stereo is supported, providing that the required hardware (e.g. shutter glasses/emitter/display, a corresponding 3D TV or a stereo station) is available and installed. In the 3D Viewer toolbar the button Enable/Disable DirectX Stereo is then shown (see chapter 4.6.8) and in the map properties **Technique DirectX Stereo** is added under **Stereoscopic View** (see chapter 5.1.7).

- **Enable Oculus Rift support:** if checked, the Oculus Rift interface is activated for VR output. The **Enable/Disable Oculus Rift** button is then added to the 3D Viewer toolbar (see chapter 4.6.9) and the technique **Oculus Rift** is added to the Map properties under **Stereoscopic View** (see chapter 5.1.7).

With the following settings you can then customize the VR view for Oculus:

- **Monitor Mirror Mode:** determines if and how the headset's displays are mirrored on the screen. You can choose between **Disabled** (displays are not mirrored on the screen), **SingleEye** (one display is mirrored on the screen, free of warp), and **WarpedBothEyes** (both displays are mirrored on the screen, warped). The effect is only visible when the headset is connected and activated in the 3D viewer.
- **Pixel Density Factor:** defines the displayed resolution of the VR display. A higher value (1.2 - 2) leads to a sharper display but reduces performance.
Tip: If you increase the pixel density factor, you should reduce the **Performance Rating** to achieve a constant performance as compensation. Always make sure you have enough FPS (frames per second) for a smooth display.
- **Use mipmaps for SwapChain textures:** if checked, rendered images are filtered at the peripheral area of the VR display to avoid aliasing. This option is recommended if a high pixel density factor is entered, but might reduce performance.
- **Enable SteamVR support:** if checked, the SteamVR interface is activated for VR output. The **Enable/Disable SteamVR** button is then added to the 3D Viewer toolbar (see chapter 4.6.10) and the technique **SteamVR** is added to the Map properties under **Stereoscopic View** (see chapter 5.1.7).
- **Enable OpenXR support:** if checked, the OpenXR interface is activated for VR output. The **Enable/Disable OpenXR** button is then added to the 3D Viewer toolbar (see chapter 4.6.11) and the technique **OpenXR** is added to the Map Properties under **Stereoscopic View** (see chapter 5.1.7).

For Oculus Rift (S) headsets, the Oculus Rift interface in GAFmap® is recommended, and for Windows Mixed Reality (WMR) headsets, the OpenXR interface. For most other VR headsets, SteamVR will probably give the best results.

For more information on how to enable VR mode, see chapter 5.1.7, and for other information on virtual reality (general notes, controls, possible actions, etc.), see chapter 8.

Cache Options

- **Graphics Cache [MB]:** determines the volume of data loaded to the graphics card. If you use a graphics card with small memory or if "out of memory" errors occur, the

value should be reduced. As a guideline, a value slightly below the dedicated video memory of the graphics card is recommended.

- **Texture Compression:** determines whether textures are compressed on-the-fly to reduce the graphics memory usage (**On**) or not (**Off**). A compression of textures can be useful if a graphics card with little memory or 3D models with large textures are used. Note, however, that compressing can slow down the streaming significantly.
 - **DEM:** if checked, the textures of elevation models (DEMs) are compressed.
 - **Model:** if checked, the textures of 3D models are compressed. If the textures are already in a compressed DDS format, they do not need to be compressed again and can be loaded directly onto the graphics card.

Other Options

- **Multi Sample:** specifies the used anti-aliasing mode. Anti-aliasing reduces unwanted optical effects (artifacts) that can occur when creating a graphic due to the limited resolution of the pixel raster.
- **Shadow Map and Viewshed Quality:** determines how high resolved terrain and object shadows as well as the result of the on-the-fly viewshed are displayed in the 3D viewer. The higher the selected quality, the better the resolution. Note, however, that a high resolution has a negative effect on the performance (especially the frame rate) and that depending on the hardware (especially the graphics card) used the quality level should not be too high. The preentered value is determined automatically depending on the graphics card used. With the button **Reset** (see above), the default value can be restored at any time.

For more information on **Shadows**, see chapter 4.6.5, for information on the 3D viewshed, see chapter 4.6.6.

- **Present Interval:** determines how often a raster image is rendered. If **One** is set (recommended), rendering is limited to the monitor's refreshing rate.
- **Frame Limit per Second:** here, you can limit the frame rate (frames per second). If you enter e.g. 30, a maximum of 30 frames per second is displayed during a camera movement. Limiting the frame rate can be useful e.g. if you use monitors with G-SYNC or FreeSync, because ideally you should stay just below the possible refresh rate of the monitor. If 0 is entered, the frame rate is not limited.

Show frames per second: if checked, the frame rate is displayed in fps (frames per second) in the top right corner of the 3D viewer whenever the camera is moving. At e.g. 60 fps, 60 frames per second are displayed. For smooth movements, the frame rate should be at least 30 fps.

- **Default Exaggeration:** determines which exaggeration factor is entered by default. The **Exaggeration** can be checked and adjusted in the Map properties (see chapter 5.1.7).
- **Default DEM Culling Mode:** determines which culling mode is selected by default for digital elevation models (i.e. for DEMs and 3D surfaced; see chapter 5.3.4.1).
- **Flight Recording Interval [s]** (*not relevant for GAFmap® Express*): determines the recording time interval when recording a flight, i.e. the time difference between the flight points.

4.6.20 Toggle First Person Mode

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window



Toggle First Person Mode determines whether the standard mode (see chapter 7.1) is active for the mouse controls or the First Person Mode (see chapter 7.2).

Tips and notes:

- The activation status of the button is saved in your user profile.

4.6.21 Multi User

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window



Multi User lets you create a multi user server yourself or connect to the multi user server of another user (see chapter 9.2).

If you are already connected to a multi user server (session), a dialog with a participation list of the current session opens (see chapter 9.2.3).

4.6.22 Show Help

In GAFmap Express: 3D Viewer Toolbar

Only available if the project contains a 3D window



Show Help opens the software help for the 3D viewer.

4.7 Graphics Toolbar

4.7.1 Edit Graphics

In GAFmap Express: Graphics Toolbar




Edit Graphics lets you select all graphic elements and modify self-created graphics. For this, activate the black arrow from the graphics toolbar and select the required graphics within the map viewer or the TOC. Depending on type and number of the selected graphic elements, various editing options are available (directly or in context menus).

Selecting Graphics

You can select a graphic by a left-click in the map viewer on the geometry/object or by choosing the corresponding layer within the TOC. Multi-selection is possible if you press Ctrl while selecting.

Alternatively, you can drag a selection rectangle within the map viewer. All graphics that are within the rectangle or intersect it are selected.

If you select graphic within the map viewer or the TOC, they are always highlighted in cyan in the map viewer and dark blue in the TOC. This means, they are always selected in map viewer and TOC at the same time.

Note that a graphic cannot be selected with the Graphics Edit Tool if the property **Selectable** is turned off (see chapter 5.2.1.10). The graphic is then marked in the TOC with the corresponding  overlay icon. Via the TOC a graphic can always be selected, i.e. independent of this property.

Moving Graphics

Only possible for self-created graphics and only within the (2D) map window

As soon as one or multiple graphics are selected, the mouse pointer turns into a move arrow. To move the selected elements, grab them by a left-click in the map viewer, hold the mouse button, drag them to the desired position, and release the mouse button.



Figure 110: Moving a graphic using **Edit Graphics**

Activating / Deactivating Graphic Vertices

Only possible for self-created graphics and only within the (2D) map window

You can **activate the vertices** of a single selected graphic by

- a double-click on the geometry in the map viewer or
- pressing F2 after selecting the graphic.

You can **deactivate the vertices** by

- a left-click next to the geometry in the map viewer or
- pressing F2.

Editing Graphic Vertices

Only possible for self-created graphics and only within the (2D) map window

After activating the graphic's vertices, you can select and modify single vertices.

Please note: If you edit graphics of the type AOI, rectangle, circle/ellipse, and image, you can only change their extent, but not single vertices. If you want to change single vertices of a rectangle or circle/ellipse anyway, convert it to a polygon first (see chapter 5.2.6.1 and/or 5.2.8.1).

Copy Graphics

As long as the **Graphics Edit Tool** is active, you can always copy/paste selected graphics using Ctrl+C/Ctrl+V.

Graphics Context Menu

In context menus, various options to change and organize selected graphics are available. You can call up the context menu of selected graphics by a right-click in the map viewer with the Edit Graphics pointer or by a right-click on the corresponding layer within the TOC. The content of the context menu depends on type and number of selected graphics. It only shows functions that are suitable for the current selection.

For more information on graphic context menus, see chapter 5.2. For more information on show (vertex) coordinates, see chapter 4.2.2.


Shortcuts, Key Commands, etc.:

- Ctrl when selecting: add selection to current selection. Already selected graphics are deselected when they are selected twice.
- Ctrl + Shift when selecting: add selection to current selection. Already selected graphics are not deselected when they are selected twice.
- Shift when selecting: Already selected graphics are deselected when they are selected twice. Other graphics are not added to the current selection.
- Alt while dragging a selection rectangle: create square
- Alt when selecting by click: select all (overlapping) layers
- Delete after selection: delete all selected graphics (*only for self-created graphics*).
- Shift when moving a graphic element: show auxiliary line
- F2 when a graphic is selected: switch to vertex display mode / end vertex display mode (*only for self-created graphics*)
- Esc while editing: cancel
- Ctrl+C/Ctrl+V: copy/paste selected graphic
- Ctrl+Z/Ctrl+Y: undo/redo changes
- Ctrl+S: save changes

4.7.2 Rotate Selected Graphics

In GAFmap Express: Graphics Toolbar

Only possible for self-created graphics and only within the (2D) map window

 **Rotate Selected Graphics** lets you rotate one or multiple selected graphics around a self-selected center point.

Select the feature(s) to be rotated and determine the **center of rotation** with a left-click in the map viewer. It is indicated by a cross. The cross is visible while the rotation is active. The current rotation angle is displayed in degrees. End the rotation with a second click:

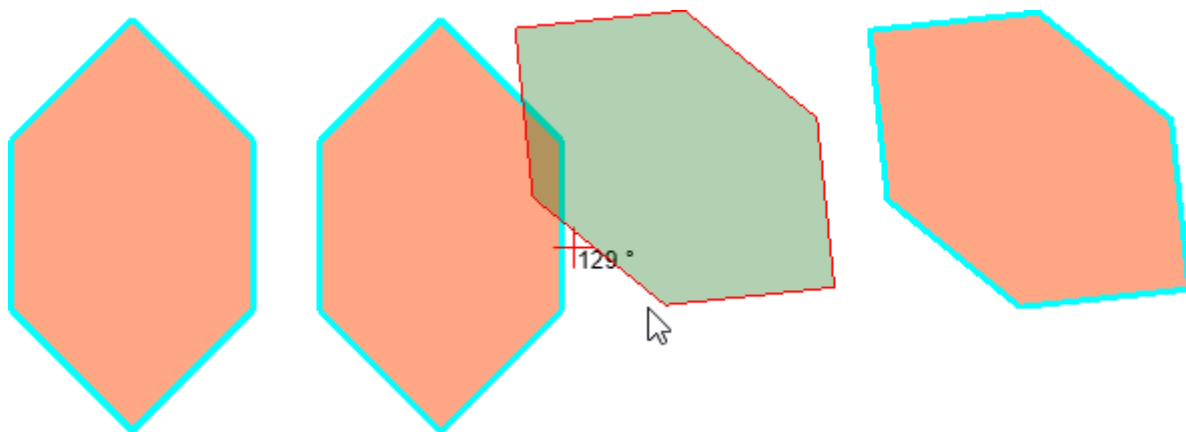


Figure 111: **Rotate Selected Graphics**, Example. Center of rotation (cross) with rotation angle

You can also enter the desired rotation angle. To do so, open the context menu with a right-click after setting the center of rotation, and select **Set Angle**. Enter the desired relative rotation angle in geographic degrees (i.e. "clockwise") and confirm with **OK**.

If you want to cancel **Rotate Selected Graphics**, press Esc. All selected features then retain their original orientation and location.

Note that graphics of the type **rectangle** and **circle/ellipse** are automatically converted to **polygons** when rotated. For more information, see e.g. chapter 5.2.6.1:

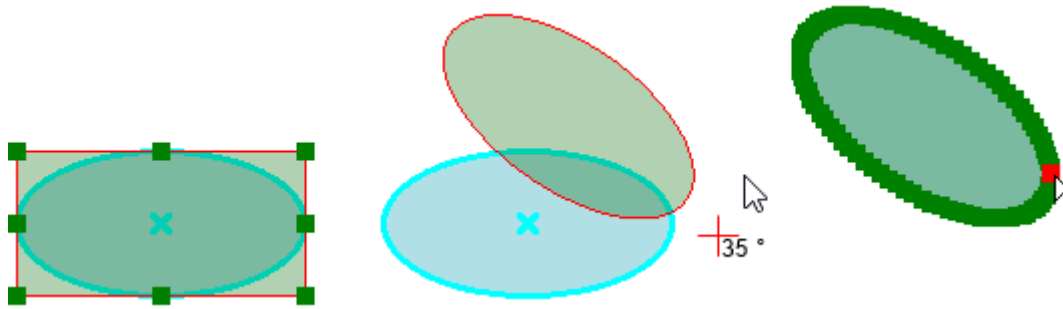


Figure 112: **Rotate Selected Graphics**, Example. Rotation an ellipse

The shape of the geometry remains unchanged but geometrical properties and edit behaviour alter.

The exact position of the rotated geometry/geometries can always be adjusted using e.g. the **Graphics Edit Tool** (see chapter 4.7.1).

Shortcuts, Key Commands, etc.:

- Esc while rotating: cancel
- Right mouse button while rotating: open context menu for entering the angle

4.7.3 Add AOI

In GAFmap Express: Graphics Toolbar

Only possible within the (2D) map window



Add AOI lets you create new AOIs ("Area Of Interest"; see chapter 5.2.2). To do this, simply activate the button, left-click into the map viewer, hold the mouse button, and drag the desired rectangle. Hold down the Alt key to create a square.

Each AOI is initially displayed with the AOI default symbology as simple red frame, but you can always change its symbology via the AOI properties (see chapter 5.2.2.4 and 5.2.1.10).

Shortcuts, Key Commands, etc.:

- Alt while dragging the rectangle: create square
- Double-click on layer icon in TOC: open Fill Symbols dialog (see chapter 6.3)
- Alt + double-click click on layer icon in TOC: open Line Pen dialog (see chapter 6.2)
- For more shortcuts, see chapter 4.7.6

Tips and notes:

- Please note that AOI graphics are not 3D-capable and are therefore only available as textures in the 3D Viewer (see chapter 2.2.3.2).
- For more tips and notes, see chapters 4.7.5 and 4.7.7.

4.7.4 Add Reference Point

In GAFmap Express: Graphics Toolbar



Add Reference Point lets you create new Reference Points (see chapter 5.2.3). To do this, simply activate the button and click into the map viewer. Each left-click on the map creates a new Reference Point at the corresponding position.


By default, a reference point's height is set to 0 above ground. If you hold Ctrl while creating a new reference point, the absolute height is entered instead. The prerequisite is that the reference point is placed on a digital elevation model (DEM; see chapter 5.3.4) from which the height can be interpolated. If multiple rasters are defined as DEM, always the DEM lying on top is used. This is also true if this DEM is disabled in the TOC. NoData areas and single-channel rasters that are not defined as DEM are not taken into account.

Each reference point is initially displayed with the Reference Point default symbology as little red cross, but you can always change its symbology via the Reference Point properties (see chapter 5.2.3.2 and 5.2.1.10).

Shortcuts, Key Commands, etc.:


- Ctrl when setting the Reference Point: interpolate absolute height from DEM
- Double-click on layer icon in TOC: open Point Symbols dialog (see chapter 6.1)
- For more shortcuts, see chapter 4.7.6

Tips and notes:

- Each Reference Point is marked with a  over layer icon.
- For more tips and notes, see chapter 4.7.5.

4.7.5 Add Point

In *GAFmap Express: Graphics Toolbar*

 **Add Point** lets you create new points (see chapter 5.2.4). To do this, simply activate the button and click into the map viewer. Each left-click on the map creates a new point at the corresponding position.

Each point is initially displayed with the default symbology set for new graphics (see chapter 4.7.17), but you can always change its symbology via the point properties (see chapters 5.2.4.2 and 5.2.1.10).

Shortcuts, Key Commands, etc.:

- Double-click on layer icon in TOC: open Point Symbols dialog (see chapter 6.1)
- For more shortcuts, see chapter 4.7.6

Tips and notes:

- For general information about graphics in GAFmap® Express, see chapter 5.2.
- Newly created graphics are added separately to the main group **Graphics**. If any graphic groups (subfolders) exist, they are added to the group that is currently active, i.e. selected in the TOC/ highlighted in blue.
- The default symbology of graphics can be modified using the **Symbology** button in the Graphics Toolbar (see chapter 4.7.17) or via the general settings under **Viewing** (see chapter 3.4.1.3).
- By default, new graphics are named after the geometry type. If you want the names for newly created graphics to be queried, activate the corresponding option in the general settings under **Other** (see chapter 3.4.1.8). A text input field then opens each time.
- Self-created graphics can be modified at any time using the **Graphics Edit Tool** (see chapter 4.7.1).
- Please note that simple point graphics are not 3D-capable and are therefore only available as textures in the 3D viewer (see chapter 2.2.3.2). Consider adding a 3D point if needed (see chapter 4.7.11).

4.7.6 Add Line

In **GAFmap Express: Graphics Toolbar**



Add Line lets you create new lines (see chapter 5.2.5). To do this, simply activate the button, draw a line with any number of vertices in the map viewer, and then end the edit sketch with a double-click or F2.

Each line is initially displayed with the default symbology set for new graphics (see chapter 4.7.17), but you can always change its symbology via the line properties (see chapters 5.2.5.4 and 5.2.1.10).

Shortcuts, Key Commands, etc.:

- Right-click while drawing: undo last vertex
- F2 while drawing: finish geometry
- F3 while drawing: set the length/angle of the next line segment, or the coordinates of the next vertex
- F4 while drawing: enable/disable tracing
- F6 while drawing: flip digitizing direction
- Esc while drawing: cancel
- Shift while drawing: enable snapping auxiliary line
- N: temporarily deactivate snapping
- Ctrl+Z/Ctrl+Y: Undo/Redo
- Double-click on layer icon in TOC: open Line Symbols dialog (see chapter 6.2)
- For shortcuts to adjust the display extent, see chapter 4.1.3

Tips and notes:

- Press the F3 key while drawing the sketch to set the length/angle of the next line segment, or the coordinates of the next vertex, the F4 key to enable/disable tracing.
- Please note that line graphics are not 3D-capable and are therefore only available as textures in the 3D Viewer (see chapter 2.2.3.2).
- For tips and notes, see chapter 4.7.5.

4.7.7 Add Rectangle

In GAFmap Express: Graphics Toolbar

Only possible within the (2D) map window



Add Rectangle lets you create new rectangles (see chapter 5.2.6). To do this, simply activate the button, left-click into the map viewer, hold down the mouse button, and then drag a rectangle. Press and hold the Alt key to create a square.

Each rectangle is initially displayed with the default symbology set for new graphics (see chapter 4.7.17), but you can always change its symbology via the rectangle properties (see chapters 5.2.6.2 and 5.2.1.10).

Shortcuts, Key Commands, etc.:

- Alt while dragging the rectangle: create square
- Double-click on layer icon in TOC: open Fill Symbols dialog (see chapter 6.3)
- Alt + double-click on layer icon in TOC: open Line Pen dialog (see chapter 6.2)
- For more shortcuts, see chapter 4.7.6

Tips and notes:

- Rectangle graphics are always upright. If you need a rotated rectangle, you can e.g. rotate the rectangle graphic afterwards (see chapter 4.7.2) or create a polygon graphic with right-angled corners (with F3 key; see chapter 4.7.8).
- With **Convert to Polygon** in the context menu of the Rectangle you can convert it into the graphic type polygon. The shape of the geometry does not change when converted, but its geometrical properties and editability (see chapter 5.2.6.1).
- Please note that rectangle graphics are not 3D-capable and are therefore only available as textures in the 3D Viewer (see chapter 2.2.3.2).
- For more tips and notes, see chapter 4.7.5.

4.7.8 Add Polygon

In GAFmap Express: Graphics Toolbar



Add Polygon lets you create new polygons (see chapter 5.2.7). To do this, simply activate the button, draw a polygon with any number of vertices in the map viewer, and then end the edit sketch with a double-click or F2.

Each polygon is initially displayed with the standard symbology set for new graphics (see chapter 4.7.17), but you can always change its symbology via the polygon properties (see chapters 5.2.7.2 and 5.2.1.10).

Shortcuts, Key Commands, etc.:

- Double-click on layer icon in TOC: open Fill Symbols dialog (see chapter 6.3)
- Alt + double-click on layer icon in TOC: open Line Pen dialog (see chapter 6.2)
- For more shortcuts, see chapter 4.7.6

Tips and notes:

- Press the F3 key while drawing the sketch to set the length/angle of the next line segment, or the coordinates of the next vertex, the F4 key to enable/disable tracing.
- Please note that polygon graphics are not 3D-capable and are therefore only available as textures in the 3D viewer (see chapter 2.2.3.2).
- For more tips and notes, see chapter 4.7.5.

4.7.9 Add Circle/Ellipse

In GAFmap Express: Graphics Toolbar

Only possible within the (2D) map window



Add Circle/Ellipse lets you create new circles or ellipses (see chapter 5.2.8). To do this, simply activate the button, left-click into the map viewer, hold down the mouse button, and then drag the circle. Press and hold the Alt key to create an ellipse. The radius in X-direction and the radius in Y-direction are displayed temporarily while digitizing. The center of the circle/ellipse is displayed as a cross. It can be hidden via the Circle properties (see chapter 5.2.8.2).

Each ellipse is initially displayed with the default symbology set for new graphics (see chapter 4.7.17), but you can always change its symbology via the Ellipse properties (see chapters 5.2.8.2 and 5.2.1.10).

Shortcuts, Key Commands, etc.:


- Alt while dragging the circle: create ellipse
- Double-click on layer icon in TOC: open Fill Symbols dialog (see chapter 6.3)
- Alt + double-click click on layer icon in TOC: open Line Pen dialog (see chapter 6.2)
- For more shortcuts, see chapter 4.7.6

Tips and notes:

- With **Convert to Polygon** in the context menu of the circle/ellipse you can convert it into the graphic type polygon. The shape of the geometry does not change when converted, but its geometrical properties and editability (see chapter 5.2.8.1).
- Please note that circle/ellipse graphics are not 3D-capable and are therefore only available as textures in the 3D viewer (see chapter 2.2.3.2)
- For more tips and notes, see chapter 4.7.5.

4.7.10 Add Text Label

In GAFmap Express: Graphics Toolbar

 **Add Text Label** lets you create new text labels (see chapter 5.2.9). To do this, simply activate the button and click into the map viewer where you want the text to be anchored. An input window opens. Type in the desired text and confirm with **OK**. You can still change the text later via the graphics properties and/or determine how it is positioned relative to the anchor point (see chapter 5.2.9.2).

Each text label is initially displayed with the default symbology set for new graphics (see chapter 4.7.17), but you can always change its symbology via the text label properties (see chapters 5.2.9.2 and 5.2.1.10).

Shortcuts, Key Commands, etc.:

- Double-click on layer icon in TOC: open Labeling dialog (see chapter 6.4)
- For more shortcuts, see chapter 4.7.6

Tips and notes:

- Please note that simple text labels are not 3D-capable and are therefore only available as textures in the 3D viewer (see chapter 2.2.3.2). Consider adding a 3D text label if needed (see chapter 4.7.12).
- For tips and notes, see chapter 4.7.5.

4.7.11 Add 3D Point

In GAFmap Express: Graphics Toolbar

Only available if the project contains a 3D window



Add 3D Point lets you create new 3D points (see chapter 5.2.12). Just activate the button and click at the desired target position in the (2D) map viewer or the 3D viewer. Each click creates a new 3D point with the set default symbology (see chapter 4.7.17).

Note that in 3D the points can only be placed on a surface, i.e. on DEMs, 3D models, three-dimensional graphic elements, or (extruded) features etc., and not into "empty space". If there is no 3D dataset on the screen at the clicked position, no point is created.

If you create the 3D point in 2D, 0 above ground is entered as **Height** by default. In 3D, the height is taken from the hit (terrain) surface and entered as absolute height. Thus, the point always sits exactly on the hit surface.

All 3D points are displayed in the TOC with the 2D point symbol defined for them.

Via the properties of a self-created 3D point, you can adjust its height, the position, and the (2D/3D) symbology including the labeling at any time (see chapter 5.2.12.1).

Dialog Add 3D Point

If you add 3D points in the 3D viewer, a dialog opens, where you can adjust the symbology of the last added 3D point:

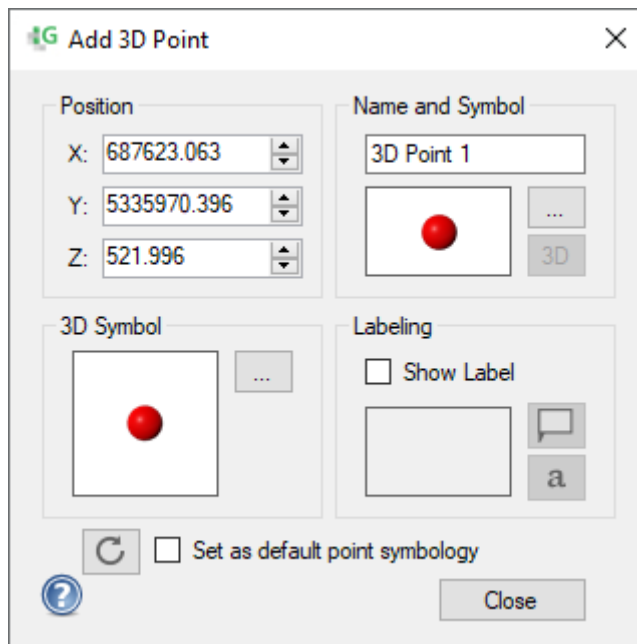


Figure 113: Add 3D Punkt dialog

- **Position:** shows the X/Y/Z coordinates of the 3D point in the map coordinate system. If desired, you can manually adjust the coordinates and move the 3D point into the "empty space" (e.g. above the terrain).
- **Name and Symbol:** determines the name and (2D) point symbol for the 3D point. The 3D point is listed with this name and layer icon in the TOC and is displayed with the selected point symbol in the (2D) map viewer.

... opens the (2D) **Point Symbols** dialog (see chapter 6.1)

3D uses the 3D point symbol as (2D) point symbol (as image).


Note: if for the default symbology for the 3D point the property **Generate 2D Point Symbol from 3D Point Symbol** is enabled (see chapter 4.7.17), the 3D point symbol is automatically adapted as (2D) point symbol.

- **3D Symbol:** determines the 3D point symbol for the 3D point. The 3D point is displayed with this symbol in the 3D viewer.

... opens the **3D Point Symbol** dialog (see chapter 6.6)


- **Labeling:** If **Show Label** is checked, the 3D point is labeled in the 3D viewer. You can then adjust the label style as follows:

☐ opens the **3D Labeling** dialog (see chapter 6.7). All settings you make here refer to the style of the 3D labeling panel.

 opens the (2D) **Labeling** dialog (see chapter 6.4). All settings you make here refer to the style of the text on the labeling panel.

As label text, the name of the 3D point (from the TOC) is used by default. You can always enter a different text via the properties of the 3D point (see chapter 5.2.12.1).

If **Show Label** is unchecked, the 3D point is not labeled in the 3D viewer (for the time being).

-  **Reset Symbology** resets all settings in the dialog to the default symbology for the 3D Point.
- **Set as default point symbology**: if checked, the symbology set in the dialog is used as new default symbology for new 3D points as soon as you click **Close**, i.e. the current default symbology is overwritten with the symbology from the dialog (see chapter 4.7.17). If unchecked, the default symbology remains unchanged.

All changes you make in the dialog are directly applied in the 3D viewer. With **Close** the dialog is closed.

Tips and notes:

- In the (2D) map viewer you can also change the position of a 3D point subsequently by using the **Graphics Edit Tool**. Note that the entered height remains unchanged. This is relevant if an absolute height is entered (not e.g. at "0 above ground"), because the 3D point in 3D then usually does not lie on the terrain after moving, but moves above/below the terrain surface.
- With default setting, 3D points are added with the symbol size unit **Pixel**. This has the advantage that newly added 3D points are always visible on the screen and you are, for example, never "inside the point". Disadvantage is that the feeling of distance/depth is lost. Via the general settings (see chapter 4.7.17) or the **Add 3D Point** dialog (see above) you can always adjust the default unit, e.g. to **Scene**. For more information on the **Size Unit**, see chapter 6.6.1.
- For information on adding 3D points in VR, see chapter 8.3.4.

4.7.12 Add 3D Text Label

In GAFmap Express: Graphics Toolbar

Only available if the project contains a 3D window



Add 3D Text Label lets you create new 3D Text Labels (see chapter 5.2.13). Just activate the button and click the position in the (2D) map viewer or 3D viewer where the 3D text label is to be anchored. Each click creates a new 3D text label with the set default labeling style (see chapter 4.7.17).

Note that in 3D the anchor point can only be placed on a surface, i.e. on DEMs, 3D models, three-dimensional graphic elements, or (extruded) features etc., and not into "empty space". If there is no 3D dataset on the screen at the clicked position, no 3D text label is created.

If you create the 3D text label in 2D, 0 above ground is entered as **Height** by default. In 3D, the height is taken from the hit (terrain) surface and entered as absolute height. Thus, the anchor point always sits exactly on the hit surface.

Via the properties of a self-created 3D text label you can adjust the height and the position of the anchor point as well as the label text and style at any time (see chapter 5.2.13).

4.7.13 Add View Point

In GAFmap Express: Graphics Toolbar

Only available if the project contains a 3D window



Add View Point lets you create/set new view points (see chapter 5.2.15). Activate the button and click at the desired target position in the (2D) map viewer or the 3D viewer. Each click creates a new view point.

Note that view points in 3D can only be placed on a surface, i.e. on DEMs, 3D models, three-dimensional graphic elements, or (extruded) features etc., and not into "empty space". If there is no 3D dataset on the screen at the clicked position, no view point is created.


- If you create a view point in 3D, the height is taken from the hit surface and entered as absolute **Height**. The point then rests directly on the surface. The **viewing angle** is automatically adjusted so that your current position is in the focus of the view point, i.e. exactly opposite the current viewing direction.
- Creating view points in 3D is recommended e.g. if you want to simulate the view from a certain point, like the view from a window. Simply position yourself at the point that

is to be in the focus of the view point and then place the point directly on the window / facade.

- If you create a view point in 2D, 500 above ground is entered as **Height** by default and the **Viewing Angle** is set to north and slightly downwards.
- Creating view points in 2D is recommended e.g. if you want to place it above a certain location, because points in 3D can only be set on the surface, but not above it (see above).


Via the properties of a self-created view point you can adjust its height and viewing angle at any time (see chapter 5.2.15.2).

Save current view in 3D Viewer


 **Save Current View Point** in the 3D Viewer toolbar lets you save your current view in the 3D viewer (see chapter 4.6.12). A view point is then created automatically whose height and viewing angle exactly match your current viewing position and direction.

Fly to View Points

In the 3D viewer, you can fly to view points from your current position and thus restore the saved view at any time. This is possible in the following ways:

- Via Alt + click on the layer name of the view point in the 3D TOC.
- Via the command  **View from Point** in the context menu of the view point (see chapter 5.2.15.1).
- Via the keys 1-9, if the 3D window is active (highlighted): with 1 the topmost view point in the TOC is approached, with 2 the second, with 3 the third, etc.

If necessary, click on the frame of the 3D window once, to activate it.

- Via the  Play button in the 3D Viewer toolbar (see chapter 4.6.13) when a view point is selected (highlighted in blue) in the TOC.

In all cases, a 3D flight animation is started, which takes you from your current position directly to the saved view. The flight can always be stopped or paused by using the corresponding buttons in the 3D Viewer toolbar (see chapter 4.6.13 et seq.).

Shortcuts, Key Commands, etc.:


- Alt+click on a view point's layer name in the 3D TOC: start animation
- Key 1-9, while the 3D window is aktiv: fly to 1st-9th view point in the TOC

- Esc while animation: cancel animation
- I while animation: cancel streaming

4.7.14 Add Viewshed Point

In GAFmap Express: Graphics Toolbar



Add Viewshed Point lets you create a new 3D point that by default has the property **Use for Viewshed = On** (indicated by the  viewshed symbol next to the point symbol). Such a viewshed point (VSP) defines a starting point for the on-the-fly viewshed, i.e. a (view)point from which the visibility of the terrain is analyzed.

For more information on the viewshed, see chapter 4.5.6 or, especially on viewshed in the 3D Viewer, chapter 4.6.6.

Workflow


VSPs can be created in the (2D) map viewer or the 3D viewer. Proceed the same way as when creating a "normal" 3D point (see chapter 4.7.11).

Note especially regarding VSPs:

- If you set a VSP in the 3D viewer, unlike as for a 3D point, not the height taken from the terrain is entered as absolute **Height**, but "height taken + eye height". You can view and adjust the **Eye Height** in the general settings under **Viewing** (see chapter 3.4.1.3). If you add the VSP in the (2D) map viewer, the entered **Height** is analog "eye height above ground" (instead of 0 above ground as for the 3D point).


Note: If you subsequently convert 3D points to VSPs by setting the property **Use for Viewshed** to **On** (see chapter 5.2.12.1), the entered height remains unchanged, i.e. the eye height is not added. The same applies vice versa.

- If a **Click Position Offset [m]** is specified in the Map properties, this is additionally applied (see chapter 5.1.7). It causes VSPs to be moved a certain, usually small distance away from the clicked target position opposite the current viewing direction. VSPs are thus slightly lifted off the (terrain) surface, which helps to avoid unwanted optical effects (artifacts), especially on rough terrain, (building) edges or facades.
- You can also place VSPs in 3D on vertical surfaces such as facades, e.g. to analyze the visibility from a window. In this case, you can subsequently limit the **Sector Angle** via the VSP properties so you only look "forward", i.e. "out of the window" (see chapter 5.2.12.1).

All VSPs are added as  **Viewshed Point** under the main group **Graphics** in the TOC. Via the VSP's properties, you can always adjust the assigned height and position, the viewing distance and sector angle, and the (2D/3D) symbology including the labeling (see chapter 5.2.12.1 or 5.2.1.10).

If not already active, the on-the-fly viewshed rendering is automatically enabled as soon as a new VSP is set. However, it can always be disabled and re-enabled through **Enable/Disable Viewshed** in the Map Viewer toolbar.

Moving self-created Viewshed Points

 **Add Viewshed Point** also lets you move self-created VSPs to another location. Simply run the mouse pointer over the VSP until it turns into a moving arrow. You can now grab the VSP with a left-click, drag the VSP to the desired position by holding down the mouse button, and then release it. As long as you hold down the mouse button, you can move the VPS freely to any position. If the on-the-fly viewshed rendering is enabled, it is updated directly while the VSP is moved.


You can also move existing VSPs with the **Graphics Edit Tool** (see chapter 4.7.1). If you use this tool, the on-the-fly viewshed rendering is not updated until the VSP is finally placed (i.e. not while it is moved).

Tips and Notes:

- The property **Use for Viewshed** can always be switched on/off for self-created VSPs / 3D points. This way you can, for example, exclude a VSP from the on-the-fly viewshed without having to delete or disable it.

4.7.15 Add Sight Line

In GAFmap Express: Graphics Toolbar

 **Add Sight Line** lets you create a line graphic that allows you to see whether a particular target point is visible from an observer's position.

Such a sight line is only possible if the project contains a digital elevation model marked as DEM (see chapter 5.3.4).

Workflow in 2D

Proceed as follows to create a sight line in the (2D) map viewer:

- Click the **Add Sight Line** button
- Click on the desired start point (= observer's position) in the map viewer. As soon as the starting point is placed, the sight line is displayed. You can now move it in any direction. The visibility is then displayed on-the-fly for the current target point (= mouse position/head of arrow):



Figure 114: Example for creating a Sight Line

The green part is visible from the observer's position, the red part is invisible. In case the target position is not visible, you can easily identify where the sight obstacle is located on the sight line, as the arrow's color changes from green to red at this point.

- Finalize the sight line by double-clicking the target position. The sight line is then added to the TOC as a Sight Line graphic.

By default, a start height (eye elevation) of 1.75m is used for the observer when creating the sight line, and a target height of 0m. You can adjust the default heights in the general settings under Viewing (see chapter 3.4.1.3). For self-created sight lines, you can also change the height values via the respective layer properties (see chapter 5.2.18.1).

Workflow in 3D

Sight lines can also be visualized and created in the 3D viewer. Note that in 3D start point and end point can only be set on a surface, i.e. on DEMs, 3D models, three-dimensional graphic

elements, or (extruded) features etc., and not into "empty space". If there is no 3D dataset on the screen at the clicked position, the point is not created.

When creating a sight line in the 3D viewer, the (terrain) height at the start point and target point is taken from the base elevation model. In the Sight Line properties, the following absolute heights are then entered for **Eye Height** and **Target Height**:

- **Eye Height** = taken terrain height + (general) **Eye Height**
- **Target Height** = taken terrain height + (general) **Target Height**

Note: When creating a sight line in 2D, the same applies. However, no terrain heights are taken, but relative heights are entered, i.e. (general) eye height and (general) target height "above ground".

Tips and notes:

- Unlike the 3D viewshed (see chapter 4.6.6), for the sight line only DEMs are considered, even in 3D.

4.7.16 Open Multimedia

In GAFmap Express: Graphics Toolbar



Open Multimedia lets you open linked multimedia objects (see chapter 5.2.19) by clicking the respective link(s) within the map viewer. To do this, simply activate the button and click the link to be called up in the map viewer with the mouse pointer ("finger"). The multimedia object is always opened with the assigned standard program for the respective file type, e.g. URLs are opened with the standard internet browser or PDFs with Acrobat Reader etc.

Alternatively, you can open a linked multimedia object via **Open Multimedia** in the Multimedia context menu (see chapter 5.2.19.1).

4.7.17 Symbology

In GAFmap Express: Graphics Toolbar



Symbology takes you to a Properties window, where the default symbology for graphics can be checked and modified. If applicable, the listed predefined properties are initially applied to all newly created graphics.

This default symbology for graphics can also be set in the general settings under **Viewing**. Settings made there are automatically applied here and vice versa. For more information and an explanation of the individual Symbology properties, see chapter 3.4.1.3.

You can always customize the symbology for Graphics subsequently via the Graphics properties. For more information, see chapter 5.2.

5 GAFmap Layers (Context Menus)

Right-clicking selected (highlighted in blue) (main) groups, graphics and/or layers in the TOC opens a context menu containing functions and commands specifically tailored to the source element(s). Which functions are included depends primarily on the level in the TOC, the number, and the type of the selected elements. Hence, the context menu for the main group Graphics is different from that of a graphics group, and the context menu of a layer group contains different functions than that of a single raster etc.

The following chapters cover all the functions/commands that appear in the different context menus.

Selecting Elements in the TOC

You can select an element in the TOC with a simple left-click (on the layer icon or name); it is then highlighted in blue. Multi-selection is possible e.g. by holding down the Ctrl or Shift key.

Alternatively, you can select graphic elements and layers in the map viewer with **Select Layer** (see chapter 4.1.10) and graphic elements with the **Graphics Edit Tool** (see chapter 4.7.1). They are then also highlighted in blue in the TOC.

Shortcuts, Key Commands, etc.:

- Left-click on element in the TOC: select element
- Ctrl when selecting: add selection to current selection. Already selected features are deselected when they are selected twice.
- Shift when selecting: select consecutive elements (Ctrl + click on first and last element to be selected)
- Ctrl+A within TOC: select all layers
- Right-click on individual / multiple selected elements in the TOC: open context menu
- X: toggle layer(s) selected in TOC (with multiple map windows only in the active one)
- C: toggle layer(s) selected in TOC globally (with multiple map windows in all windows)
- Alt + left-click on a selected layer, graphic, or group in the TOC: zoom to element
- Alt + checking a layer, graphic, or group in the TOC: zoom to the checked element

5.1 Map

5.1.1 Zoom to Full Extent

In GAFmap Express: TOC > Context Menu Map



Zoom to Full Extent zooms the map extent to the full extent of all loaded datasets (see also chapter 4.1.6).

Shortcuts, Key Commands, etc.:

- Alt + left-click on selected layer(s)/group(s) in the TOC: zoom to layer(s)/group(s)

5.1.2 Set Map Scale

In GAFmap Express: TOC > Context Menu Map

1:1 **Set Map Scale** opens a dialog where you can enter a desired map scale; pre-entered is the current scale. If you confirm with **OK**, the (associated) map viewer is zoomed accordingly and the scale displayed in the main toolbar is adjusted. **Cancel** closes the dialog without further action.

Tips and notes:

- Alternatively, the map scale can be set directly via the scale field in the main toolbar (see also chapter 4.1.7).

5.1.3 Find Layer

In GAFmap Express: TOC > Context Menu Map



Find Layer lets you search the TOC for layers with a specific name or name component. After calling up the command, a dialog opens. Enter any character string and confirm with **OK**. All elements below the main groups that contain this character string are then selected in the TOC (highlighted in blue). If the search is unsuccessful, a corresponding message appears.

The search is not case-sensitive. * serves as a placeholder/wildcard.

5.1.4 Collapse All / Expand All

In GAFmap Express: TOC > Context Menu Map



Collapse All / Expand All lets you fully collapse/expand all groups, subgroups, and layers under the main groups in the TOC at once (see also chapter 2.2.2.2).

If you only want to expand/collapse selected groups and/or layers, use the corresponding command at group or layer level (see chapter 5.2.1.9 or 5.3.1.6), or the forward or back arrow keys.

Shortcuts, Key Commands, etc.:

- Arrow key back (with mouse focus on TOC): collapse selected groups and/or layers in the TOC
- Arrow key forward (with mouse focus on TOC): expand selected groups and/or layers in the TOC

5.1.5 Show Project Info

In GAFmap Express: TOC > Context Menu Map

Only available if a project info is saved

If a project info is available for the project, i.e. if the map property field **Project Info** contains an entry, then this info can be called directly from the map's context menu via the command **Show Project Info**. The project info is then displayed in a separate window, either as plain text or with (HTML) formatting, depending on the form of the entry.

5.1.6 Reset Properties

In GAFmap Express: TOC > Context Menu Map

Only available if the project contains a 3D window



Reset Properties resets any map properties that you may have changed to as they are set in the original project (i.e. "as stored in *.cmp").

5.1.7 Properties

In GAFmap Express: TOC > Context Menu Map




Only available if the project contains a 3D window

 Under **Properties**, all essential properties of the map / 3D scene are listed.

Many of the properties that can be set here are 3D viewer-specific and affect the visualization of the data in the 3D viewer in general and/or the display of the 3D viewer itself, i.e. the "empty space" in which the data is visualized. These properties are only available if the project contains a 3D window.

Project

Here, basic information about the project is shown.

- **Project File Path:** shows the file path to the project file (*.cmp).
 opens project file path in a textbox
- **Spatial Reference:** shows the project/map spatial reference.
 opens a window with more detailed information about the map spatial reference
- **Project Info:** if available, additional information about the project can be viewed here (e.g. general information about the map, a project editor, data sources, etc.)
 opens the Project Info window

If a project info is entered, it can alternatively be called up via **Show Project Info** command in the map context menu (see chapter 5.1.5); texts with HTML syntax are then usually displayed formatted (here always as source text)


Lighting Direction

These properties influence the position of the virtual light source ("sun"), which is used to calculate the (on-the-fly) shading and shadows in 2D and 3D (see chapters 4.5.4 et seq. (for 2D) and 4.6.4 et seq. (for 3D)).


If you use **SkyBox** textures as background mode (see below), the virtual light source is displayed as "sun in the sky" at the right position.

- **From Date/Time:** determines whether the position of the virtual light source is defined via **Date [UTC]** and **Time [UTC] (On)**, or via **Azimuth** and **Elevation (Off)**.


- **Date [UTC]** (*only available if From Date/Time = On*): specifies the point in time for which the position of the sun and thus the position of the virtual light source "on site" is calculated. Type in the desired date or select it from the calendar.

 opens a calendar

Time [UTC] (*only available if From Date/Time = On*): specifies the time of day for which the position of the sun is calculated for the given date. Type in the desired time or use the slider.

 opens a slider

- **Azimuth [°]** (*only available if From Date/Time = Off*): specifies the cardinal direction from which the virtual light source shines. Enter the geographical angle, i.e. clockwise to north (0° = north, 90° = east, 180° = south and 270° = west). If you enter negative angles or angles $\geq 360^\circ$, these are converted to the value range of [0;360°[.

 opens a slider

Elevation [°] (*only available if From Date/Time = Off*): specifies the elevation of the virtual light source. You can enter angles from -90° (vertical from below) to 0° (on the horizon) to 90° (vertical from above; at the zenith). If you enter angles $> |90^\circ|$, these are set to 90°. For actually needed angles of $|90^\circ-180^\circ|$, switch the azimuth instead!

 opens a slider

Tip: If you use the sliders, the lighting conditions in the map viewer are updated on-the-fly.

Lighting

These properties only affect the lighting in the (2D) map viewer. They influence the intensity of the virtual light source. If lighting and shadows are deactivated (see chapters 4.5.4 et seq.), these properties have no effect (i.e. they do not influence, for example, the general brightness in the map viewer).

- **Ambient** (*affects Lighting and Shadows*): determines the initial brightness of the map. Enter values from 0 (completely dark) to 1 (maximum brightness).

The higher the initial brightness, the brighter (less intensive) shadows are drawn.

- **Specular** (*only affects Lighting*): determines the brightness of the light reflected by the surface. Enter values from 0 (completely dark) to 1 (maximum brightness).
- **Shininess** (*only affects Lighting*): determines the reflection properties of the surface (albedo). Enter values from 0 (no reflection) to 100 (maximum reflection)
- **Shading Contrast** (*only affects Lighting*): determines the contrast between shaded and unshaded areas. The higher the value, the greater the contrast between areas facing the light and areas facing away from the light. Recommended are values between 1


(low contrast) and 10 (high contrast). However, in areas with low relief, higher values may be necessary.

3D Lighting


Only available if the project contains a 3D window

These properties only affect the lighting in the 3D viewer. They affect the lighting situation in the 3D viewer in general, i.e. the light in the "surrounding 3D space", regardless of loaded layers.

- **Ambient:** determines the initial brightness of the scene, i.e. how bright a point without any illumination is displayed. The directional light of the virtual light source is added to the basic brightness. Values between 0 (completely dark) and 1 (maximum brightness) are available for ambient. The Ambient setting also affects the intensity of shadows.

 opens a slider

- **Ambient Reflections:** determines how strongly light is reflected by non-metallic, "natural" surfaces. The lower the value, the less these surfaces reflect. Areas and structures are then displayed more realistically without appearing unnaturally metallic. At high values, non-metallic surfaces also appear metallic.

 opens a calendar

The lower the set **Roughness** (see chapter 5.3.4.1), the stronger the effect.

Tip: Use **Ambient Reflection** in combination with **Skybox Textures** (see below) to achieve a realistic representation of objects and surfaces in open air.

3D Viewer

Only available if the project contains a 3D window

- **Exaggeration:** Here, you can add a vertical exaggeration, i.e. an enlargement of the height scale in relation to the scale of length. This is usually applied to intensify the stereoscopic impression of the data. 1 means that height scale and scale of length are equal (no exaggeration), for values > 1 the height scale is enlarged by the respective factor. You can add an exaggeration up to 20.
- **Background Mode:** Here you can adjust the background in the 3D viewer, i.e. the appearance of the "empty space" in which the 3D data is located. At choice are:

- **Constant Color:** The background is displayed in one color.

Via **Background Color** you can then specify the color to be used.

 opens the colour picker dialog (see chapter 6.5)

Via **Use Fog** you can determine whether the data in the 3D viewer is superimposed by fog (**On**) or not (**Off**). If **On**, specify the desired maximum visibility via **Fog Max Viability [m]**. The lower the entered value, the more restricted your visibility is, and the more details disappear in the fog/background. The fog appears in the specified background color.

- **Color Gradient:** The background is displayed with a grey to blue color gradient.
- **SkyBox Textures:** The background is represented by a sky texture. In addition, the current position of the sun is simulated according to date and time of day or to azimuth and elevation, and a respective twilight effect is applied. The sky texture theme can be specified via **SkyBox**.

3D Labeling

Only available if the project contains a 3D window

These properties affect all labels in the 3D viewer across all layers:

- **Prevent Overlaps:** if **On**, overlapping of 3D labels / label boards in the 3D viewer is prevented. 3D labels are then hidden when they are covered by another 3D label that is closer to the current viewing position. This applies across layers and independent of the type of 3D labeling.

If required, you can prioritize 3D labels differently via a **Label Priority**, e.g. to achieve that certain labels are always displayed (see e.g. chapter 5.2.1.10 or 5.3.2.5).

Via **Prevent Overlaps Delay [ms]** you can then define a delay, after which the labels are hidden or shown again when you move in the 3D viewer, i.e. when the viewing position changes. The greater the entered delay, the later the labeling changes. Especially if you play back flight animations or record flights, a longer delay time can avoid, that the labeling switches too fast or too often.

If **Prevent Overlaps** is turned **Off**, all activated 3D labels are drawn, regardless of whether they overlap or not. In this case, also covered and unreadable labels are displayed. Please note that it has a negative effect on the performance if many labels are displayed.

Viewshed

Only available if the project contains a 3D window

These properties affect the 3D viewshed (see chapter 4.6.6):

- **Click Position Offset [m]:** the offset specified here is always applied when a Viewshed Point (VSP) is newly created in the 3D viewer; it causes the VSP to be offset from the clicked target position by the specified distance. Usually, the click position offset is

used to slightly lift the VSPs off the (terrain) surface in order to minimize unwanted optical effects (artifacts) that can be caused by an uneven surface, especially in the direct surroundings of a VPS.

The offset is always performed towards your current viewing direction.

Stereoscopic View

Only available if the project contains a 3D window

Here, you can select a stereoscopic technique with which the data is visualized in the 3D viewer. Available are:

- **Deactivated:** if selected, no stereoscopic view is used.
- Technique **Anaglyph:** if selected, an anaglyph rendering is applied to the 3D viewer. In combination with suitable anaglyph glasses, you get a more intense three-dimensional impression of the data.

The anaglyph rendering can be configured via the settings listet below (see below).

You can also enable the anaglyph rendering via the respective button in the 3D viewer Toolbar (see chapter 4.6.7).

- Technique **Side by Side:** if selected, a stereo image pair is output in the 3D viewer. This is primarily intended for the presentation via 3D-ready television screens. If you use this method, you should switch to full screen mode and select side-by-side in the the screen's menu. This method can also be used to create side-by-side videos that can be shown on 3D-capable devices.

The side-by-side rendering can still be configured via various settings (see below).

- Technique **DirectX Stereo** (*only available if DirectX Stereo support is enabled; see chapter 4.6.19*): if selected, the 3D viewer is displayed on a Direct3D 11.1 Stereoscopic compatible screen. Prerequisite is that the respective hardware (e.g. shutter glasses/emitter/display, a corresponding 3D-TV, or a stereo station) is connected and installed.

The stereo rendering can still be configured via various settings (see below).

You can also enable the DirectX stereo rendering via the button **Enable/Disable DirectX Stereo** in the 3D Viewer toolbar (see chapter 4.6.8).

- Technique **Oculus Rift, SteamVR, or OpenXR** (*only available if the correspondig interface is enabled; see chapter 4.6.19*): if selected, the 3D viewer is output on the displays of the VR headset. Prerequisite is that a VR headset is connected and ready for operation. Always select the interface here via which your headset is actually addressed.

The VR display can be configured via various settings (see below).

You can also enable the the VR output via the respective button in the 3D Viewer toolbar (see chapter 4.6.9 et seqq.).

The stereoscopic views mentioned above (Technique = **Anagly**, **Side-by-Side**, or **DirectX Stereo**) can be configured via the following properties:

- **Stereo Color Mode** (*only with Technique = Anaglyph*): determines the color mode used for anaglyph rendering.
- **Use Virtual World Scale = On:**
 - **Virtual World Scale:** sets the scale for the virtual world. A value of 1 (= 1:1) corresponds to a real scale. A smaller scale, e.g. 1:200, causes the virtual world to appear smaller, which increases the stereo impression and thus makes it easier to estimate relative distances and sizes.
 - **Screen Offset Factor:** adjusts the **Virtual World Scale** to the size of the monitor used. An adjustment is only necessary if you want to display the 3D viewer on very big screens or a projector. For a correct adjustment of the Screen Offset Factor, start with a small value and increase it as long as you can comfortably focus on distant objects. You can use shortcuts F3/F4 to decrease/increase the **Screen Offset Factor**.
- **Use Virtual World Scale = Off:**
 - **Focus Distance:** determines the distance of objects that seem to be right on the screen surface. Smaller values virtually make the objects appear to be behind the screen surface, higher values make them appear in front.
 - **Stereo Depth:** determines the stereo depth's exaggeration. The default value of 0.3 can usually be retained. If you use a big screen or the stereo impression seems to get lost, you can try a lower value to reach a better result.

The VR views mentioned above (Technique = **Oculus Rift**, **Steam VR**, or **OpenXR**) can be configured via the following properties:

- **Resolution:** shows the resolution used for the virtual reality hardware.

When using the Oculus Rift interface, the resolution used can be adjusted via the **Pixel Density Factor** in the configuration dialog (see chapter 4.6.19). For SteamVR, the resolution can be scaled via the SteamVR settings in Steam, and for Windows Mixed Reality (WMR) headsets, there is a corresponding setting in the Mixed Reality Portal app of Windows.

- **Virtual World Scale:** sets the scale for the virtual world. A value of 1 (= 1:1) corresponds to a real scale. A smaller scale, e.g. 1:200, causes the virtual world to appear smaller,

which increases the stereo impression and thus makes it easier to estimate relative distances and sizes.

- **Tracking-Positional Streaming:** specifies whether the tracking position of the VR headset affects the streaming (**On**) or not (**Off**). Disable this option on a trial basis if you notice unwanted interruptions while looking around, which may be caused by reloading data. Please note that the given position may not be displayed in the highest **Level of Detail** (LOD, see also chapter 5.3.4.1) if you have moved too far away from the original position. If this option is disabled, you should center your position regularly (see chapter 8.2), especially when mounting the VR headset or physically moving away from the original position.

For more information on Virtual Reality mode (general notes, controls, possible actions, etc.), see chapter 8.

HUD / Visual Hints

Only available if the project contains a 3D window

These properties affect the visual hints / navigation aids in the 3D viewer (HUD = head-up-display):

- **HUD Color:** determines the color of compass band and crosshair. Info text in the top right or bottom right corner of the 3D viewer, e.g. on streaming or rendering, is also displayed in this color.



opens the Color Picker dialog (see chapter 6.5)

- **HUD Scaling:** determines the size of compass needle, compass band and crosshair. Info text in the top right or bottom right corner of the 3D viewer, e.g. on streaming or rendering, is also displayed with this scaling.



opens a slider

- **Show Compass Needle:** if **On**, a compass needle is shown in the 3D viewer's upper left corner. The needle rotates and tilts with the 3D view; the red tip always points north.

The size of the compass needle depends on the **HUD Scaling**.

If **Off**, no compass needle is displayed.

- **Show Compass Band:** if **On**, a compass band is shown at the 3D viewer's upper and left edge. The band at the upper edge shows the horizontal viewing direction, i.e. which cardinal direction you are currently facing. Indicated is the azimuth angle and the main cardinal direction (0°/N = north, 45°/NE = northeast, 90°/E = east etc.). The band at the left edge shows the vertical viewing direction, i.e. the inclination of the 3D view towards the horizon. Indicated is the angle of inclination (0° = horizontal viewing direction; 90°/-90° = vertical viewing direction from above/below).

The color of the compass band depends on the **HUD Color**, the size on the **HUD Scaling**.

If **Off**, no compass band is displayed.

- **Show Crosshair:** determines whether a crosshair is displayed in the 3D viewer. Available for selection are:
 - **Deactivated:** no crosshair is displayed.
 - **Centered Cross:** a cross at the screen center of the 3D viewer is displayed.
 - **Horizontal Line:** a horizontal line at the horizon is displayed. On this line, the height of the virtual viewer "above sea level" is displayed, i.e. the height from which you are looking at the data in the 3D viewer.
 - **Both:** a centered cross and a horizontal line are displayed. This is helpful "when flying" / navigating, for example: if the centered cross and the horizontal line are aligned, you are moving exactly horizontally.
- **Show Coordinate System:** if **On**, the 3D viewer's coordinate system is displayed. The axes are colored as follows:
 - X-axis: red
 - Y-axis: green
 - Z-axis: blue

In the coordinate system, a white vector beam indicates the direction of lighting. If you change the position of the virtual light source (see above), the beam moves accordingly

If **Off**, no coordinate system is displayed.


Horizontal Plane

Only available if the project contains a 3D window

- **Show Plane:** if **On**, a single horizontal plane is displayed in the 3D viewer. This plane can for example be used to simulate a certain ground or water level.

The plane does not go to infinity in the 3D viewer. Its extent always corresponds to the full extent of the data in the project (not e.g. the extent loaded into the 3D viewer). If you want the plane to extend further than the displayed data, mark the desired extent in the (2D) map viewer, e.g. with point graphics. The plane is then extended accordingly.

The following properties can be assigned to the horizontal plane:

- **Plane Height [m]:** determines the absolute height at which the plane is placed.
 -  opens a slider
- **3D Material:** specifies the 3D material used to texture the plane.

 opens the 3D Material dialog

Note that a realistic representation of the water texture like in the open sky can only be achieved if a **SkyBox** is used as background for the 3D viewer (see above).

Streaming

Only available if the project contains a 3D window


- **View Dependent Streaming** (*only available if VR, Viewshed, and Shadows are disabled*): if **On**, the camera's viewing direction while streaming is used (not only the camera's distance and position). This enhances the visualization quality for areas that lie in the user's field of view.

5.2 Graphics

In GAFmap®, **graphics** are simple (vector) geometries, symbols, and forms of any type that are located within the map by coordinates. Unlike **layers** (see chapter 5.3), graphics do not refer to an external data set, but are directly stored in the project file (*.xmp) contained in the Pack&Go Container (*.cmp), or, for graphics that are self-created in GAFmap® Express, in the sidecar file (*.cmpaux).



Each graphic is listed individually under the main group **Graphics** in the TOC and thus forms its own "graphics layer". Compared to vector layers,
















- graphics are attribute-free, i.e. they do not have any additional information besides geometry and location.
- graphics do not consist of multiple features, but always of a single geometry.

Different from layers, you can always add new graphics to a Pack&Go project via the Graphics toolbar (see chapter 4.7). Subsequently added graphics, i.e. graphics that are not included in the original Pack&Go container, are marked with a  green star in the TOC and can be edited or deleted as desired. All other graphics are unchangeable. This concerns both the geometry and the properties

Types of Graphics

The following types of graphic elements can occur. Graphic types, which you can add by yourself to the project in GAFmap® Express are marked with a green star:

-  AOIs (see chapter 5.2.2)
-  Reference Points (see chapter 5.2.3)

-  Points,  Lines,  Rectangles,  Polygons,  Circle/Ellipses and Labels (see chapter 5.2.4 et seqq.)
-  3D Points and  3D Text Labels (see chapter 5.2.12 et seq.)
-  3D Models (see chapter 5.2.14)
-  Viewshed Points and  Sight Lines (see chapter 5.2.17 et seq.)
-  Flight Lines and  View Points (see chapter 5.2.15 et seq.)
-  Images and  Multimedia Links (see chapter 5.2.10 or 5.2.19)
-  Auxilliary Grid (see chapter 5.2.11)

Selecting Graphics

You can select a graphic element or graphics group in the TOC with a simple left-click (on the icon or name); it is then highlighted in blue. Multi-selection is possible e.g. by holding down the Ctrl or Shift key.

Alternatively, you can select graphic elements in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) or **Select Layer** (see chapter 4.1.10). They are then also highlighted in blue in the TOC.

Context Menu

Right-clicking the main group **Graphics**, selected groups or graphics in the TOC takes you to a context menu that provides various functions or commands specifically for the selected elements. The content of the context menu depends on the level, number, and type of the selected elements, and on whether the project contains a map viewer and/or a 3D viewer and whether you have created a graphic/group yourself or it is part of the original project.

The context menu of selected graphics can also be opened by right-clicking into the map viewer with the **Graphics Edit Tool** (see also chapter 4.7.1).

Shortcuts, Key Commands, etc.:

- Left-click on element in the TOC: select element
- Ctrl when selecting: add selection to current selection. Already selected features are deselected when they are selected twice.
- Shift when selecting: select consecutive elements (Ctrl + click on first and last element to be selected)
- Right-click on individual / multiple selected elements in the TOC: open context menu

- X: toggle graphic(s), layer(s), and/or group(s) selected in TOC (with multiple map windows only in the active one)
- C: toggle graphic(s), layer(s), and/or group(s) selected in TOC globally (with multiple map windows in all windows)
- Alt + left-click on a selected layer, graphic, or group in the TOC: zoom to element
- Alt + checking a layer, graphic, or group in the TOC: zoom to the checked element

5.2.1 All Graphics and Graphics Groups

In GAFmap Express: TOC > Graphics

A right-click on one or multiple selected graphic elements or graphics groups in the TOC opens their context menu. The content of the context menu can differ depending on the type and number of selected elements, as well as whether a graphic is included in the original project or is self-created.

This chapter covers all functions and commands that potentially appear in the context menu of all graphic elements or graphics groups (incl. the main group **Graphics**). Functions that are only available for certain graphic types, follow in the chapters 5.2.2 to 5.2.19.

Tips and notes:

- The context menu of selected graphics can also be opened by right-clicking into the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1).

5.2.1.1 Zoom To Layer / Zoom to Selected Layers

In GAFmap Express: TOC > Graphics > Context Menu All Graphics and Graphics Groups



Zoom to Layer (in case of a single selected element) or **Zoom to Selected Layers** (in case of multi-selection) zooms the map to the extent of the element(s) currently selected in the TOC. If the selection holds only a single point, the map extent is centered on this point.

Zoom to Selected Layers is also available if the multi-selection contains TOC elements of any type (i.e. graphics, layers, and/or groups).

Zoom To Layer in the 3D Window

If you execute the command in the 3D TOC, a flight animation to the layer is performed in the 3D viewer. You then fly from your current view point on the shortest way to a view point from

which you have a complete overview of the layer. You can define the desired **Zoom To Flight Duration** in the general settings under Other (see chapter 3.4.1.8).


Shortcuts, Key Commands, etc.:

- Alt + left-click on a selected layer, graphic, or group in the TOC: zoom to element
- Alt + checking a layer, graphic, or group in the TOC: zoom to the checked element

5.2.1.2 Remove / Remove Selected

In GAFmap Express: TOC > Graphics > Context Menu All Graphics and Graphics Groups

Only available for self-created graphics and groups

 **Remove** (in case of a single selected element) or **Remove Selected** (in case of multi-selection) removes the currently selected element(s) from the TOC/project. The process is only completed if it is confirmed in the following dialog box.


Shortcuts, Key Commands, etc.:

- Del while focus on TOC (*only for self-created graphics and groups*): remove selected graphics or groups

5.2.1.3 Move to Top / Move to Bottom

In GAFmap Express: TOC > Graphics > Context Menu All Graphics and Graphics Groups

Only available for self-created graphics and groups

 **Move to Top/Bottom** moves one or multiple selected graphics and/or groups within the main group Graphics in the TOC to the top/bottom.

If multiple elements are selected, they are moved in the order in which they were selected. So if you first select element A and then element B and move them to the top, B will be at the very top and A in second place.

Please note when moving groups: If the group level is selected, the entire group is moved. If elements below the group are selected, these are moved individually, i.e. independently of the group.

5.2.1.4 Add Graphics Group / Move to New Group

In GAFmap Express: TOC > Graphics > Context Menu All Graphics and Graphics Groups



If the main group Graphics or a single graphics group is selected, then **Add Graphics Group** lets you create a new graphics group below the source group (i.e. a new subfolder). Afterwards, you can add new graphics directly to this group or drag and drop self-created graphics (subsequently) into it.

After calling the command a dialog opens. Enter the name for the new group and confirm with **OK**. You can change the name at any time.



Alternatively, you can group selected elements below the main group Graphics with **Move to New Group** (subsequently) to a new graphics group. The command is available as soon as multiple graphics or groups below the main group are selected in the TOC and if the selection contains only self-created graphics and/or groups.

5.2.1.5 Ungroup

In GAFmap Express: TOC > Graphics > Context Menu All Graphics and Graphics Groups

Only available for self-created groups



If one or multiple groups self-created are selected, you can ungroup these with **Ungroup**. Subgroups are retained.

5.2.1.6 Select All Layers

In GAFmap Express: TOC > Graphics > Context Menu All Graphics and Graphics Groups

Only available for groups

Select All Layers selects all graphics below the graphics group in the TOC. Graphics in subgroups are taken into account, groups are excluded from the selection.

5.2.1.7 Mutual Exclusive

In GAFmap Express: TOC > Graphics > Context Menu All Graphics and Graphics Groups

Only available for groups but not for the main group Graphics

The function corresponds to **Mutual Exclusive** in the Layer Group context menu. For more information, see chapter 5.3.1.3.

5.2.1.8 Check Selected / Uncheck Selected / Toggle Selected

In GAFmap Express: TOC > Graphics > Context Menu All Graphics and Graphics Groups

Only available if multiple graphics, layers, and/or groups are selected



Check Selected / Uncheck Selected lets you activate/deactivate all graphics, layers, and groups currently selected in the TOC at once. Checked/activated elements are visible in the map viewer; unchecked/deactivated elements are hidden.



Toggle Selected lets you switch the activation state of the selected elements so that checked ones are unchecked and unchecked ones are checked.

All three commands are also available if the multi-selection contains TOC elements of any type (i.e. graphics, layers, and/or groups).

Shortcuts, Key Commands, etc.:

- X: toggle graphic(s), layer(s), and/or group(s) selected in TOC (with multiple map windows only in the active one)
- C: toggle graphic(s), layer(s), and/or group(s) selected in TOC globally (with multiple map windows in all windows)

5.2.1.9 Collapse / Expand

In GAFmap Express: TOC > Graphics > Context Menu All Graphics and Graphics Groups

Only available if at least two groups and/or layers are selected



Collapse / Expand lets you collapse/expand selected graphics groups, layer groups, and/or layers in the TOC at once (see also chapter 2.2.2.2). Unselected groups and layers under selected groups are not collapsed or expanded.

The commands are only available if they are actually applicable, i.e. they are missing if all selected groups and layers are already fully collapsed or expanded.

Shortcuts, Key Commands, etc.:

- Arrow key back (with mouse focus on TOC): collapse selected groups and/or layers in the TOC
- Arrow key forward (with mouse focus on TOC): expand selected groups and/or layers in the TOC

5.2.1.10 Properties

In GAFmap Express: TOC > Graphics > Context Menu All Graphics and Graphics Groups

Not available for groups




Via **Properties** you reach the Properties window where all essential properties of the graphic selected in the TOC are listed. If multiple graphics are selected, all properties available for all selected graphics are displayed (= combined properties).

For graphics that are part of the original project, the properties are grayed out and can only be viewed. If you have created a graphic yourself, you can adjust the properties as desired. Note: If multiple graphics are selected in the TOC, changes affect all selected graphics.

In this chapter, all common graphics properties are listed, i.e. those that are available for all or many different types of graphics. Type-specific properties can be found under the corresponding graphics types (see chapter 5.2.2 et seq.).

General

- **Selectable:** determines whether a graphic can be selected in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) (**On**) or not (**Off**). If a graphic is not selectable, it is marked in the TOC with the corresponding  overlay icon.

A graphic can always be selected via the TOC, i.e. independently of this property.

- **Description:** here, additional information regarding the graphic can be viewed, modified, or added (as a simple string or in HTML syntax).



opens the additional information window

Geometry

- **X-/Y-Coordinate:** determines the X-/Y-Coordinate of a point in the set map coordinate system.
- **Length:** shows the total length of a line. The unit (m or km) depends on the predefined length unit (see chapter 3.4.1.4).

The measuring method corresponds to that of the **Measure** tool (see chapter 4.1.13.1).

- **X/Y Min:** determines the X/Y-coordinate of a rectangle's lower left corner according to the map coordinate system.

X/Y Max: determines the X/Y-coordinate of a rectangle's upper right corner according to the map coordinate system.

- **Area:** shows the total area of an areal graphic. The unit (m², ha or km²) depends on the predefined area unit (see chapter 3.4.1.4).

The measuring method corresponds to that of the **Measure** tool (see chapter 4.1.13.1).

- **Outer Perimeter:** shows the outer perimeter of a polygon (= length of the outline). The unit (m or km) depends on the predefined length unit (see chapter 3.4.1.4).

The measuring method corresponds to that of the **Measure** tool (see chapter 4.1.13.1).

- **Height [m]:** determines the height (Z-coordinate) of a point.
- **Relative to Ground:** if **On**, the height is measured relative to the ground (i.e. above the underlying DEM). If **Off**, it is measured in absolute terms.

If the height is measured above ground but the point is not located on a DEM, 0 is used as reference height.

Scale Range

- **Scale Range:** determines whether a graphic activated in the TOC is only displayed in the map viewer if the zoom level of the map is within a certain scale range (**On**) or always, regardless of the zoom level (**Off**).

If **On**, you can specify the valid scale range, i.e. the desired lower/upper limit, under **Min. Scale / Max. Scale**.

If a graphic is used as a texture in the 3D viewer, it is only displayed within the valid scale range. The reference is then the **Texture Map Scale** (see chapter 5.3.4.1).

In contrast to vector layers (see chapter 5.3.2.5), this property affects not only the actual geometry of graphics, but all its components, e.g. also the labeling, the selection symbol, etc.

! Please note that a graphic is not deactivated outside the valid scale range, but is set to transparent. This means, for example, that outside the valid scale range a selected graphic can still be moved with the **Graphics Edit Tool** (see chapter 4.7.1), although it is not visible in the map viewer, or that a viewshed point (see chapter 5.2.17) is not displayed, but is still considered in the viewshed analysis.

Symbology

- **Point Symbol:** determines the symbol used to display a point.



opens the Point Symbols dialog (see chapter 6.1)

- **Line Pen:** determines the symbol used to display a line / a polygon's outline.



opens the Line Pen dialog (see chapter 6.2)

- **Fill Brush:** determines how a polygon is filled.



opens the Fill Symbols dialog (see chapter 6.3)

- **Show Label:** determines whether a graphic is labeled in the map with the **Text** entered below (**On**) or not (**Off**).

If **On**, the following additional property is available:

- **Labeling:** determines the label style.



opens the Labeling dialog (see chapter 6.4)

- **Transparency [%]:** determines the degree of transparency a graphic is displayed with (0 = non-transparent/opaque, 100 = fully transparent/invisible).



opens a slider

- **Symbol Scale:** changes the size of the graphic symbol as a whole.



opens a slider

- **Smoothing:** determines whether a spline interpolation is used when rendering a line or outline of a polygon (**On**) or not (**Off**).
- **Disentangle** (*for point graphics and text labels*): If **On**, the point / label is displayed "disentangled", i.e. slightly offset from its original position (e.g. to improve the readability if points are in close proximity to each other). The original position is indicated by a disentangle line. For more information, see chapter 5.2.4.1.

If you set **Disentangle** to **Off** (*only possible for self-created graphics*), the point/label is reset to its original position (= starting point of the disentangle line).

If **On**, the following additional properties are shown:

- **Disentangle Intermediate Vertex:** If the disentangle line of a selected point has at least one vertex in addition to start point and end point, this property is set to **On**. If you switch it to **Off** (*only possible for self-created graphics*), all intermediate vertices are deleted. Please note that these vertices will not be restored if you switch this property back to **On**. In that case, exactly one vertex is inserted in the middle of the (straight) line.

If you manually insert intermediate vertices into the disentangle line of self-created graphics or delete all of them, this property is automatically set accordingly.

- **Disentangle Line:** determines the symbol used to display the disentangle line.



opens the Line Pen dialog (see chapter 6.2)

- **Reference Scale Rendering:** if **Off**, symbol and label of a graphic are always drawn in the specified symbol/text size, independent of the scale. If **On**, the size only applies at the **Reference Scale** specified below. If you change the map scale, line symbol and label are scaled up/down accordingly.

3D Symbologie

Only visible if the project contains a 3D window

- **Symbol Size Unit:** determines which measurement unit is used for the **Symbol Size**. The following are available:

- **Meter [m]:** the symbol size is given in meters. This unit is recommended if the absolute size of the object is decisive for its display.
- **Scene [‰]:** the symbol size is given in relation to the size of the entire scene. This unit is recommended if a visually appealing result is to be achieved quickly for very large or very small scenes.
- **Pixel [px]:** if selected, line objects are drawn as a simple thin line. The width of the line cannot be changed. Note that simple lines are not three-dimensional objects, and therefore, **Symbol Size**, and **Shading** cannot be enabled.



opens a drop-down list

- **Symbol Size** (*not available if Symbol Size Unit = Pixel*): determines the size of the sight line symbol. Depending on the selected **Symbol Size Unit** the symbol sSize is displayed in meters [m] or in a per mille share of the entire scene [‰].



opens a slider

- **3D Labeling:** if **On**, the graphic is labeled in the 3D viewer. The label text is taken from the Properties field **Text**.

For the display of the label in the 3D viewer applies:

- You can adjust the label style (font, font size, font color, background, halo, etc.) via **Labeling** under **Symbology**.
- The style of the 3D label / labeling Boards under **3D Labeling**.



opens the 3D Labeling dialog (see chapter 6.7)

- The label / the labeling board is always anchored to the actual 3D point object (horizontally and vertically). Note that the label might not be visible if the respective 3D point lies far above/under the DEM. In this case, e.g. adjust the height of the 3D point in the 2D properties (see above).
- The 3D labels / labeling boards always point to the front, i.e. they rotate when moved.
- **Label Priority Expression** (*only relevant if in the Map properties Prevent Overlaps = On; see chapter 5.1.7*): By default, the label that is actually covered, i.e. the one that is further away from the current viewing position, is hidden if 3D labels overlap. If certain labels are to be displayed preferentially, this can be forced by using **Label Priority**. If 3D labels with different label priority overlap, the label with lower priority is always hidden, even if it is in front.

By default, all 3D labels have priority 0. If a larger/smaller value is entered, the label is prioritized higher or lower accordingly.

- **Shading**: determines whether the graphic is displayed shaded (**On**) or not (**Off**). If **On**, areas facing the light appear brighter and areas not facing the light appear darker. This creates a plastic impression.

The virtual light source is specified for the entire scene in the map properties under **Lighting** (see chapter 5.1.7).

- **Shadows / View Obstruction**: if **On**, the graphic casts shadows and it is considered as view obstruction when calculating an on-the-fly viewshed in the 3D viewer.


If **Off**, the graphic does not participate in the shadow and 3D viewshed at all. This means that it is not only not considered as light or view obstruction, but it also neither reflects shadows cast by other objects nor the result of the 3D viewshed.

For more information on shadows and 3D viewshed, see chapters 4.6.5 and 4.6.6.

Text


- **Text** (*only available for Text Labels or if Show Label = On*): determines the text used to label a graphic in the map. Enter the desired labeling text. If you use the text input window, you can also set line breaks.

The wildcard [LayerName] is replaced in the map with the graphic name from the TOC. It can be inserted into the text as desired.

 opens a text input window

5.2.2 AOI

In GAFmap Express: TOC > Graphics

 An **AOI** ("Area of Interest") is a rectangle graphic (see chapter 5.2.6), with which you can mark certain areas in the map. Via the context menu of an AOI you can start various functions and execute them directly for the enclosed map extent, e.g. reduce/update the extent in the 3D viewer to this extent or export the enclosed section.

Context Menu

Right-clicking on one or multiple selected AOI(s) in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) opens the corresponding graphics context menu. In the following, only graphics type-specific functions/commands and properties are explained. For general functions/properties, i.e. those that are available for all graphics and/or graphics groups irrespective of the type, see chapter 5.2.1.

5.2.2.1 Start 3D Viewer

In GAFmap Express: TOC > Graphics > Context Menu AOI

Only available if the project contains a 3D window



Start 3D Viewer lets you reduce/update the map extent currently visible/loaded in the 3D Viewer to the extent of the AOI (see also chapter 4.1.15).

5.2.2.2 Export Map

In GAFmap Express: TOC > Graphics > Context Menu AOI

Only available if the project contains a (2D) map window



Export map opens the dialog of the corresponding function in the Map Viewer toolbar. For more information, see chapter 4.5.12. **Drag Rectangle / Extent** already holds the outermost coordinates of the AOI so that the export is delimited to the area of the AOI by default (i.e. as long as not changed manually).

5.2.2.3 Copy to Clipboard

In GAFmap Express: TOC > Graphics > Context Menu AOI

Only available if the project contains a (2D) map window



Copy to Clipboard creates a screenshot of the map extent within the AOI and copies it to the (Windows) clipboard. The Screenshot can then for example be inserted in another document with Paste / Ctrl+V.

Unlike a screenshot taken with **Export Map** (see chapter 5.2.2.2 or 4.5.12), the screenshot copied to the clipboard has no georeferencing.

5.2.2.4 Properties

In GAFmap Express: TOC > Graphics > Context Menu AOI



Via **Properties** you reach the Properties window where all essential properties of the selected AOI are listed. For more information on the individual properties, see chapter 5.2.1.10.

5.2.3 Reference Point

In GAFmap Express: TOC > Graphics



Reference Point is a point graphic (see chapter 5.2.4) that is labeled with its position coordinates. You can use it, for example, to mark a certain location in the map with a georeference or to retrieve the coordinates of a certain location.

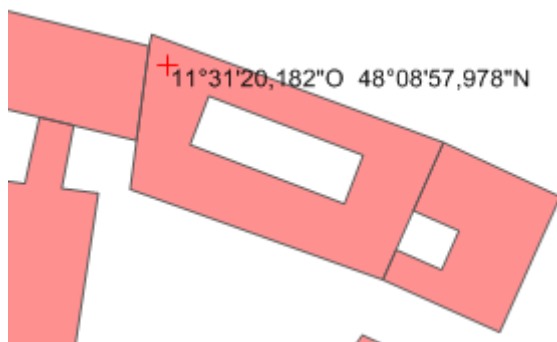


Figure 115: Reference Point, Example

The display format of the coordinates corresponds to that in the status bar (see chapter 2.2.1.3). It can be adjusted via the general settings under Viewing (see chapter 3.4.1.3) and is then adopted for all reference points that are already set.

In addition to the X-/Y-coordinates, a reference point can contain an absolute or relative **Height** (see chapter 5.2.1.10). Note, however, that this height is taken from a DEM when setting the point (see chapter 4.7.4) or is entered manually and, unlike the location coordinates, it is not updated if the position of a reference point subsequently changes.

Each reference point is marked with an  over the layer icon.

Context Menu

Right-clicking on one or multiple selected reference point(s) in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) opens the corresponding graphics context menu. In the following, only graphics type-specific functions/commands and properties are explained. For general functions/properties, i.e. those that are available for all graphics and/or graphics groups irrespective of the type, see chapter 5.2.1.

5.2.3.1 Disentangle

In GAFmap Express: TOC > Graphics > Context Menu Reference Point

Only available for self-created point and text label graphics

Disentangle (On) lets you disentangle/separate (closely spaced) point graphics or labels, e.g. to improve their legibility. For more information, see chapter 5.2.4.1.

Disentangle Off resets disentangled points to their original position (i.e. to the start point of the disentangle line).

5.2.3.2 Properties

In GAFmap Express: TOC > Graphics > Context Menu Reference Point



Via **Properties** you reach the Properties window where all essential properties of the selected Reference Point(s) are listed. For more information on the individual properties, see chapter 5.2.1.10.


Note for the following property especially for Reference Points:

Geometry

- **X/Y-Coordinate:** defines the X/Y-coordinate of the Reference Point. These are always map coordinates, even if another **Coordinate Display Format** is selected in the general settings (see chapter 3.4.1.3). This setting only affects the label of the reference point.

5.2.4 Point

In GAFmap Express: TOC > Graphics

 **Point** A **Point** is a simple point vector geometry that is directly located in the map by X/Y-coordinates.

Amongst others, the following special forms of point graphics can occur in GAFmap®:

- **Text Labels** are anchor points for a label text; the anchor point is not displayed as geometry (see chapter 5.2.9).
- **3D Points** additionally contain an (absolute or relative) height and are therefore 3D capable (see chapter 5.2.12).
- **Reference Points** (as special form of the 3D point) are labeled with their position coordinates and thus represent a georeference in the map (see chapter 5.2.3).
- **Viewshed Points** (as special form of the 3D point) form the basis for the on-the-fly viewshed as "viewpoint of the observer" (see chapter 5.2.17 or 4.5.6 and 4.6.6).
- **Multimedia** points (as special form of the 3D point) are anchor points for links to multimedia objects (see chapter 5.2.19).

Context Menu

Right-clicking on one or multiple selected point(s) in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) opens the corresponding graphics context menu. In the following, only graphics type-specific functions/commands and properties are explained. For general functions/properties, i.e. those that are available for all graphics and/or graphics groups irrespective of the type, see chapter 5.2.1.

5.2.4.1 Disentangle

In **GAFmap Express**: TOC > Graphics > Context Menu Point

Only available for self-created point and text label graphics

Disentangle (On) lets you disentangle (closely spaced) self-created point graphics or text labels, e.g. to improve their legibility. For this purpose, the points or labels are moved (outwards) in a specific arrangement, a (disentangle) line refers to the original point/label position.

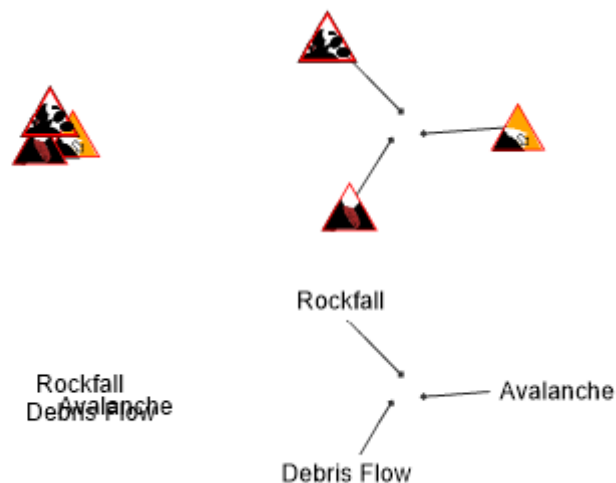


Figure 116: **Disentangle**, example: disentangled points (top) or labels (bottom)

Select the point graphics and/or text labels to be disentangled in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1), and then execute the **Disentangle** command with the desired arrangement type:

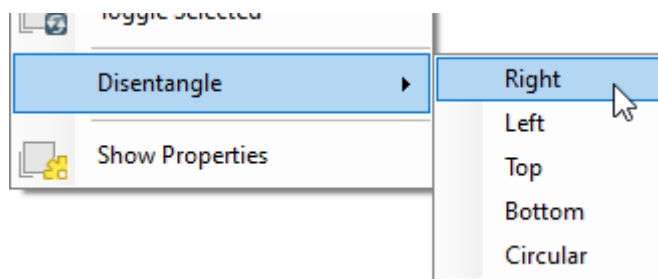


Figure 117: **Disentangle**, submenu with different arrangement types

The points or labels are then arranged in the selected manner:

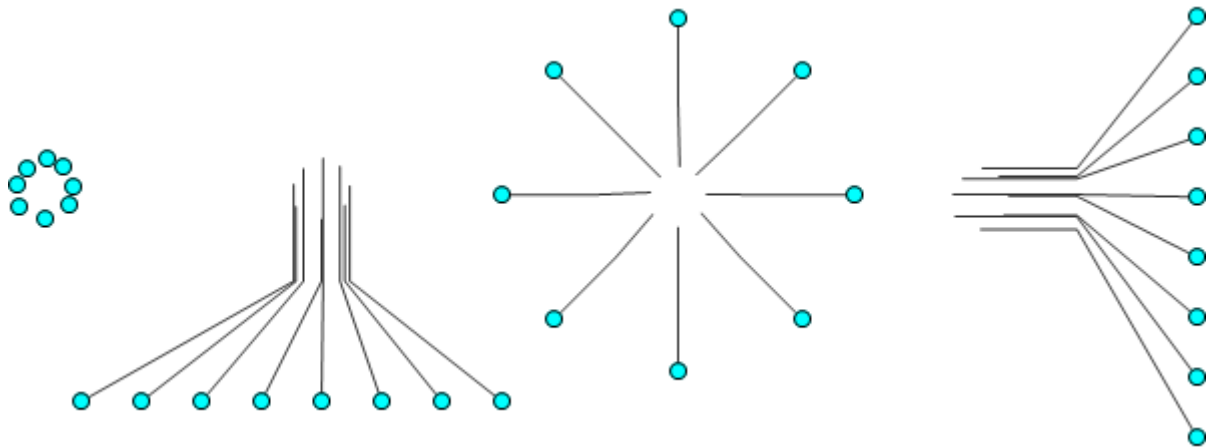


Figure 118: **Disentangle**, examples - from left to right: not disentangled / disentangled with arrangement type bottom / circular / right

If a single element is "disentangled", it is always automatically misaligned to the right.

Alternatively, you can disentangle individual or multiple points or labels at once by setting the **Disentangle** property to **On** (see chapter 5.2.4.2). The elements are then also misaligned to the right each (and not "arranged" on the right across all points/labels).

Edit Disentangle Line / Position

You can always manually adjust the arrangement of the points via the **disentangle line**. To do this, activate the **Graphics Edit Tool** and then double-click a line so that its vertices become visible. The start point of the line marks the original position of the point (before disentangling), the end point marks the position after disentangling. You can move both points as required by drag & drop; however, the position of the start point should only be changed if the exact original position is not relevant, e.g. for converted labels of polygons or lines.



Figure 119: Adjust disentangle line / position of a disentangled point

If necessary, you can insert additional vertices into the lines or delete or edit existing ones. For more information on this and the **Graphics Edit Tool** in general, see chapter 4.7.1.

Intermediate vertices can be removed alternatively and for multiple disentangle lines at once with **Disentangle Intermediate Vertex** in the properties of disentangled points; the line symbol can be adjusted via the **Disentangle Line** property (see chapter 5.2.4.2).

Disentangle Off

Only available for self-created point and text label graphics and only if at least one of the selected elements is disentangled

You can always move a point/label back to its original position by executing the **Disentangle Off** command in the point context menu or by setting **Disentangle** to **Off** in its properties (see chapter 5.2.4.2).

Note that the point is moved back to the start point of the disentangle line. If you have moved that point manually with the Graphics Edit Tool (see above), the position of the point will no longer correspond to the position before disentangling!

If you switch **Disentangle** off, GAFmap® remembers the last disentangle line for each point/label and restores it as soon as you switch the **Disentangle** property back to **On**. However, this only applies during the session, i.e. until the project is closed, and only if the position of the point/label has not been changed in the meantime.

Tips and notes:

- If you are disentangling labels (see chapter 5.2.9.1), the (text) alignment **MiddleCenter** and **Use Box = On** is recommended for these (see chapter 5.2.9.2 or 6.4).
- Labels can only be disentangled if they are of the graphic type text label, and not labels that have been activated for other graphic elements or vector layers via their properties.

5.2.4.2 Properties

In GAFmap Express: TOC > Graphics > Context Menu Point




Via **Properties** you reach the Properties window where all essential properties of the selected point(s) are listed. For more information on the individual properties, see chapter 5.2.1.10.

Please note: if multiple elements in the TOC are selected, all changes within the Properties window apply to all selected elements.

5.2.5 Line

In GAFmap Express: TOC > Graphics

 **Line** A **Line** is a simple line vector geometry. Location and course of the line are defined by individual vertices that are directly connected in a specific order, i.e. by straight line segments.

You can graphically display the line vertices e.g. with the **Graphics Edit Tool** (see chapter 4.7.1) or list them via the context menu command **Show Coordinates** including coordinates and IDs (see chapter 5.2.5.1).

Lines have a clearly defined direction, which results from the digitizing direction and is fixed in the vertex IDs (from the starting point with ID=0 to the end point with ID=max). It can be relevant with regard to certain line symbols (e.g. for arrow anchors or patterns; see chapter 6.2 et seqq.) and can be flipped e.g. via the context menu command **Flip direction** (see chapter 5.2.5.2).

Lines can also be displayed "smoothed", i.e. rounded off at the vertices (see chapter 5.2.5.4 or 5.2.1.10).

Amongst others, the following special forms of line graphics can occur in GAFmap®:

- **Height Profile** lines serve as base for profile sections through digital terrain models (see chapter 4.1.14).
- **Sight Lines** are lines with only one start and one end point. They allow a quick analysis of whether a certain target point is visible to an observer (see chapter 5.2.18).
- **Flight Lines** are smoothed lines that serve as basis for 3D flight animations (see chapter 5.2.16). In the (2D) map viewer only a two-dimensional display of flight line is possible.

Context Menu

Right-clicking on one or multiple selected Line(s) in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) opens the corresponding graphics context menu. In the following, only graphics type-specific functions/commands and properties are explained. For general functions/properties, i.e. those that are available for all graphics and/or graphics groups irrespective of the type, see chapter 5.2.1.

5.2.5.1 Show Coordinates

In GAFmap Express: TOC > Graphics > Context Menu Line

X: Y: Via **Show Coordinates** you can open a list of all the line's vertices and their coordinates, and edit them for newly created lines. For more information on the Coordinates window, see chapter 4.2.2.

5.2.5.2 Flip direction

In GAFmap Express: TOC > Graphics > Context Menu Line

Only available for self-created lines



Flip direction lets you reverse the direction/orientation of a line graphic. This means, start point and end point of the line are inverted, and the IDs of the vertices in between are turned accordingly.

The orientation of a line is relevant, for example, if you use a directional line symbol (such as an arrow), or if you use the line to create a height profile (because it determines the viewing direction).

5.2.5.3 Create Height Profile

In GAFmap Express: TOC > Graphics > Context Menu Line



Create Height Profile lets you visualise a height profile based on a digital elevation model (= single channel raster with property **Use as DEM = On**; see chapter 5.3.4) using an existing line graphic. For more information see chapter 4.1.14.

5.2.5.4 Properties

In GAFmap Express: TOC > Graphics > Context Menu Line




Via **Properties** you reach the Properties window where all essential properties of the selected line are listed. For more information on the individual properties, see chapter 5.2.1.10.

Please note: if multiple elements in the TOC are selected, all changes within the Properties window apply to all selected elements.

5.2.6 Rectangle

In GAFmap Express: TOC > Graphics

 **Rectangle** A **Rectangle** is a simple, plane vector geometry with four right angles and sides that are aligned exactly horizontally and vertically. Unlike a polygon (see chapter 5.2.7), the position and shape of a rectangle is not defined by individual outline vertices but by edge coordinates (**X/Y Min/Max**).

Rectangles always have only one outline/ring, which is then filled two-dimensionally. Unlike Polygons, they can therefore never consist of multiple geometry parts or have "holes".

The shape of a rectangle is editable only to a limited extent. With the **Graphics Edit Tool** (see chapter 4.7.1) or by adjusting the respective properties (see chapter 5.2.6.2 or 5.2.1.10) you can only move a rectangle, increase/decrease its size, or change its aspect ratio. If you want to edit a rectangle freely, it must first be converted into a polygon (see chapter 5.2.6.1).

Context Menu

Right-clicking on one or multiple selected Rectangle(s) in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) opens the corresponding graphics context menu. In the following, only graphics type-specific functions/commands and properties are explained. For general functions/properties, i.e. those that are available for all graphics and/or graphics groups irrespective of the type, see chapter 5.2.1.

5.2.6.1 Convert to Polygon

In GAFmap Express: TOC > Graphics > Context Menu Rectangle

Only available for self-created rectangles

Convert to Polygon lets you convert a rectangle into the graphic type polygon. In doing so, the shape of the geometry remains unchanged, but geometrical properties and edit behaviour alter.

While a rectangle is defined by its maximal extent in X/Y-direction (i.e. the coordinates of the bottom left and top right corner), a polygon is determined by all its vertices. Therefore, a rectangle can only be enlarged/shrunk, contorted, or moved as such, while a polygon is editable at will, as vertices can randomly be inserted, deleted, or moved. But consequently, right angles are no longer guaranteed when working with polygons:

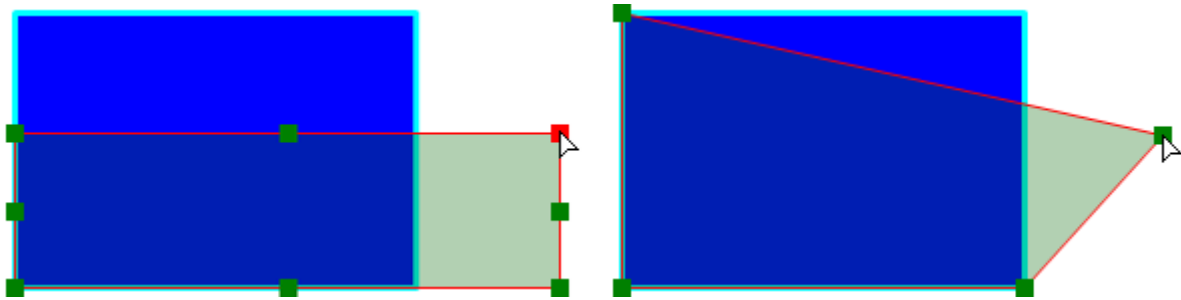



Figure 120: Example: Editing a rectangle before (left) and after (right) it is converted into a polygon

5.2.6.2 Properties


In GAFmap Express: TOC > Graphics > Context Menu Rectangle

 Via **Properties** you reach the Properties window where all essential properties of the selected rectangle are listed. For more information on the individual properties, see chapter 5.2.1.10.

Please note: if multiple elements in the TOC are selected, all changes within the Properties window apply to all selected elements.

5.2.7 Polygon

In GAFmap Express: TOC > Graphics

 **Polygon** A **Polygon** is a simple, plane vector geometry of any shape. Location and shape of the polygon are defined by a linear, closed outline/ring, which is then filled two-dimensional; the ring is defined by individual vertices.

You can graphically display the polygon vertices e.g. with the **Graphics Edit Tool** (see chapter 4.7.1) or list them via the context menu command **Show Coordinates** including coordinates and IDs (see chapter 5.2.7.1).

Context Menu

Right-clicking on one or multiple selected Polygon(s) in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) opens the corresponding graphics context menu. In the following, only graphics type-specific functions/commands and properties are explained. For general functions/properties, i.e. those that are available for all graphics and/or graphics groups irrespective of the type, see chapter 5.2.1.

5.2.7.1 Show Coordinates

In GAFmap Express: TOC > Graphics > Context Menu Polygon

X: Y: Via **Show Coordinates** you can open a list of all the polygon's vertices and their coordinates, and edit them for newly created polygons. For more information on the Coordinates window, see chapter 4.2.2.

5.2.7.2 Properties

In GAFmap Express: TOC > Graphics > Context Menu Polygon



Via **Properties** you reach the Properties window where all essential properties of the selected polygon are listed. For more information on the individual properties, see chapter 5.2.1.10.

Please note: if multiple elements in the TOC are selected, all changes within the Properties window apply to all selected elements.

5.2.8 Ellipse

In GAFmap Express: TOC > Graphics



Ellipse An **Ellipse** is a simple, plane vector geometry. Unlike a polygon (see chapter 5.2.7), the location and shape of an ellipse is not defined by individual outline vertices, but by a center point, which is located in the map with X/Y-coordinates, and a radius in X and Y direction (i.e. the length of the semiaxes).

Ellipses always have only one outline/ring, which is then filled two-dimensionally. Unlike polygons, they can therefore never consist of multiple geometry parts or have "holes".

The shape of an ellipse is editable only to a limited extent. With the **Graphics Edit Tool** (see chapter 4.7.1) or by adjusting the respective properties (see chapter 5.2.8.2 or 5.2.1.10) you can only move a ellipse, increase/decrease its size, or change the ratio of the semi-axes. If you want to edit an ellipse freely, it must first be converted into a polygon (see chapter 5.2.8.1).

Context Menu

Right-clicking on one or multiple selected ellipse(s) in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) opens the the corresponding graphics context menu. In the following, only graphics type-specific functions/commands and properties are explained.

For general functions/properties, i.e. those that are available for all graphics and/or graphics groups irrespective of the type, see chapter 5.2.1.

5.2.8.1 Convert to Polygon

In GAFmap Express: TOC > Graphics > Context Menu Ellipse

Only available for self-created circles/ellipses

Convert to Polygon lets you convert an ellipse into the graphic type polygon. In doing so, the arc of the ellipse is replaced by a regular polygon outline. Depending on the graphic's size, the minimal number of vertices needed to make the output polygon look almost exactly like the original ellipse is determined automatically.

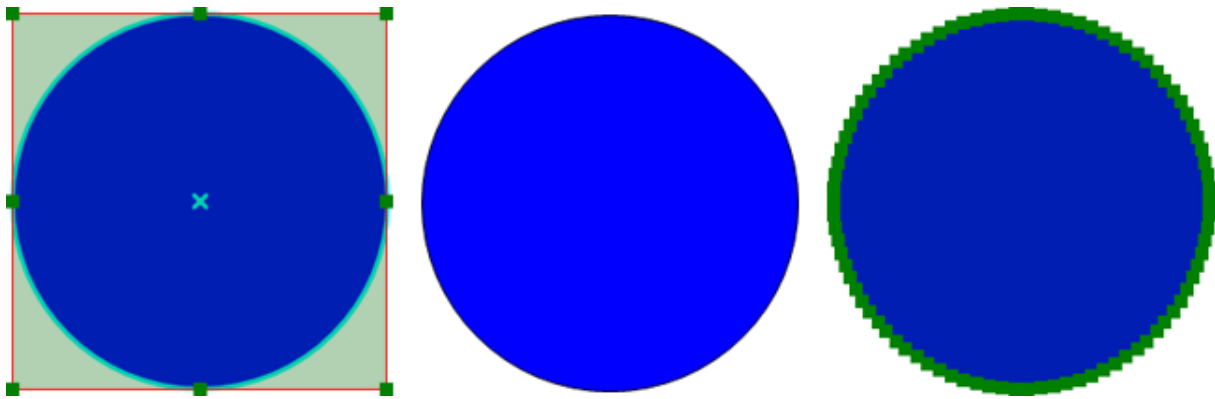


Figure 121: Circle before (left) and after (right) it is converted into a polygon; middle: geometry shown without vertices (almost identical for both)

While a ellipse is defined by its center coordinates and the length the radius/semiaxis in X- and Y-direction, a polygon is determined by its outline vertices. Therefore, a circle/ellipse can only be enlarged/shrunk, contorted, or moved as such, while a polygon is editable at will, as vertices can randomly be inserted, deleted, or moved. Consequently, a regular ellipse shape is no longer guaranteed when working with polygons.

5.2.8.2 Properties

In GAFmap Express: TOC > Graphics > Context Menu Ellipse



Via **Properties** you reach the Properties window where all essential properties of the selected ellipse are listed. For more information on the individual properties, see chapter 5.2.1.10.

Also note the following properties for ellipse:

Geometry

- **Center X/Y:** determines the X/Y-coordinate of the ellipse's center according to the map coordinate system.
- **Radius X/Y:** determines the length of the semiaxis in X/Y-direction. The unit (m or °) depends on the map coordinate system and the size of the graphic.


Symbology

- **Draw Center Cross:** determines whether the center cross is drawn (**On**) or not (**Off**).

Please note: if multiple elements in the TOC are selected, all changes within the Properties window apply to all selected elements.

5.2.9 Text Label

In GAFmap Express: TOC > Graphics

 **Example** A **Text Label** is a text element that can be placed freely (i.e. without an associated object/feature) in the map. The location is based on the X/Y-coordinates of an anchor point. The label text and how it is positioned/aligned relative to the anchor point is determined in the graphics properties.

Technically, a text label is a simple point graphic (see chapter 5.2.4), where the (anchor) point is not drawn.

Context Menu

Right-clicking on one or multiple selected text label(s) in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) opens the corresponding graphics context menu. In the following, only graphics type-specific functions/commands and properties are explained. For general functions/properties, i.e. those that are available for all graphics and/or graphics groups irrespective of the type, see chapter 5.2.1.

5.2.9.1 Disentangle

In GAFmap Express: TOC > Graphics > Context Menu Text Label

Only available for self-created point and text label graphics

Disentangle (On) lets you disentangle/separate (closely spaced) point graphics or labels, e.g. to improve their legibility. For more information, see chapter 5.2.4.1.

Disentangle Off resets disentangled points to their original position (i.e. to the start point of the disentangle line).

5.2.9.2 Properties

In GAFmap Express: TOC > Graphics > Context Menu Text Label



Via **Properties** you reach the Properties window where all essential properties of the selected text label(s) are listed. For more information on the individual properties, see chapter 5.2.1.10.

Note for the following properties especially for text labels:

Geometry

- **X/Y-Coordinate:** determines the X/Y-coordinate of the anchor point according to the map coordinate system.

Under **Labeling**, you can specify the placement of the text label relative to the anchor point.

Text

- **Text:** determines the labelling text. Enter the desired text. If you use the text input window, you can also set line breaks.

The wildcard [LayerName] is replaced in the map with the graphic name from the TOC. It can be inserted into the text as desired.




opens a text input window

Alternatively, you can directly open the text input window by double-clicking the textbox in the map viewer using the **Graphics Edit Tool** (see chapter 4.7.1).

Please note: if multiple elements in the TOC are selected, all changes within the Properties window apply to all selected elements.

5.2.10 Image

In GAFmap Express: TOC > Graphics

 An **Image** is a rectangle position frame within which an image is displayed. For this, a specific image file is linked, i.e. the image itself is not stored in the GAFmap® project itself. The path to the image is stored in the Image properties. If the linked Image file is subsequently deleted, renamed, or moved, the Image can no longer be displayed. For GAFmap® Express projects, the image is usually stored in the Pack&Go container (i.e. the link refers to the container).


Unlike raster layers (see chapter 5.3.3), no raster layer icon is displayed for an image in the TOC, but the image itself.

Context Menu

Right-clicking on one or multiple selected image(s) in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) opens the corresponding graphics context menu. In the following, only graphics type-specific functions/commands and properties are explained. For general functions/properties, i.e. those that are available for all graphics and/or graphics groups irrespective of the type, see chapter 5.2.1.

5.2.10.1 Properties

In GAFmap Express: TOC > Graphics > Context Menu Image

 Via **Properties** you reach the Properties window where all essential properties of the selected image are listed. For more information on the individual properties, see chapter 5.2.1.10.

Also note the following property for images:

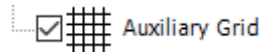
Image

- **File Path:** shows the complete file path of the linked image. For GAFmap® Express projects, the the link usually refers to the container.

Please note: if multiple elements in the TOC are selected, all changes within the Properties window apply to all selected elements.

5.2.11 Auxiliary Grid

In GAFmap Express: TOC > Graphics



Auxiliary Grid

An **Auxiliary Grid** is a simple coordinate grid, which, unlike the on-the-fly coordinate grid (see chapter 4.5.10), is not only displayed on the screen but is loaded into the TOC as an "object" and can therefore also be used for snapping. Thus, it serves primarily as a tool for coordinate-accurate editing and positioning of graphics and vector features.

Reference for the grid is always the map spatial reference. You can adjust the distance between the grid lines in the Auxiliary Grid properties; starting point is always the coordinate origin (0|0).

Auxiliary grids can only be selected via the TOC, not in the map viewer.

Context Menu

Right-clicking on one or multiple selected auxiliary grid(s) in the TOC opens the corresponding graphics context menu. In the following, only graphics type-specific functions/commands and properties are explained. For general functions/properties, i.e. those that are available for all graphics and/or graphics groups irrespective of the type, see chapter 5.2.1.

5.2.11.1 Properties

In GAFmap Express: TOC > Graphics > Context Menu Auxiliary Grid



Via **Properties** you reach the Properties window where all essential properties of the selected auxiliary grid are listed. For more information on the individual properties, see chapter 5.2.1.10.

Also note the following property for auxiliary grids:


Grid

- **Spacing in X-/Y-Direction:** determines the spacing between the grid lines in X-/Y-direction. The unit depends on the map spatial reference. Please note that the grid lines might not be visible if the map scale is too small in relation to the defined spacing.
- **Offset in X-/Y-Direction:** Without offset, i.e. with offset = 0, the grid origin is coincident to the origin of the map coordinate system (0|0). If the grid is not to pass through 0|0, you can specify the desired absolute offset in the X/Y direction here. The unit depends on the map spatial reference.

Please note: if multiple elements in the TOC are selected, all changes within the Properties window apply to all selected elements.

5.2.12 3D Point

In GAFmap Express: TOC > Graphics


 **3D Point** A **3D Point** is a 3D capable point graphic that contains an absolute or relative height information and therefore can be positioned differently in space, unlike a simple (2D) point (see chapter 5.2.4).

Context Menu

Right-clicking on one or multiple selected 3D Point(s) in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) opens the corresponding graphics context menu. In the following, only graphics type-specific functions/commands and properties are explained. For point-specific functions/properties, see chapter 5.2.4, for general ones, i.e. those that are available for all graphics and/or graphics groups irrespective of the type, see chapter 5.2.1.

5.2.12.1 Properties

In GAFmap Express: TOC > Graphics > Context Menu 3D Point

 Via **Properties** you reach the Properties window where all essential properties of the selected 3D point(s) are listed. For more information on the individual properties, see chapter 5.2.1.10.

Also note the following properties for 3D points:

3D Symbolology

- **3D Point Symbol:** determines the symbol used to visualize the 3D point in the 3D viewer.

 opens the 3D Point Symbol dialog (see chapter 6.6)

Viewshed

- **Use for Viewshed:** determines whether the 3D point is used as viewshed point for the on-the-fly viewshed (**On**) or not (**Off**).

If **On**, you can make the following additional settings for the viewshed:


- **Minimum/Maximum Sector Angle [°]:** delimits the sector to be analyzed, e.g. to simulate a specific viewing angle. The angle from/to is specified in geographic degrees (i.e. north = 0°, east = 90°, etc.). If the same value is entered at Minimum and Maximum (e.g. 0/0), the whole circle is analyzed.

If you enter values outside the value range of 0-360°, the angle is automatically converted.

- **Maximum Viewing Distance [m]:** delimits the radius of the area to be analyzed. If the field is left empty, the analysis is performed without distance limitation.
- **Vertical Field of View [°]** (*only available if the project contains a 3D window and if the sector angle is limited*): determines the vertical viewing angle in degrees. Possible are values from 1° to 120°. The larger the angle, the larger the field of view.



opens a slider


As long as **Use for Viewshed** is enabled, the viewshed symbol () is displayed next to the point symbol in the TOC. If you set the property to **Off**, the symbol is hidden.

For more information on the viewshed, see chapter 4.5.6 (for 2D) or 4.6.6 (for 3D).

Please note: if multiple elements in the TOC are selected, all changes within the Properties window apply to all selected elements.

5.2.13 3D Text Label

In GAFmap Express: TOC > Graphics

 **3D Text Label** A **3D Text Label** is a special form of the 3D point (see chapter 5.2.12) for which the actual point is not displayed but only serves as (non visible) anchor point for a simple text label graphic in 2D or a labeling panel in 3D.

Context Menu

Right-clicking on one or multiple selected 3D text label(s) in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) opens the corresponding graphics context menu. It does not contain any graphics type-specific functions or properties. For point-specific functions/properties, see chapter 5.2.4, for general ones, i.e. those that are available for all graphics and/or graphics groups irrespective of the type, see chapter 5.2.1.

5.2.14 3D Model

In GAFmap Express: TOC > Graphics



3D models describe objects/bodies as vectors in an internal, three-dimensional (model) coordinate system. Usually textures are assigned to the body surfaces, so that, depending on type and quality, realistic images of objects, buildings, the terrain, etc. are created. The orientation of the model surfaces usually is clearly defined, which makes it possible to distinguish between inner and outer surfaces and to calculate shadows and viewshed.

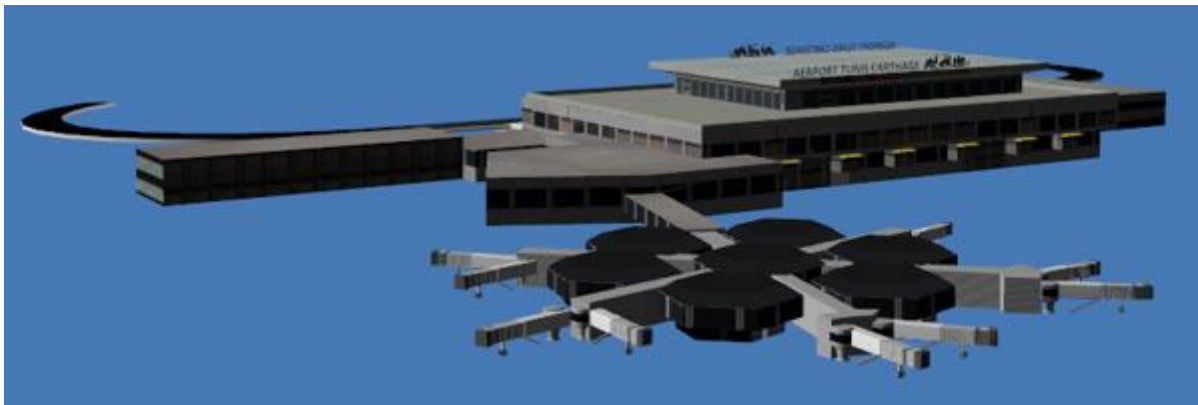


Figure 122: 3D model, example

Tiled 3D models are a set of any number of individual "3D tiles", which are assembled into a complete model for visualization. The 3D tiles are stored in a spatial, hierarchical data structure, which enables precise rendering and fast streaming. Tiling means that the 3D models are practically unlimited in terms of (data) size. They are therefore particularly suitable for the storage and reproduction of spatial data with large extents / data volume.

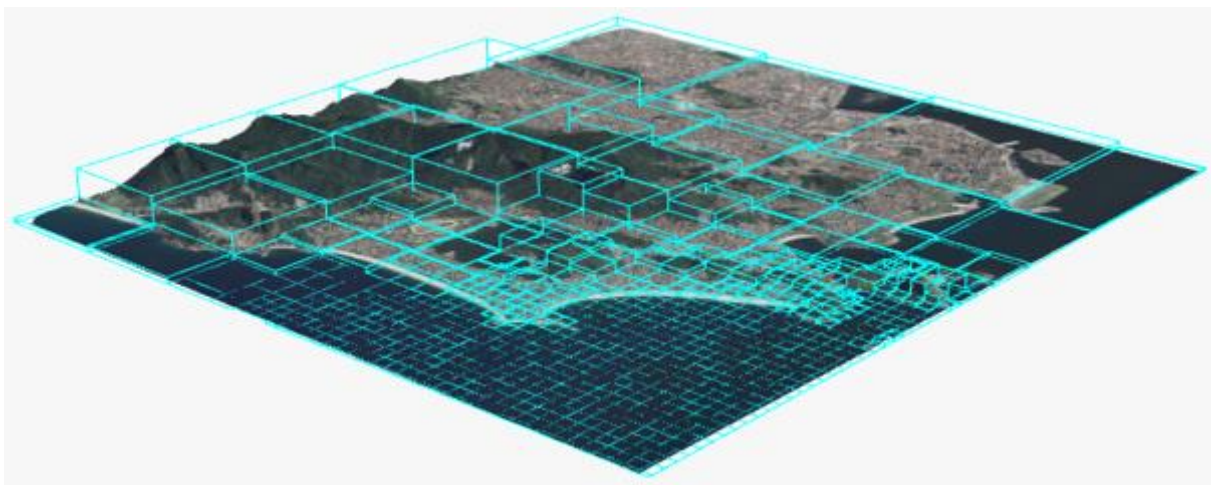


Figure 123: Tiled 3D model with Rendering Information (see chapter 5.2.14.1)

In the (2D) map viewer, 3D models can only be visualized to a limited extent: Depending on the properties set, either anchor point and data extent are displayed or a wireframe model projected vertically downwards (chapter 5.2.14.1). A three-dimensional visualization is only possible in the 3D window.

Physically Based Rendering (PBR)

GAFmap® (Express) supports **physically based rendering (PBR)**. PBR describes an approach in computer graphics that aims to represent surfaces in a way that accurately reflects the flow of light in the real world. The following figure compares a model with and without PBR:



Figure 124: 3D model without PBR (left) and with PBR (right) [Image source: <https://sketchfab.com/models/b81008d513954189a063ff901f7abfe4>]

Note that for 3D models with PBR, a realistic outdoor view can only be achieved if a **SkyBox** is used for the background of the 3D viewer (see chapter 5.1.7).

Context Menu

Right-clicking on one or multiple selected 3D model(s) in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) opens the corresponding graphics context menu. In the following, only graphics type-specific functions/commands and properties are explained. For general functions/properties, i.e. those that are available for all graphics and/or graphics groups irrespective of the type, see chapter 5.2.1.

5.2.14.1 Properties

In GAFmap Express: TOC > Graphics > Context Menu 3D Model



Via **Properties** you reach the Properties window where all essential properties of the selected 3D model are listed. For more information on the individual properties, see chapter 5.2.1.10.

Also note the following properties for 3D models:

Model

- **Filepath:** shows the complete file path and name of the 3D model.
- **Height Conversion** (*only displayed if Relative to Ground = Off*): shows whether the absolute height stored in the dataset is directly adopted (None), or whether it is interpreted as geoidal/ellipsoidal height and converted **To Ellipsoidal / To Geoidal**.
- **Model Axis:** shows the coordinate system that defines the orientation of the 3D model's axes.
- **Heading/Tilt/Roll:** shows the rotation angle clockwise around the Z/X/Y axis of the model.
- **Scale X/Y/Z:** shows a scaling factor (i.e. a multiplier) in X/Y/Z direction.

Symbology

- **Draw Wireframe:** if **On**, a wireframe of the model is drawn in the (2D) map viewer, if **Off**, the 3D model is displayed with a simple point symbol and a position frame in the (2D) map viewer.

3D Symbology

- **Culling:** shows the culling mode the 3D model is displayed with.

Culling is a method of 3D computer graphics that excludes surfaces from visualization - e.g. surfaces facing away from the observer - depending on the relationship between observer and an object's surface (consisting of triangles). As a result, an additional increase in performance can be achieved.

The following modes can occur:


- **Default:** the culling mode recommended from the model is used.
- **Double Sided:** no culling is applied. All triangles defined as "double sided" show a different shading depending on the viewing side (facing away or towards the observer).

- **One Sided:** excludes all triangles that have a clockwise rotation direction after being projected into the screen plane.
- **Double Sided Inversed:** no culling is applied. All triangles defined as "double sided" show an inverted shading.
- **One Sided Inversed:** excludes all triangles that have an anti-clockwise rotation direction after being projected into the screen plane.
- **Double Sided Inconsistent:** no culling is applied. All triangles defined as "double sided" display the same shading on each viewing side (facing away or towards the observer).
- **LOD Quality** (*only for tiled 3D models*): shows the quality (**low, medium, high**) with which tiles that are further away from the viewer are displayed, i.e. which level of detail is used for tiles located e.g. at the edge of the field of view. The higher the quality level, the better the LOD used, but the lower the performance, especially if models with a very large extent are loaded.
- **Show Rendering Info** (*only for tiled 3D models*): shows whether the blocks underlying the Rendering (see chapter 5.3.4.1) are displayed as transparent cubes in the 3D viewer (**On**) or not (**Off**). If **On**, the following additional information is displayed on the bottom right of the 3D Viewer:
 - Loaded graphics data: amount of data [MB]
 - Layer [name as shown in the TOC]: number of triangles; number of displayed blocks and the achieved level of detail

Please note: if multiple elements in the TOC are selected, all changes within the Properties window apply to all selected elements.

5.2.15 View Point

In GAFmap Express: TOC > Graphics

 **View Point** **View Points** are a special form of 3D points (see chapter 5.2.12). In addition to absolute or relative height information, they also contain information on the viewing direction. This makes it possible to save the position and angle of a viewer in space and thus a certain view of the data in the 3D viewer, e.g. to view/use it again during presentations ("3D bookmark").

View Points are primarily auxiliary geometries for saving views, but can also be visualized as three-dimensional objects in the 3D viewer, e.g. to analyze the position and viewing angle of the observer "from the perspective of a third party".

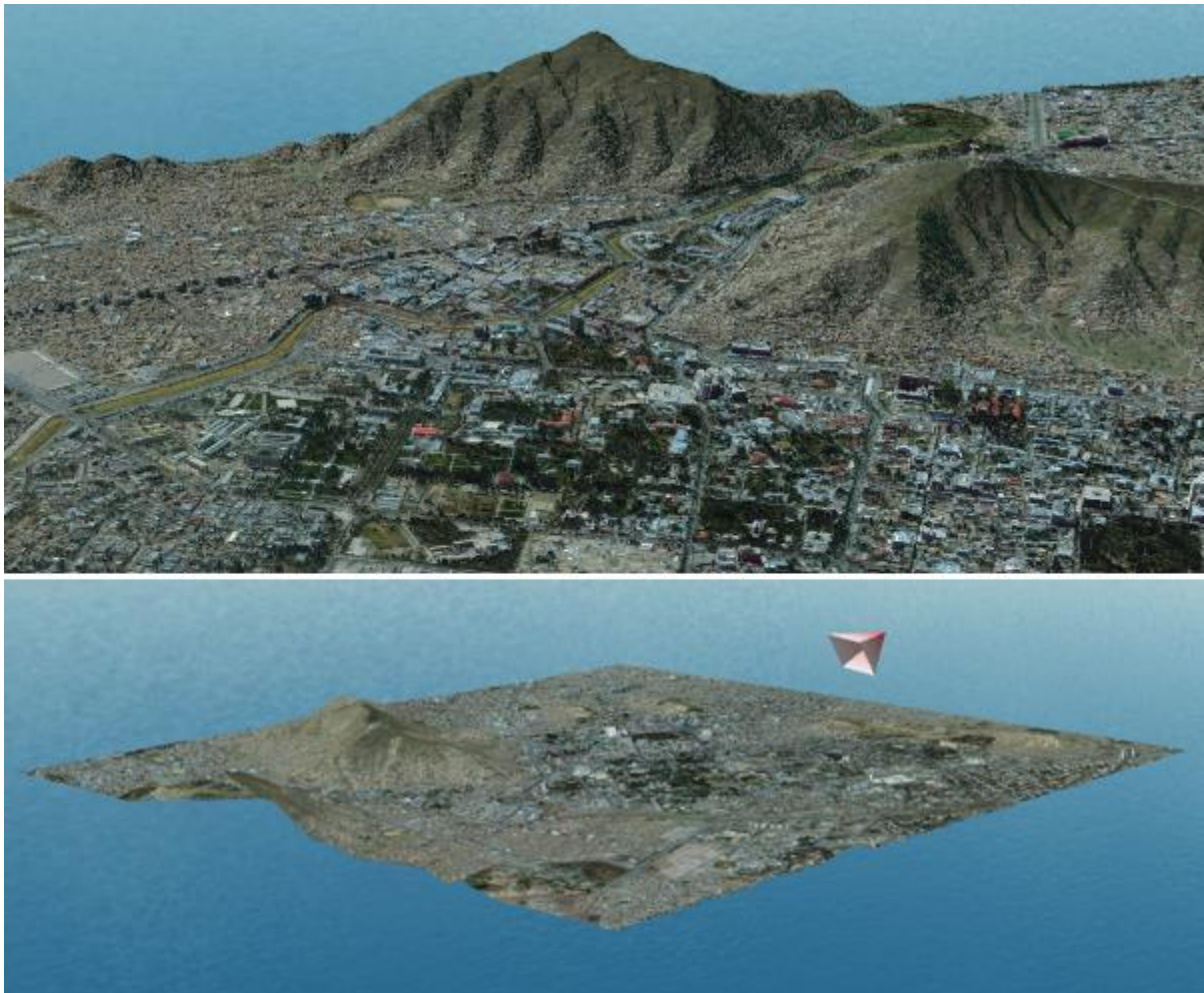


Figure 125: View Point, example: saved view (top) and visualized View Point (bottom)

A saved view can be restored at any time by performing a flight animation from any place in the 3D viewer to the respective view point (see chapter 5.2.15.1). Therefore, view points can also be used as a basis for 3D flights.

Context Menu


Right-clicking on one or multiple selected view point(s) in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) opens the corresponding graphics context menu. In the following, only graphics type-specific functions/commands and properties are explained. For point-specific functions/properties, see chapter 5.2.4, for general ones, i.e. those that are available for all graphics and/or graphics groups irrespective of the type, see chapter 5.2.1.

5.2.15.1 View from Point

In GAFmap Express: TOC > Graphics > Context Menu View Point

Only available if the project contains a 3D window



View from Point starts a flight animation to the selected view point in the 3D viewer. Alternatively, you can start the flight animation with the  Play button in the toolbar (see chapter 4.6.13).

Shortcuts, Key Commands, etc.:

- Alt+click on a view point's layer name in the 3D TOC: start animation
- Key 1-9, while the 3D window is aktiv: fly to 1st-9th view point in the TOC
- Esc while animation: cancel animation
- I while animation: cancel streaming

5.2.15.2 Properties

In GAFmap Express: TOC > Graphics > Context Menu View Point



Via **Properties** you reach the Properties window where all essential properties of the selected view point are listed. For more information on the individual properties, see chapter 5.2.1.10.

Also note the following properties for view points:

View Angles

- **Pitch [°]:** determines the vertical viewing direction of the view point. This value always refers to the horizontal plane (value = 0). For values greater than 0, the viewing direction turns upwards from the horizontal. For negative values, the viewing direction turns downwards from the horizontal. You can enter values between -90 and 90.



opens a slider


- **Yaw [°]:** determines the horizontal viewing direction (azimuth angle) of the view point. This value always refers to North (value = 0). For positive values greater than 0 the viewing direction turns from North towards East. For negative values smaller than 0, the viewing direction turns from North towards West. Negative values or values > 359° are automatically converted to the value range of 0-359°.



opens a slider

- **Use IFOV:** determines whether the FOV is specified below (**Off**) or the IFOV (**On**).
- **FOV** (*only available if Use IFOV = Off*): sets the vertical field of view in degrees. Increasing/decreasing the field of view causes the 3D viewer to be zoomed in or out while the "location" of the observer remains unchanged.


Possible are values from 0 to 120. 45° is the default; smaller values bring the 3D view closer like with binoculars, larger values draw it further away like with a wide angle lens / fisheye (example see chapter 7.1).

 opens a slider

- **IFOV** (*only available if Use IFOV = On*): sets the IFOV ("Instantaneous Field of View") or rather the "FOV per pixel". The entered value is multiplied by the vertical resolution of the 3D viewer, i.e. the number of monitor pixels the 3D viewer is high. Or put the other way around: $IFOV = FOV / \text{height of 3D viewer in monitor pixels}$.



Default is 0.05; smaller values bring the 3D view closer, larger values draw it further away.

While the **FOV** defines via the viewing angle which section of the 3D view is visible from the observer's location, the **IFOV** defines the resolution of the 3D view, i.e. the "zoom step". If the (window) size of the 3D viewer changes, the FOV adjusts the resolution/zoom step while the visible extent remains unchanged and the IFOV adjusts the visible extent while the resolution remains unchanged.

 opens a slider

5.2.16 Flight Lines / Recorded Flight

In GAFmap Express: TOC > Graphics

  **Flight Line** **Flight Lines** are 3D-capable, smoothed line graphics. They determine the course of a flight and contain information about altitude, viewing direction and angle, and speed. They are the basis for 3D flight animations and can be started for presentation purposes.

Each flight line is defined by individual **Flight Points**. They correspond to the line vertices. Besides the location, the following information is stored for each Flight Point:

- the time at which it is reached (measured by the total time of the flight)
- the altitude (absolute or relative / above ground)
- the horizontal and vertical viewing angle (absolute or relativ to the flight line)

Between the defined flight points, the flight line is interpolated. The course is smoothed with a spline interpolation to ensure a harmonious flight movement when changing direction.

Flight lines are primarily auxiliary geometries for flight animations, but can also be visualized as three-dimensional objects in the 3D viewer, e.g. to analyze the course of a flight "from the perspective of a third party".

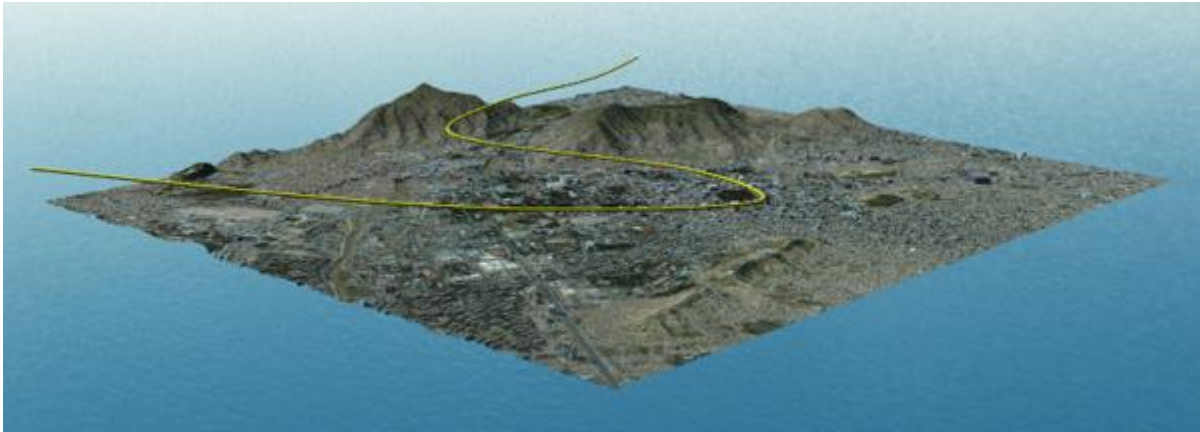


Figure 126: Visualization of a Flight Line



Context Menu

Right-clicking on one or multiple selected flight line(s) in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) opens the corresponding graphics context menu. In the following, only graphics type-specific functions/commands and properties are explained. For line-specific functions/properties, see chapter 5.2.5, for general ones, i.e. those that are available for all graphics and/or graphics groups irrespective of the type, see chapter 5.2.1.

5.2.16.1 Start Flight

In GAFmap Express: TOC > Graphics > Context Menu Flight Lines / Recorded Flight

Only available if the project contains a 3D window

 **Start Flight in 3D Viewer** starts the flight animation within the 3D viewer. Alternatively, you can start the flight animation with the  Play button in the 3D Viewer toolbar (see chapter 4.6.13).

Shortcuts, Key Commands, etc.:

- Alt+click on a flight line's layer name in the 3D TOC: start animation
- Ctrl+Key 1-9, while the 3D window is aktiv: start 1st-9th flight in the TOC
- Esc: cancel animation
- I while animation: cancel streaming

5.2.16.2 Set View to Start Point

In GAFmap Express: TOC > Graphics > Context Menu Flight Lines / Recorded Flight

Only available if the project contains a 3D window



Set View to Start Point lets you jump to the start point of the flight line without starting the flight directly. You then take exactly the view of the first flight point in the 3D viewer, regardless of whether the command is executed in the 3D window or in the (2D) map window.

5.2.16.3 Properties

In GAFmap Express: TOC > Graphics > Context Menu Flight Lines / Recorded Flight



Via **Properties** you reach the Properties window where all essential properties of the selected flight lines are listed. For more information on the individual properties, see chapter 5.2.1.10.

Also note the following properties for flight lines:

3D Symbology

- **Draw Wireframe** (*not visible if Symbol Size Unit = Pixel*): if **On**, the flight line line/tube is drawn as wireframe, i.e. only the outlines of the triangles the tube is built with are drawn.

Flight Line

- **Time Scale**: shows the factor with which the duration of the animation (= "flight time") is scaled/multiplied. For 1, the animation is replayed in real time, for values > 1 it runs faster, for values < 1 slower. The time steps between the individual flight points (see chapter 5.2.16) remain proportionally the same.


If the flight time is scaled, it deviates from the timestamps set for the the flight points. Therefore, the HUD time display (in the upper right corner of the 3D viewer) always shows the "real" time of a flight according to the timestamps and consequently does not match the duration of the animation for scaled flights.

- **Scales Total Duration**: shows the duration of the flight after scaling.
- **Ignore Heading**: if **On**, you can change the camera's viewing direction during the animation interactively by using the mouse. In this case, the flight still follows the predefined flight line, but the viewing direction can still be influenced, independent off the saved settings. If **Off**, the viewing direction cannot be influenced during the flight.

- **Use Look At Location** (*only visible if Ignore Heading = Off*): If **On**, the view is directed to the coordinate entered at **Look At Point** during the entire flight. If **Off**, no such observation point is used.
- **Animation Mode**: determines whether the flight is played only **once** (forwards or backwards) or as a **loop** (forwards, backwards, or forth and back).

5.2.17 Viewshed Point

In GAFmap Express: TOC > Graphics

 **Viewshed Point** A **Viewshed Point** (VSP) is a simple 3D point (see chapter 5.2.12). VSPs serve as basis for the on-the-fly viewshed by marking the viewer's locations from which the visibility of the terrain is analyzed (see chapter 4.5.6 (for 2D) and 4.6.6 (for 3D)).

Whether a point is actually used as VSP or not can be controlled via the graphics property **Use for Viewshed** (see chapter 5.2.12.1). If a new VSP is added (see chapter 4.7.14), this property is set to **On** by default. However, the property can always be deactivated if the point is not to be used as VSP, i.e. not to be taken into account in the on-the-fly viewshed.

Each point that is used as VSP is marked with the  viewshed icon over the layer icon.

Context Menus

Right-clicking on one or multiple selected VSP(s) in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) opens the corresponding graphics context menu. For more information, see chapter 5.2.12 (3D point).

Additionally, the following function, which only appears in a 3D point's context menu if the **Use for Viewshed** property is enabled, is available:

Tips and Notes:

- For general information on VSPs, see chapter 4.7.14, for information on the on-the-fly viewshed, see chapter 4.5.6 (for 2D) or 4.6.6 (for 3D).

5.2.17.1 View from Point

In GAFmap Express: TOC > Graphics > Context Menu Viewshed Point

Only available in the 3D window



With **View from Point** you take the viewing position of the virtual viewer at the SAP. For this, an animated flight to the selected SAP is started in the 3D viewer.

Shortcuts, Key Commands, etc.:

- Alt + click on a view point's layer name in the 3D TOC: zoom to layer (not view from point)
- Esc while animation: cancel animation
- I while animation: cancel streaming

5.2.18 Sight Line

In GAFmap Express: TOC > Graphics



A **Sight Line** is a simple, straight line graphic (see chapter 5.2.5), whose position is defined by exactly two line vertices (i.e. by start and end point). Additionally to the X-/Y-coordinate, the height is stored for both points.

With a sight line you can analyse whether a certain target point is visible to a viewer from a certain location. The sight analysis is based on a digital terrain or surface model, i.e. it can only be performed if a DEM is loaded and marked as such (see chapter 5.3.4).


For more information, see chapter 4.7.15.

Context Menus

Right-clicking on one or multiple selected sight line(s) in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) opens the corresponding graphics context menu. In the following, only graphics type-specific functions/commands and properties are explained. For line-specific functions/properties, see chapter 5.2.5, for general ones, i.e. those that are available for all graphics and/or graphics groups irrespective of the type, see chapter 5.2.1.

5.2.18.1 Properties

In GAFmap Express: TOC > Graphics > Context Menu Sight Line

 Via **Properties** you reach the Properties window where all essential properties of the selected sight line are listed. For more information on the individual properties, see chapter 5.2.1.10.

Especially note the following properties for sight lines:

Geometry

- **Eye Height [m]**: specifies the eye level of the observer, i.e. the start height of the sight line.
- **Target Height [m]**: specifies the end height of the Sight Line, i.e. the height of the point to be seen.
- **Relative to Ground**: if **On**, eye height and end height are measured above ground, i.e. above the underlying DEM. If **Off**, start height and end height are measured absolutely above sea level.

5.2.19 Multimedia

In GAFmap Express: TOC > Graphics



  www.gaf.de A **Multimedia point** is a special form of the 3D point (see chapter 5.2.12). Via Multimedia points, links to specific multimedia objects, e.g. URLs or multimedia files, can be anchored in the map. You can then open them e.g. directly from the map with **Open Multimedia** (see chapter 4.7.16) or via the Multimedia context menu (see chapter 5.2.19.1). Depending on the type, the link will be opened with the corresponding default program, e.g. the specified default Internet browser for URLs, the default image viewer for image files, or Acrobat Reader for PDFs etc.



Figure 127: **Multimedia**, example

Note that a link can no longer be accessed if an URL is not valid any more or the linked file has been subsequently deleted, moved, or renamed.

Context Menu

Right-clicking on one or multiple selected Multimedia point(s) in the TOC or in the map viewer with the **Graphics Edit Tool** (see chapter 4.7.1) opens the corresponding graphics context menu. In the following, only graphics type-specific functions/commands and properties are explained. For point-specific functions/properties, see chapter 5.2.4, for general ones, i.e. those that are available for all graphics and/or graphics groups irrespective of the type, see chapter 5.2.1.

5.2.19.1 Open Multimedia

In GAFmap Express: TOC > Graphics > Context Menu Multimedia



Open Multimedia you open the link to a multimedia object. The link is always opened with the assigned standard program for the respective file type, e.g. URLs are opened with the standard internet browser or PDFs with Acrobat Reader etc. If multiple multimedia objects are linked at one multimedia point, each link is listed separately in the context menu.

Alternatively, you can open multimedia links via **Open Multimedia** in the Graphics Toolbar (see chapter 4.7.16).

5.2.19.2 Properties

In GAFmap Express: TOC > Graphics > Context Menu Multimedia



Via **Properties** you reach the Properties window where all essential properties of the selected Multimedia point are listed. For more information on the individual properties, see chapter 5.2.1.10.

Also note the following properties for Multimedia:

Multimedia

- **URL:** shows the URL or file path to the linked multimedia object. If multiple multimedia objects are linked, the different URLs/paths are separated by semicolon.
- **Only Show File Name:** if **On**, only the multimedia object's filename is displayed in the map viewer. If **Off**, the entire path is displayed.

5.3 Layer



Layer in GAFmap® includes all types of vector layers, raster layers, point clouds, and tables. Unlike graphics (see chapter 5.2), which are stored directly in the actual project file (*.xmp), each layer refers to an external data set. In Pack&Go projects, these data sets are usually stored in the container (*.cmp) next to the project file as well, but can also be linked. In the *.xmp file contained in the CMP then only the corresponding connection details are stored.

Types of Graphic Elements

The following types of layers can occur:



- **Vector Layer** ( Point,  Line and  Polygon Layer) (see chapter 5.3.2 et seqq.)

Each vector layer consists of individual point, line, or polygon features. Apart from the geometry displayed in the map/3D viewer, each feature has attributes. These attributes can be viewed for the entire layer in the **Attribute Table** (see chapter 5.3.2.1) or be queried feature-by-feature with **Show Attributes** (see chapter 4.2.1).


- **Raster Layer** ( multi-channel and  single-channel rasters) (see chapter 5.3.3 et seqq.)

For all rasters, the (image) information is stored in a uniform raster pixel by pixel. Rasters can have one or more channels / raster bands, up to four of which can be used for visualization (3 color bands + 1 alpha band). Multi-channel rasters are usually displayed as color image, single-channel rasters as black and white image, color ramp, or classification raster.

Due to their special properties, these special types of raster layers are treated separately in the following:

-  **Digital Elevation Models:** single-channel rasters where the (terrain) height is stored for each pixel (see chapter 5.3.4).
-  **Raster with RPC Information:** usually multi-channel rasters for which the exact recording geometry is stored and can thus be used for the display of side views in the 3D viewer (see chapter 5.3.5).
- **Mosaic Layer:** virtual mosaics of multiple single- or multi-channel rasters (see chapter 5.3.6)

Note: Rasters of WMS/WMTS/TMS are loaded and treated as "normal" raster layers in GAFmap®.

-  **Point Clouds** (see chapter 5.3.7 et seq.)

Point clouds consist of a multitude of individually located (measurement) points in space. They can only be visualized in the 3D viewer (as 3D dataset) in GAFmap®, in the (2D) map viewer only the extent of the point cloud is displayed as rectangle.

-  (simple) **Tables** (see chapter 5.3.8)

All types of layers can only be read with GAFmap® Express and not be changed or newly added.

Selecting Layers

You can select a layer or layer group in the TOC with a simple left-click (on the icon or name); it is then highlighted in blue. Multi-selection is possible e.g. by holding down the Ctrl or Shift key.

Alternatively, you can select layer in the map viewer with **Select Layer** (see chapter 4.1.10). They are then also highlighted in blue in the TOC..

Context Menu

Right-clicking the main group **Layer**, selected groups or layers in the TOC takes you to a context menu that provides various functions or commands specifically for the selected elements. The content of the context menu depends on the level, number, and type of the selected elements and on whether the project contains a map viewer and/or a 3D viewer.

The following chapters cover all functions/commands that appear in the context menus of the various layer types. These can be categorized as follows:

- General layer functions, i.e. those that are available for all or most layers and layer groups (see chapter 5.3.1 et seqq.),
- Layer specific functions, i.e. those that are only available specifically for vector, raster, point clouds or tables (see chapter 5.3.2 et seqq.)

Shortcuts, Key Commands, etc.:

- Left-click on element in the TOC: select element
- Ctrl when selecting: add selection to current selection. Already selected features are deselected when they are selected twice.
- Shift when selecting: select consecutive elements (Ctrl + click on first and last element to be selected)
- Right-click on individual / multiple selected elements in the TOC: open context menu

- X: toggle graphic(s), layer(s), and/or group(s) selected in TOC (with multiple map windows only in the active one)
- C: toggle graphic(s), layer(s), and/or group(s) selected in TOC globally (with multiple map windows in all windows)
- Alt + left-click on a selected layer, graphic, or group in the TOC: zoom to element
- Alt + checking a layer, graphic, or group in the TOC: zoom to the checked element

5.3.1 All Layers and Layer Groups

In GAFmap Express: TOC > Layer

A right-click on one or multiple selected layers in the TOC opens the graphics context menu. The content of the context menu depends on the type and number of selected elements.

In the following, all potentially included, general functions of the layer context menu are explained. Functions that are only available for vector layers or raster layers, can be found in chapters 5.3.2 to 5.3.6.

5.3.1.1 Zoom to Layer / Zoom to Selected Layers

In GAFmap Express: TOC > Layer > Context Menu All Layers and Layer Groups



Zoom to Layer (in case of a single selected element) or **Zoom to Selected Layers** (in case of multi-selection) zooms the map to the extent of the element(s) currently selected in the TOC. If the selection holds only a single point, the map extent is centered on this point.

Zoom to Selected Layers is also available if the multi-selection contains TOC elements of any type (i.e. graphics, layers, and/or groups).

Zoom To Layer in the 3D Window

If you execute the command in the 3D TOC, a flight animation to the layer is performed in the 3D viewer. You then fly from your current view point on the shortest way to a view point from which you have a complete overview of the layer. You can define the desired **Zoom To Flight Duration** in the general settings under Other (see chapter 3.4.1.8).

Shortcuts, Key Commands, etc.:

- Alt+left-click on a selected layer, graphic or group in the TOC: zoom to element
- Alt+checking a layer, graphic or group in the TOC: zoom to the checked element

Tips and notes:

- Special case mosaic layer (see chapter 5.3.6): Note that the extent of a mosaic layer depends on whether or which single rasters below the mosaic layer are activated (i.e. checked in the TOC). If e.g. only one raster is activated, the extent corresponds to that of this raster, if multiple or all rasters are activated, it corresponds to the extent of all (activated) rasters.

5.3.1.2 Select All Layers

In GAFmap Express: TOC > Layer > Context Menu All Layers and Layer Groups

Only available for groups

Select All Layers selects all layers below the layer group in the TOC. Layers in subgroups are taken into account, groups are excluded from the selection.

5.3.1.3 Mutual Exclusive

In GAFmap Express: TOC > Layer > Context Menu All Layers and Layer Groups

Only available for groups but not for the main group Layers

You can activate **Mutual Exclusive** for a layer group by a single click on the command in the context menu. If activated, only one layer within this group is shown (checked/activated) at the same time. By default, first the uppermost layer within the layer group is activated and all other layers are deactivated. If you activate another layer, the first layer is automatically deactivated etc. The layers within the group are therefore only activated individually.



If **Mutual Exclusive** is activated for a layer group, a blue tick symbol appears in front of the corresponding command. The function can be deactivated at any time by simply left-clicking the command again. The tick symbol disappears and the layers within the group can be selected/activated together again.

5.3.1.4 Check Selected / Uncheck Selected / Toggle Selected

In GAFmap Express: TOC > Layer > Context Menu All Layers and Layer Groups

Only available if multiple graphics, layers, and/or groups are selected



Check Selected / Uncheck Selected lets you activate/deactivate all graphics, layers, and groups currently selected in the TOC at once. Checked/activated elements are visible in the map viewer; unchecked/deactivated elements are hidden.



Toggle Selected lets you switch the activation state of the selected elements so that checked ones are unchecked and unchecked ones are checked.

All three commands are also available if the multi-selection contains TOC elements of any type (i.e. graphics, layers, and/or groups).

Shortcuts, Key Commands, etc.:

- X: toggle graphic(s), layer(s), and/or group(s) selected in TOC (with multiple map windows only in the active one)
- C: toggle graphic(s), layer(s), and/or group(s) selected in TOC globally (with multiple map windows in all windows)

5.3.1.5 Reload Data

In GAFmap Express: TOC > Layer > Context Menu All Layers and Layer Groups

Only available if the linked dataset is not in the Pack&Go Container



Reload Data lets you refresh one or multiple layer(s) without reloading the whole project.

Reloading a layer can be necessary if the dataset behind the layer has been changed by another user / in another project after loading, e.g. if a vector file has been edited in the meantime. This editing only becomes visible in your project if the data is reloaded. Or if a raster dataset is stored on a server and the network connection has been temporarily disconnected. Without reloading, only cached raster data can be displayed.

If the command is executed on Layer Group level, all data below the group are updated, including all layers in sub-groups. If the group contains layers that cannot be reloaded, you receive a corresponding message.

Shortcuts, Key Commands, etc.:

- Ctrl+R: Reload Data for all layers
- Ctrl+F: Reload Data for selected layers

5.3.1.6 Collapse / Expand

In GAFmap Express: TOC > Layer > Context Menu All Layers and Layer Groups

Only available if at least two groups and/or layers are selected



Collapse / Expand lets you collapse/expand selected layer groups, graphics groups, and/or layers in the TOC at once (see also chapter 2.2.2.2). Unselected groups and layers under selected groups are not collapsed or expanded.

The commands are only available if they are actually applicable, i.e. they are missing if all selected groups and layers are already fully collapsed or expanded.

Shortcuts, Key Commands, etc.:

- Arrow key back (with mouse focus on TOC): collapse selected groups and/or layers in the TOC
- Arrow key forward (with mouse focus on TOC): expand selected groups and/or layers in the TOC

5.3.1.7 Show Layer Info

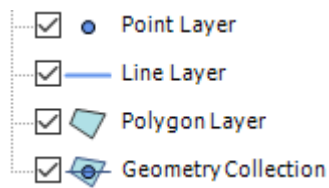
In GAFmap Express: TOC > Layer > Context Menu All Layers and Layer Groups

Only available if a single layer is selected for which a layer info is saved


If a layer info is available for a layer, i.e. if the layer property field **Layer Info** contains an entry, then this info can be called directly from the layer's context menu via the command **Show Layer Info**. The layer info is then displayed in a separate window, either as plain text or with (HTML) formatting, depending on the form of the entry.

5.3.2 Vector Layer

In GAFmap Express: TOC > Layer







A **Vector Layer** ("Feature Layer") is a **layer** (see chapter 5.3) that links to a vector dataset. It consists of any number of individual point, line, or polygon features. Besides the geometry displayed in the map viewer, each feature has attributes. These attributes can be viewed via the **Attribute Table** for the entire layer (see chapter 5.3.2.1) or queried feature-by-feature e.g. using the **Show Attributes** tool (see chapter 4.2.1).

All feature geometries are defined by individual vertices; the location in the map is done via X/Y-coordinates, which are stored for each vertex. Additionally, a vector layer can support Z-coordinates; the feature geometries can then also be located in the 3D space. Whether or not a layer has Z-coordinates can be viewed in the layer properties under **Source** (see chapter 5.3.2.5). Z-aware vector layers are also marked with a Z on the right above the layer icon in the TOC .

You can display the individual feature vertices at any time, e.g. by pressing the V key in the map viewer or by listing them with **Show Coordinates** (see chapter 4.2.2).

Geometry Types

Vector layers are classified by geometry type as follows:

-  **Point Layers** consist of any number of individual point features, which are directly located in the map via X/Y/(Z)-coordinates.
-  **Line Layers** consist of any number of individual line features. Position and course of the individual lines are defined by vertices that are directly connected in a specific order, i.e. by straight line segments.
-  **Polygon Layers** consist of any number of individual polygon features. Location and shape of the individual polygons are determined by linear, closed outline/rings, which are then filled two-dimensional; each outline/ring is defined by individual vertices. Each polygon has at least one outer ring; additionally, it can have any number of inner rings (= "holes").
-  Vector data with geometry type **GeometryCollections** or **Unknown** can contain features of all three geometry types mentioned above.

Independent of the geometry type, each vector layer can contain multipart features, i.e. features whose geometry consists of multiple parts, i.e. multiple points, lines, or polygons. In all cases, "empty geometries", i.e. simple table entries without corresponding geometry, are also possible. For more information, see chapter 5.3.2.1.

Context Menu

Right-clicking on one or multiple selected vector layers in the TOC opens the vector layer context menu. In the following, only vector layer-specific functions in the context menu and the vector layer properties are explained. For functions/commands that are available for all layers irrespective of the type and layer groups, see chapter 5.3.1.

5.3.2.1 Open Attribute Table

In GAFmap Express: TOC > Layer > Context Menu Vector Layer



Open Attribute Table or Ctrl+double-clicking on the layer name in the TOC opens a vector layer's attribute table. Here, all features of the layer including all their attributes are listed.

Attributes of countries						
	FID	SOVEREIGN ▲	CNTRY_NAME ▲	GMI_CNTRY	SQKM_CNTRY	SG ▲
	167	Nepal	Nepal	NPL	19927280	147
	0	Netherlands	Aruba	ABW	67074	182
	165	Netherlands	Netherlands	NLD	15447470	354
	170	Netherlands	Netherlands Antilles	ANT	191572	804
	53	New Zealand	Cook Islands	COK	17000	231
	172	New Zealand	New Zealand	NZL	3528197	266
	160	New Zealand	Niue	NIU	2000	227
	219	New Zealand	Tokelau	TKL	1600	20
	171	Nicaragua	Nicaragua	NIC	4275103	129
	162	Niger	Niger	NER	8797739	118
	164	Nigeria	Nigeria	NGA	97228750	912
	121	North Korea	North Korea	PRK	12054000	122

Show: Features (251 Features / 0 selected)

Figure 128: Example of an attribute table

The attribute table is structured as follows:

- Each **row** represents a feature. Each feature is represented by exactly one row. Via the row header on the left, lines can be selected.
- Each **column** represents an attribute field. The attribute field's name is shown in the column header.
- Each **cell** contains a certain attribute value for the respective feature and the respective attribute field.

The footer of the table shows how many features the vector layer contains, how many of them are selected, and whether **All** or only **Selected Features** are currently displayed. In display mode **Selected** you are additionally shown how many of the selected features are highlighted (see below).

Regarding the feature count in the footer, please note the special case **Filtered Data** (see below).

Relation between Feature Geometry and Attribute Table

Usually there is exactly one row in the attribute table for each feature geometry and vice versa, i.e. the number of geometries in the map viewer and the number of table entries matches.

You can access a feature geometry in the map viewer via the attribute table by double-clicking the corresponding row at the row header. The map extent is then zoomed to the geometry or, if you hold the Alt key, centered on the geometry. If multiple rows are selected in the table, you can zoom to / center on all selected features with Ctrl+double-click on one of the row headers.

Please note the following special cases:

- A **multipart feature** has a geometry with spatially separated geometry parts; however, it is still a single feature (with a multipart geometry), i.e. it is represented in the attribute table by only one row.
- Under certain circumstances, the attribute table can contain entries for which no geometry exists. Such **empty geometries** can be created, for example, when the geometry "collapses" during certain operations, e.g. when it is buffered too far inwards or when all vertices are snapped to one point.

For multipart features, the map viewer is always zoomed to / centered on all geometry parts when double-clicking on the row header, for empty geometries, the map extent remains unchanged.

Feature Selection (in the Attribute Table)

Features can be selected in various ways, e.g.

- in the attribute table by clicking on a row header (see below),
- in the map window with a selection tool (see chapter 4.2.3) or
- with various functions like, for example, **Select by Attribute** or **Select by Location** (see chapter 5.3.2.1.2 et seqq.)

If a feature is selected, the geometry is outlined in the map viewer in the set selection color (cyan by default) and the corresponding row in the attribute table (in display mode **All**) is highlighted in blue. This always applies, i.e. regardless of where and how the feature was selected.

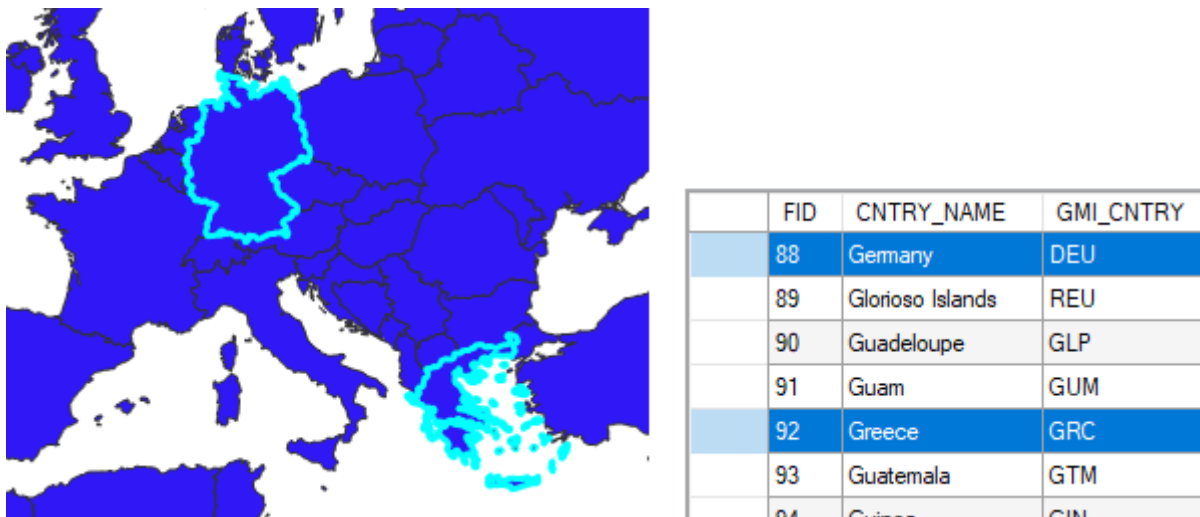


Figure 129: Feature selection in map viewer and attribute table

In the attribute table, a feature can be selected by clicking on the corresponding row header on the left (at the beginning of the line).

29	Bolivia	Bolivia	BOL	1000000	42000
30	Brazil	Brazil	BRA	8507128	32840
43	Chile	Chile	CHI	742298 188	28660

Figure 130: Selecting a feature in the attribute table

You can select multiple features

- if you hold the Ctrl key and then click on multiple row headers one after the other. If you click an already selected feature for a second time, it is deselected again.
- if you hold the Shift key and click on two line headers one after the other. These two features and all features in between are then selected.

- if you click on the row header of a feature, hold the mouse button, and drag the mouse pointer downwards/upwards on the row headers. All "passed over" features are then selected.

A click in the upper left corner of the table or Ctrl+A selects all features:

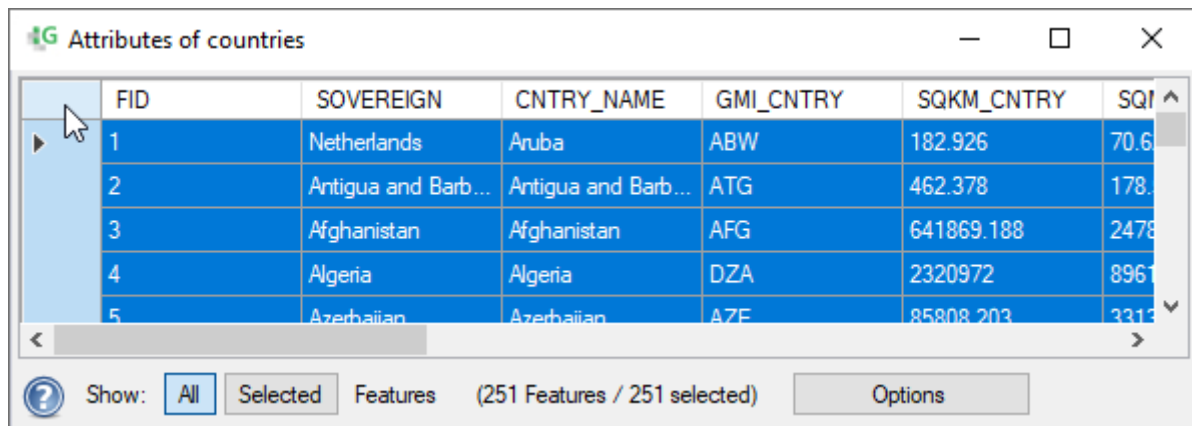


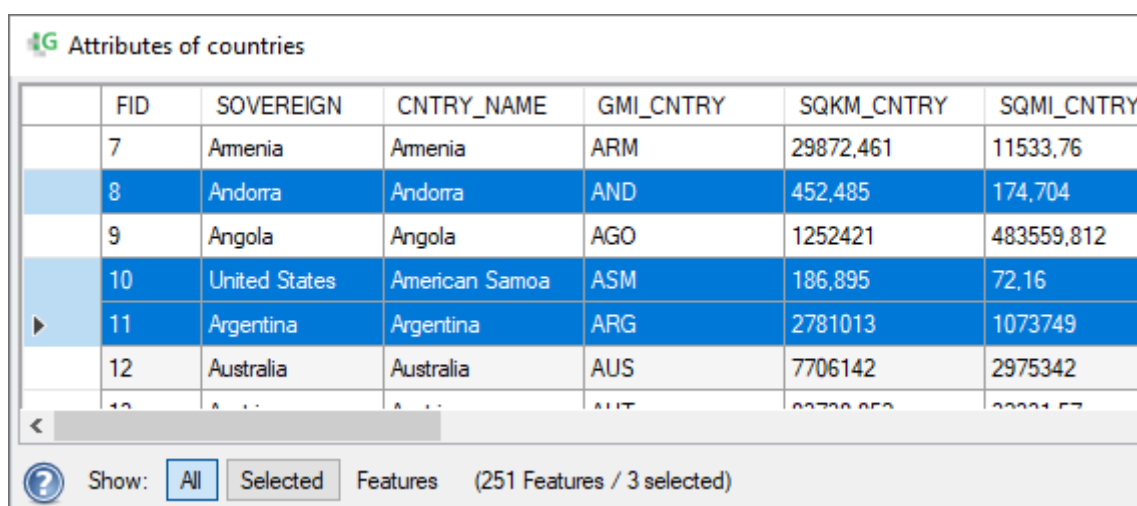
Figure 131: Selecting all features in the attribute table

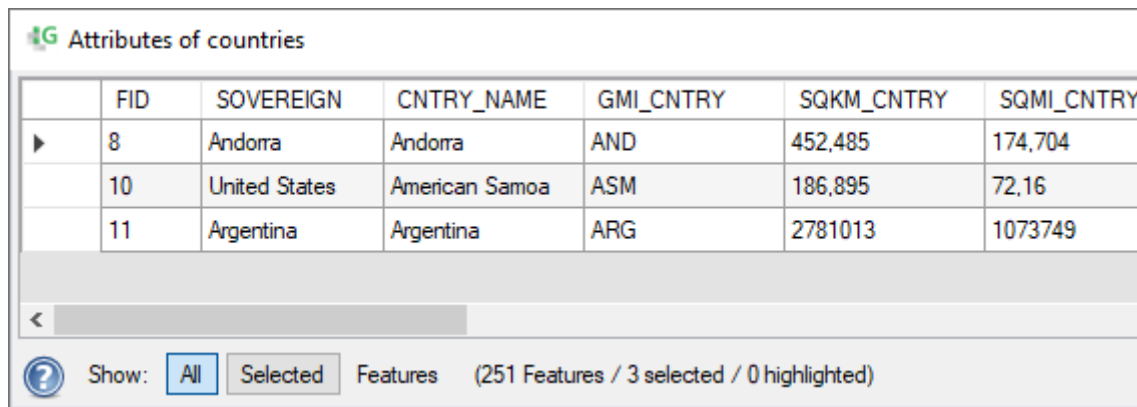
You can always clear the selection again, e.g. in the map window with the **Clear Selection** button (see chapter 4.2.4) or by clicking (off the headers) into the table.

Display Mode (All/Selected)

Via the buttons (Show) **All** or **Selected** (Features) in the table footer you can switch between the following two display modes:

- **All**: all features of the vector layer are shown in the table. If features are selected, they are highlighted in blue.
- **Selected**: only selected features of the vector layer are shown in the table; selected features are not additionally highlighted in blue.





	FID	SOVEREIGN	CNTRY_NAME	GMI_CNTRY	SQKM_CNTRY	SQMI_CNTRY
▶	8	Andorra	Andorra	AND	452,485	174,704
	10	United States	American Samoa	ASM	186,895	72,16
	11	Argentina	Argentina	ARG	2781013	1073749


 Show: **All** Selected Features (251 Features / 3 selected / 0 highlighted)

Figure 132: Attribute table in display mode **All** (top) and in display mode **Selected** (bottom)

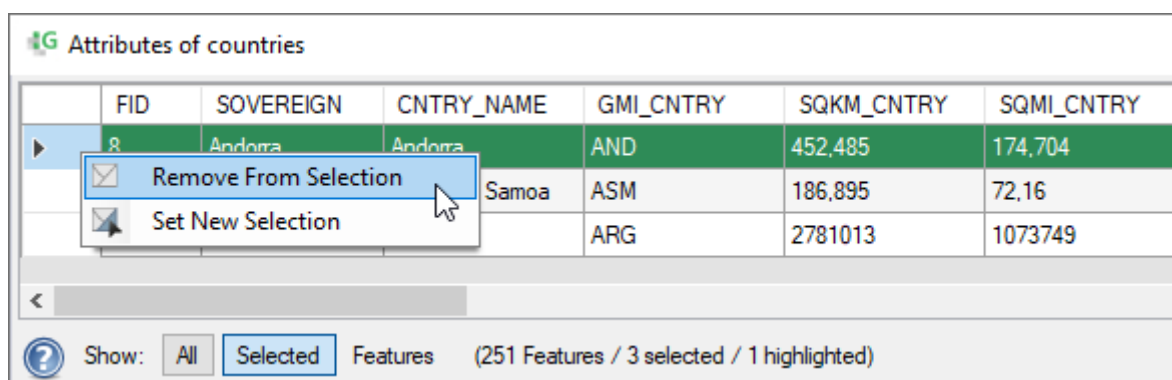
You can tell which mode you are currently in by which button is active (highlighted in blue).

Creating a Sub-Selection / Highlighting Features

In display mode **Selected**, you can create a sub-selection of the currently selected features. To do this, select the corresponding rows in the table (see above); the sub-selected rows are then highlighted in green in the table. In the map viewer, the associated geometries are also highlighted (by default in green). The count of highlighted features is shown in the footer of the table.

You can apply the sub-selection as a new selection by right-clicking on the row header to open a context menu and executing the **Set New Selection** command. All highlighted rows/features are then reselected, the others are removed from the selection.

With the **Remove From Selection** command you can deselect the highlighted rows/features; a new selection is then created containing only the non-highlighted features.



	FID	SOVEREIGN	CNTRY_NAME	GMI_CNTRY	SQKM_CNTRY	SQMI_CNTRY
▶	8	Andorra	Andorra	AND	452,485	174,704
			Samoa	ASM	186,895	72,16
				ARG	2781013	1073749


 Show: All **Selected** Features (251 Features / 3 selected / 1 highlighted)

Figure 133: Creating a sub-selection in the attribute table

Attribute Fields / Columns

The names of the attribute fields / columns are shown in the (column) headers. If you move the mouse pointer slowly over a header, the data type of the field is displayed (text, integer, date, etc.), and, if applicable/defined, in brackets the field length and the number of decimal places.

FID	Type
0	Strate

FID	Type_ID
0	0

FID	SHAPE_LEN
0	26688

Figure 134: Tooltip when moving the mouse pointer slowly over a column header: field name [data type(field length, number of possible decimal places)]

You can change the order of the fields by grabbing a column with a click on the header and dragging it to the desired position. A changed field order can be saved in the project.

Sorting Features by Attributes

You can sort rows/features by a specific attribute field by left-clicking the respective column header:

- Name The first click sorts the features ascending,
- Name the second click sorts the features descending, and
- Name the third click discards the sorting again

If you hold the Ctrl key, you can sort rows/features successively by multiple attributes, i.e. first by attribute1, then attribute2, etc.

	FID	SOVEREIGN ▲	CNTRY_NAME ▲	GMI_CNTRY	SQKM_CNTRY	SQMI_CNTRY
	168	Nepal	Nepal	NPL	147292,594	56869,672
	1	Netherlands	Aruba	ABW	182,926	70,628
	166	Netherlands	Netherlands	NLD	35492,691	13703,73
	171	Netherlands	Netherlands Antilles	ANT	804,379	310,571
	54	New Zealand	Cook Islands	COK	231,532	89,395
	173	New Zealand	New Zealand	NZL	266820,188	103019,297
	161	New Zealand	Niue	NIU	227,818	87,96
	220	New Zealand	Tokelau	TKL	20,125	7,77
	172	Nicaragua	Nicaragua	NIC	129047,398	49825,199

Figure 135: Sorting features in the attribute table. Example: First ascending by [SOVEREIGN], then ascending by [CNTRY_NAME]

Please note:

- Whether the sorting of text is case sensitive depends on the layer property **Case Sensitive** (see chapter 5.3.2.5).
- If **display names** are used for a field (see below), the sorting is still always based on the actually entered values, not on the shown alias names.

A changed sorting of the features can be saved in the project.

Function in the Cell Context Menu

In the cell context menu, which can be accessed by right-clicking into a selected cell, the following commands can be available, depending on the data type of the field:


	CNTRY_NAME	SOVEREIGN	POP_CNTRY	SQKM_CNTRY
	Aruba	Netherlands	67074	182,926
	Antigua and Barb	Antigua and Barb	65212	462,378
	Afghanistan			641869,188
	Algeria			2320972
	Azerbaijan			85808,203
	Albania	Albania	34184,5	28754,5
	Armenia	Armenia	3277220	29872,461

Figure 136: Cell context menu, using the example of a text field in edit mode

- **Copy**: copies the entered attribute value to the clipboard.
- **Show Value** (*only for text fields*): opens a text panel. Here, (longer) text is displayed as a whole. **OK** takes you back to the attribute table.
- **Open** (*only for text fields*): If a valid path to a file or an URL is entered in the text field, this file/URL is opened with the default program specified for the respective (file) type (e.g. PDFs with Adobe Reader or URLs with the default Internet browser). Otherwise, you are informed that the link cannot be opened.
- **Save Content to File** (*only for binary fields / BLOBs*): If file content is stored binary in a cell, the entry **bytes[file size]** is displayed. The stored file can then be saved again as an independent file via this context menu command or Ctrl+double-click into the cell. For this purpose, a file browser opens. Note that the file type must be known and specified when saving.
- **Open Image** (*only for binary fields / BLOBs*): If an image is stored binary in a cell, it can be opened directly via this context menu command or a double-click into the cell.

Special Case: Filtered Data

If a vector dataset is filtered by deactivating unique values in the TOC (see chapter 5.3.2.5), the filtered out features are temporarily hidden in map viewer and attribute table. In this case, the footer of the attribute table additionally shows how many features there would be unfiltered, i.e. how many features the layer actually contains:



	FID	SOVEREIGN	CNTRY_NAME	GMI_CNTRY	SQKM_CNTRY	SQ
▶	11	Argentina	Argentina	ARG	2781013	107
	25	Bolivia	Bolivia	BOL	1090353	420
	30	Brazil	Brazil	BRA	8507128	328
	43	Chile	Chile	CHL	742298,188	286
	48	Colombia	Colombia	COL	1141962	440


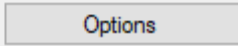

 Show: **All** Selected Features (33 Features / 0 selected / **251 unfiltered**) 

Figure 137: Example of an attribute table with subsequently filtered data

The number of "all" features displayed at the front in the () then refers to all features that are not filtered out, i.e. the features currently contained in the attribute tables.

Please note that with filtered data the number of selected features can exceed the number of "all" features, e.g. if features are first selected and then the layer is filtered. In the **Selected** display mode, you then actually see all selected features (i.e. also the ones that are filtered out).

The display "unfiltered" can also occur if the layer was filtered when the CMP file was created with GAFmap®. The layer is then marked in the TOC with a  filter icon above the layer icon. In this case, the filtered features are missing in the CMP and the number of unfiltered features therefore matches the number of all features.

Special Case: Display Names

If display names (alias names) have been assigned to an attribute field before creating the CMP file in GAFmap®, e.g. to improve the readability of coded attribute values, then the attribute table does not show the actual values entered, but "translated" values. The original values are displayed in a tooltip when you move the mouse pointer slowly over an affected cell.

	FID ▲	ID
	0	Transportation Line
	1	Transportation Line
	2	Transportation Line

Figure 138: If display names are used, the actual value entered is shown in a tooltip when you slowly move the mouse pointer over an affected cell.

Note that when features are sorted by attributes (see above), they are always sorted by the original values and never by the display names.

Further Table Functions under Options

Under the button **Options** in the table footer you reach various functions to edit and analyze the attribute table. These functions are described in the following chapters.

Shortcuts, Key Commands, etc.:

- Left-click on row header: mark* row/feature
- Shift when marking: mark several consecutive rows
- Ctrl when marking: add row(s) to current marking. Already marked rows are cleared when they are marked twice.
- Left-click in upper left table corner or Ctrl+A: mark all rows
- Ctrl+left-click in upper left table corner: invert marking
- Double-click on row header: mark row/feature and zoom map extent to corresponding feature geometry
- Ctrl+double-click on row header: zoom map extent to all marked features
- Alt(+Ctrl)+double-click on row header: center map on feature geometry/geometries (instead of zoom to)
- Left-click on column header: sort features/rows by this attribute field
- Ctrl+left-click on several column headers in a row: sort features/rows consecutively by these attribute fields
- Ctrl+double-click on layer name in TOC: open attribute table
- Arrow keys down/up with marked* line: mark next/previous line
- Arrow keys with marked* cell: mark next/previous/right/left cell

* In display mode All **mark** means **select**, in display mode Selected it means **highlight**

Tips and notes:

- The attribute table is dockable. For more information, see chapter 2.2.4.

5.3.2.1.1 Find

In **GAFmap Express**: TOC > Layer > Context Menu Vector Layer > Open Attribute Table > Options

With **Find** you can find cells in the attribute table that contain a specific word/string. To do this, simply call up the command, enter the character string you are looking for, and confirm with **OK**. In the attribute table, the first cell / attribute value after the current (cursor) position in which the searched string is found is then selected/highlighted. The search can be repeated with F3 (not with e.g. Enter); the selection then jumps to the next hit. The search is performed in "reading direction", i.e. first from left to right, then from top to bottom.

The following applies:

- An attribute value found does not have to correspond to the character string searched for, it must contain it; i.e. with *a*, not only cells containing the value *a* are returned, but also those containing *abc*, for example.
- The search is case-insensitive, i.e. upper/lower case is not taken into account.
- Numbers and dates are not recognized as such, but are interpreted as simple alphanumeric characters, i.e. as individual digits from 0-9, including the formatting with which they are currently displayed in the table. If, for example, *1,000.1* is displayed, then only *1,000.1* results in a match and not, for example, *1000,1* etc.
- If in the attribute table display names are shown (see chapter 5.3.2.1), what is currently visible in the attribute table is also decisive.
- A *|* between characters/strings means "or"; i.e. with e.g. *ab|cd* all values containing *ab* or *cd* are returned.
- *** serves as wildcard/placeholder; i.e. *a*c* finds e.g. *ac*, *abc*, *Acre*, or *Arch*.
- If you leave the input field empty, empty/unfilled cells are returned.

Using Regex

By default, the search is performed as described above. Alternatively, you can search with regex ("regular expression"). You can then perform a somewhat more complex (text) search, e.g. to find all values starting with an upper case letter and ending with a digit. For this, activate the setting **Use Regex** under menu Extras > Settings > **Search Layers**; it also affects the search in the attribute table.

Information on Regex can be found e.g. under the following links:

- [Regular expression - Wikipedia](#)
- [RegexOne - Learn Regular Expressions - Lesson 1: An Introduction, and the ABCs](#)
- [GitHub - ziishaned/learn-regex: Learn regex the easy way](#)

Please note in particular when searching in the attribute table with regex:

- The search is always only performed in individual cells, also with regex.
- Unlike the search without regex, the search with regex is case-sensitive.
- When searching with regex, `.*` serves as wildcard/placeholder instead of `*`
(`.` means "any character" in regex, `*` means "zero or more repetitions"; i.e. `a*c` finds e.g. `c`, `ac`, `aac`, `aaac` etc.; `a.*c` finds e.g. `ac`, `abc`, `acre`, or `arch`; `[aA].*c` finds e.g. `ac`, `abc`, `Acre`, or `Arch`).
- In regex, `.` is a reserved character (see above). If you search for numbers with decimal separator `.` (e.g. `1.2`), the escape character `\` must be added before the `.`. To find exactly `1.2`, you must therefore search for `1\.2`
(As the `.` means "any character" in regex and the `.` in `1.2` is in fact any character, `1.2` is found with the search expression `1.2`, but also `132`, `1,2`, `1n2` etc.)

Shortcuts, Key Commands, etc.:

- Ctrl+F: open input panel
- Enter in input panel: confirm input / start search
- F3: repeat search for previously entered string
- see chapter 5.3.2.1 for more.

Tips and Notes:

- Use the **Feature Search** in the corresponding toolbar if you want to search multiple layers at once and/or web services for a certain character string, and/or if you want to search across multiple attribute fields. Using that search, all features whose attributes contain the searched string are selected (not individual cells). For more information, see chapter 4.3.
- Alternatively, you can use **Select by Attribute** to find/select features with specific attributes or attribute combinations within a layer. There, you can explicitly address the individual attribute fields, i.e. you can, for example, find features for which the character string *Arch* appears specifically in the field [BuildType]. For more information, see chapter 5.3.2.1.2.

5.3.2.1.2 Select by Attribute

In GAFmap Express: TOC > Layer > Context Menu Vector Layer > Open Attribute Table > Options

Select by Attribute lets you select features with certain attributes within a vector layer. For this purpose, you can create a query condition either manually or with the help of an input wizard. All features that meet this condition are then selected.

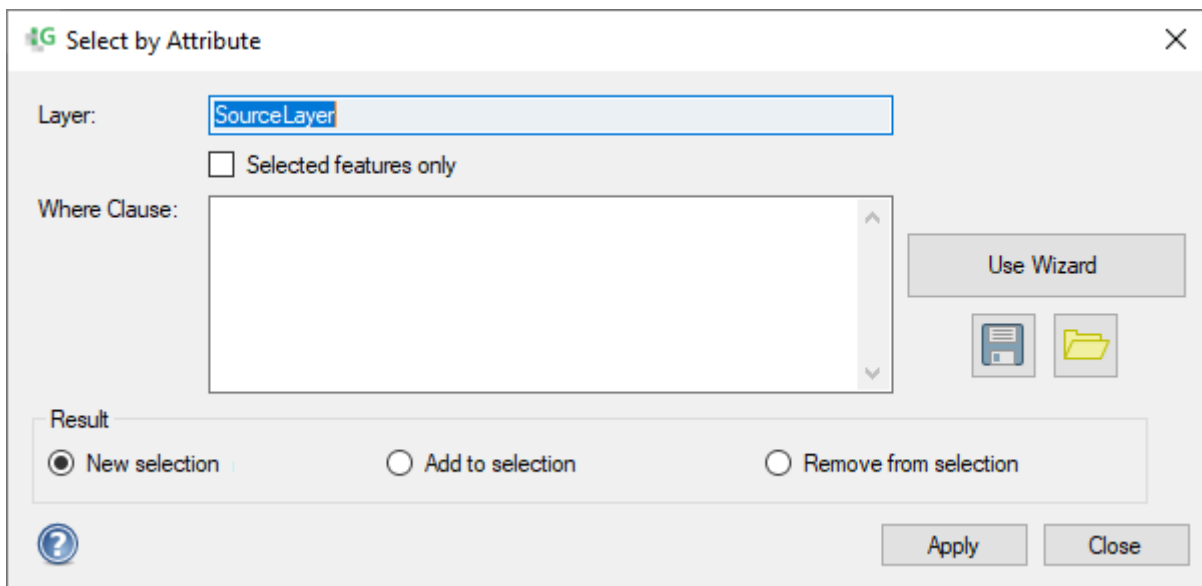


Figure 139: Dialog **Select by Attribute**

- **Layer:** displays the source layer. The features of this layer are selected if they meet the condition specified below.

Source layer is here always the vector layer from which the function was called.

Selected features only: if checked, only pre-selected features of the source layer are considered. Else, all features are considered, regardless of any existing pre-selection.

- **Where Clause:** Here, you can enter the query condition that a feature must meet to be selected (as a Where Clause). More information about how to create the input can be found below.

You can either type the condition directly or use the button **Use Wizard** to open the Query Wizard.



Save/Load: saves the entered Where Clause / opens a dialog to reload a saved Where Clause:

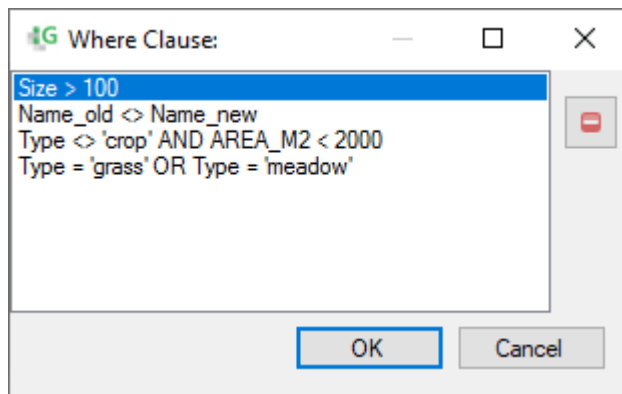



Figure 140: List of saved Where Clauses

-  deletes the selected Where Clause from the list

OK transfers the selected Where Clause to the text box in the main dialog; **Cancel** closes the list without further action. If a condition has already been entered in the text field, it remains unchanged.

If you want to save an entered query condition into an external text file instead of the list stored in the project, hold the Alt key while you click the Save button. This opens a file browser via which you can specify directory and filename for the text file (*.WhereClause). You can always reload a query condition saved as *.WhereClause by holding the Alt key and clicking the Load button.

- **Result:** depending on the selected mode, the following applies to the result of the query:
 - **New selection:** All features that meet the condition are newly selected. An existing pre-selection is discarded.
 - **Add to selection:** All features that meet the condition are selected. The result is added to the existing pre-selection.
 - **Remove from selection:** All features that meet the condition are removed from the existing pre-selection, i.e. they are deselected.

Apply sets the selection as specified, **Close** closes the dialog without further action.

Where Clauses

In the text box you can enter a query condition manually. It has to be framed as **Where Clause** in SQL syntax in the following way:

Attribute field - Operator - Attribute value or Attribute field 1 - Operator - Attribute field 2

- **Attribute field:** attribute field to be searched. The field name can be put in square brackets or be named without brackets. The field name is case insensitive.
- **Operator:** mathematical/logical condition that has to be fulfilled. Common examples are:
 - `= ; <> ; > ; < ; >= ; <=`
mathematical operators; also applicable for text and dates
 - `LIKE / NOT LIKE`
for text only; use % as wildcard
 - `IN ('value1', 'value2', 'value3')`
one of the listed values; list the searched values in round brackets, separated by commas
 - `IS NULL / IS NOT NULL`
is empty / not empty; this operator is not followed by a value or another attribute field
- **Attribute value:** searched attribute value(s) in the specified field. Please note:
 - Strings (= all entries in fields of the data type **Text**, including numbers and dates) have to be enclosed in single quotes.
 - Dates (= all entries in fields of the data type **DateTime**) have to be enclosed in single quotes. The date format is negligible.
 - Numbers (= all entries in fields of the data type **Integer**, **Double** etc.) have to be entered without quotes.
- Different queries can be connected with **AND** (all conditions apply) or **OR** (at least one condition applies). If both operations are used, **AND** has a stronger binding. However, you can always influence the order of operations with brackets.

Examples:

- `[FID] < 10`
A feature is returned if its FID is smaller than 10.
- `[SHAPE_OUTR] >= 2`
A (polygon) feature is returned if it has 2 or more outer rings, i.e. if it is a multipart polygon.*

- `[Type] = 'grass' OR [Type] = 'meadow' or [Type] LIKE 'grass' OR [Type] LIKE 'meadow' or [Type] IN ('grass','meadow')`
A feature is returned if the attribute "Type" is "grass" or "meadow".
- `[Name_old] <> [Name_new] or [Name_old] NOT LIKE [Name_new]`
A feature is returned if the attributes "Name_old" and "Name_new" differ.
- `[Type] = 'river' AND [Length_KM] < 1`
A (line) feature is returned if the attribute "Type" is "river" and if it is shorter than 1 km.*
- `[AREA_M2] > 2000 AND [Area_M2] < 5000`
A (polygon) feature is returned if its surface area is between 2000 m² und 5000 m².*
- `[Name] LIKE '%4Test%' OR [Name] LIKE '4_Test%'`
A feature is returned if the attribute "Name" contains the string "4Test" or starts with "4_Test".
- `[Date] < '2000-01-01' or [Date] < '01.01.2000'`
A feature is selected if the attribute "Date" holds a date before 01.01.2000.
- `[Type] IS NULL`
A feature is selected if the attribute field "Type" is empty.

Please note:

- * To all examples above applies: Queries regarding a feature's geometry (e.g. its length or surface area) refer to the respective **Geometry Field**. This presupposes the field is actually added to the table!
- Whether text entries (strings) are case sensitive depends on the layer property **Case Sensitive** (see chapter 5.3.2.5).
- **Empty Fields** are not included if you use the Operators `<>` or `NOT LIKE`. Therefore, the special case "empty" has to be added separately to the query if you want to select features with a certain attribute field e.g. not containing the value "A".

Example: `[Field] <> 'A' OR [Field] IS NULL.`

Query Wizard

If you need assistance with entering the Where Clause, click the **Use Wizard** button to open the **Query Wizard**:

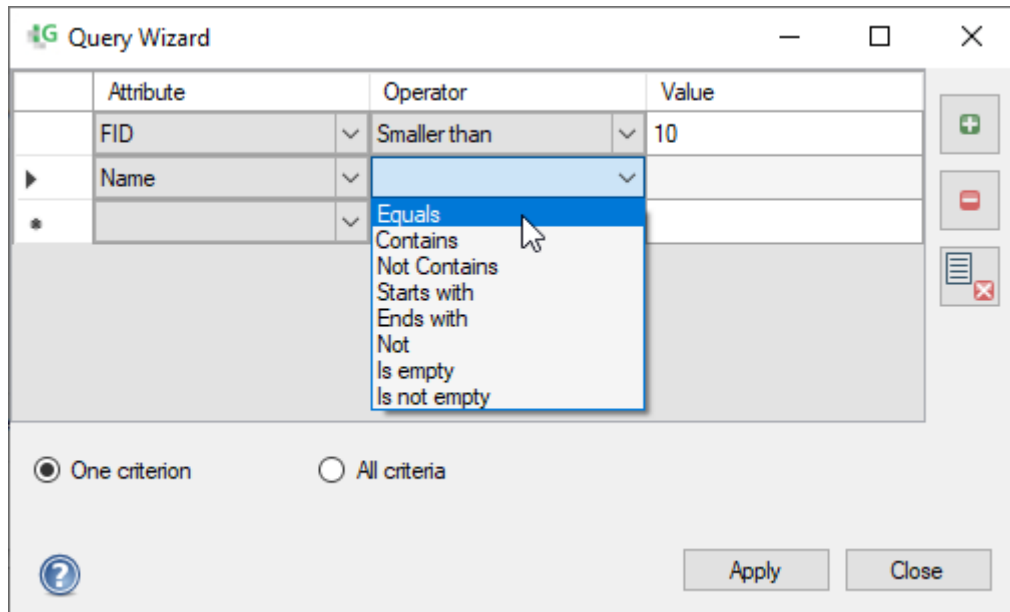


Figure 141: Dialog Select by Attribute > **Query Wizard**

- **Attribute:** attribute field to be searched. All attribute fields are available in the drop-down list.
- **Operator:** mathematical/logical condition that has to be fulfilled. Depending on the data type of the selected field, different operators are available in the drop-down list.
- **Value:** searched attribute value in the specified field. The value can either be entered manually, or selected from a list of all values currently existing in this field. You can view the list with a double-click in the field **Value**.

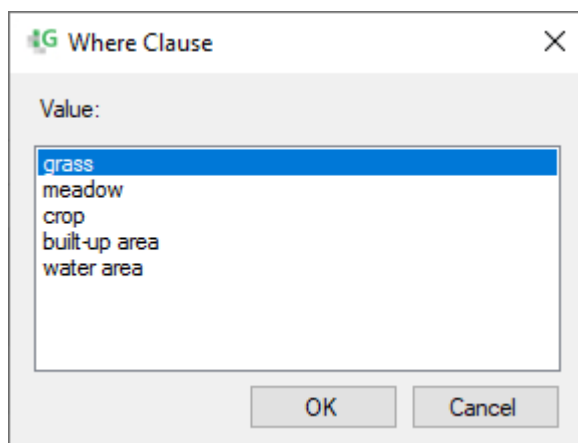





Figure 142: List of all values currently existing in the searched field

- **OK** or a double-click transfers the selected value to the field **Value**.

If you want to combine several conditions, add any number of rows and enter the different conditions.

-  adds a row for another condition
-  deletes the selected row/condition
-  deletes all rows/conditions

If multiple conditions are defined, determine via the radio buttons at the bottom if only one criterion must be met or all at once:

- **One criterion:** only one of the criteria entered must be fulfilled (**OR**-operation)
- **All criteria:** all criteria entered must be fulfilled (**AND**-operation)

Apply "translates" the entered query in SQL syntax and transfers it as **Where Clause** to the text box in the main dialog. Here, it can still be edited as needed or discarded. **Close** closes the Query Wizard without further action. If a query condition has already been entered in the text field, it remains unchanged.

The Query Wizard saves the last query until GAFmap® is closed. If the query was adjusted manually in the meantime or another condition (Where Clause) was entered manually, a corresponding error message appears when opening the wizard.

Shortcuts, Key Commands, etc.:

- Alt while clicking the Save (Where Clause) button: save the expression to a separate text file (*.WhereClause)
- Alt while clicking the Load (Where Clause) button: Load an expression saved as *.WhereClause

Tips and notes:

- You can also reach this function directly via the context menu of the vector layer (context menu > **Select by Attribute**).
- For general information on the topic Feature Selection, see chapter 4.2.3.1.

5.3.2.1.3 Select by Location

In GAFmap Express: TOC > Layer > Context Menu Vector Layer > Open Attribute Table > Options

Select by Location lets you select all features within a vector layer that have a certain spatial relation to another feature. This means that you can, for example, select all features that intersect, touch, contain, etc. another feature.

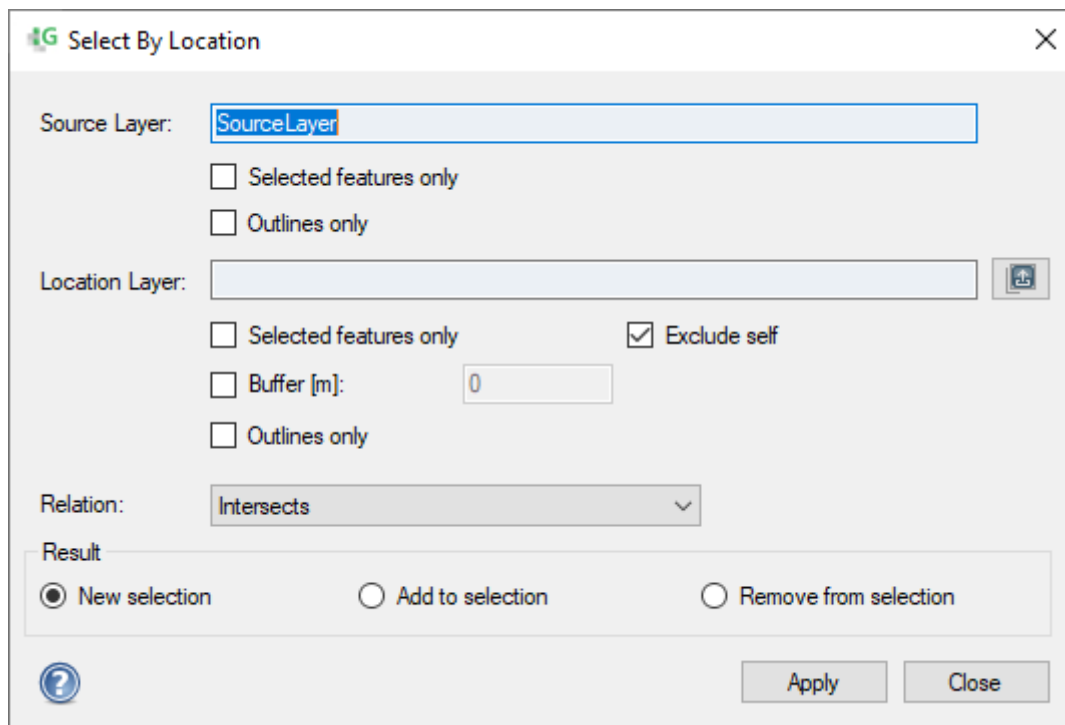


Figure 143: Dialog **Select by Location**

- **Source Layer:** determines the source layer(s). The features of the source layer(s) are selected if they meet the condition specified below.

Source layer is here always the vector layer from which the function was called.

Selected features only: if checked, only preselected features of the source layer are considered. Else, all features of the source layer are considered, regardless of any feature selection.

Outlines only (*only for polygon layers*): if checked, only the outline is considered during intersection, not the entire polygon. The polygon layer is then treated like a line layer. If a polygon has multiple outer and/or inner rings, the rings of the polygon form a multipart line.

- **Location Layer:** determines the layer the source layer is intersected with. All layers and graphics are available for selection, also the source layer.



opens a layer selection panel

Selected features only: if checked, only selected features of the location layer are considered. Else, all features of the location layer are considered, regardless of any feature selection.

Exclude self (*only relevant if source layer = location layer*): if checked, features are not checked against themselves. This is usually important when you want to query spatial relations between the individual features of a layer, e.g. if you want to find identical, intersecting, overlapping, etc. features within a layer. Otherwise, always all or no features are selected, as a feature is always e.g. identical, intersecting, overlapping, etc. "with itself". However, unchecking this option can be appropriate if you are working with different preselections for source layer and location layer and the **Selected features only** option, meaning that the geometry set to be checked is not identical).

Buffer [m]: if checked, all features of the location layer are buffered by the distance entered in the adjacent field. For the intersection, geometries that are accordingly enlarged outward (for positive values) or shrunk inward (for negative values) are then used. This lets you find, for example, source features that are located within a certain distance around the location features).

Outlines only (*only for polygon layers*): if checked, only the outline is considered during intersection, not the entire polygon. The polygon layer is then treated like a line layer. If a polygon has multiple outer and/or inner rings, the rings of the polygon form a multipart line.

- **Union:** if checked, all features of the location layer are merged before the intersection (temporarily in the background). The layer is then treated as if it contained only a single (multipart) feature. Boundaries or overlaps between individual features are therefore no longer relevant.

If unchecked, the features of the location layer are considered individually. This option is particularly relevant when checking spatial relations in which the geometry outlines are of importance, e.g. for **Completely within** (see below):

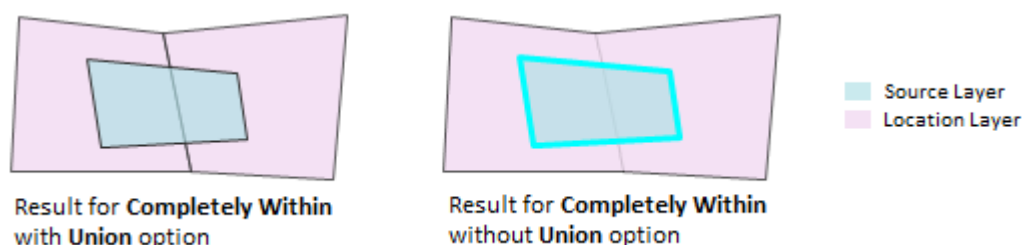


Figure 144: Impact of the **Union** option with relation **Completely within**

- **Relation:** specifies which spatial relation a feature of the source layer must have to a feature of the location layer to be selected. See below for more information about the available relations.

- **None, Any, or All:** specifies whether a feature of the source layer must not fulfill the spatial relation with any feature of the location layer, or whether it must fulfill it with any feature or with all features of the location layer, in order to be selected. Using the example **Contains**: The source feature is selected if it contains **no, any, or all** feature(s) of the location layer.
- **Result:** depending on the selected mode, the following applies to the result of the query:
 - **New selection:** All features that meet the condition are newly selected. An existing preselection is discarded.
 - **Add to selection:** All features that meet the condition are selected. The result is added to the preselection.
 - **Remove from selection:** All features that meet the condition are removed from the preselection, i.e. they are deselected.

Apply sets the selection as specified, **Close** closes the dialog without further action.

! Please consider the notes at the end of the following section!

Spatial Relations

The selection of a feature of the source layer (**SL**) is determined by its spatial relation to a feature of the location layer (**LL**). Depending on the geometry type of SL and LL, different relation types are available:

- **Intersects:**

Available for all geometry types without restrictions

The SL-feature touches at least one LL-feature in at least one point.

- **Overlaps:**

Only available if SL and LL are of the same geometry type

The SL-feature overlaps at least one LL-feature completely or partly. The following applies:

- If SL/LL = polygon: the SL-feature is only selected if the polygons truly overlap, i.e. not only their outlines or if they are partially or (in the case of inner rings) completely congruent.
- If SL/LL = line: corresponds to **Share Line Segment** (see below)
- If SL/LL = point: corresponds to **Intersects** (see above)

- **Completely Within:**

Only available if SL and LL are of the same geometry type or if LL has a higher dimension

The SL-feature is completely within at least one LL-feature. The following applies:

- If SL/LL = polygon: if the SL-feature (polygon or line) lies completely within a LL-polygon and touches its outline from the inside, it is still returned as "completely within". If the SL-feature (line or point) lies exclusively on a LL-polygon's outline, it is not returned as "completely within".
- If SL/LL = line: if the SL-feature (line) lies completely on a LL-line and touches its start/end point, it is still returned as "completely within". If the SL-feature (point) exclusively lies on a LL-line's start/end point, it is not returned as "completely within".

Special case: if a LL-line forms a closed ring, the SL-feature is also returned as "completely within" when it crosses the start/end point (line) or exclusively lies on the start/end point (point).

- If SL/LL = point: corresponds to **Intersects** (see above)

- **Contains:**

Only available if SL and LL are of the same geometry type or if SL has a higher dimension

The SL-feature contains at least one LL-feature completely, i.e. at least one LL-feature is **completely within** the SL-feature (see above).

- **Equals Topologically:**

Only available if SL and LL are of the same geometry type

The SL-feature and at least one LL-feature are coincident; this means for points that they lie exactly on top of each other, and for lines and polygons that all rings/lines have exactly the same course. In contrast to **Identical** (see below), the vertex IDs, the numbering of rings/geometry parts, and even the number of vertices can differ (as long as additional vertices are snapped to a line segment).

- **Identical:**

Only available if SL and LL are of the same geometry type

The SL-feature is identical to at least one LL-feature. Identical means "identical to the last vertex", including exact vertex coordinates without any tolerance and vertex IDs (i.e. same start/end point and direction), numbering of rings/geometry parts, Z component and Z value, etc.

- **Shares Line Segment:**

Only available if SL and LL are line layers and/or polygon layers

The SL-feature shares at least one line segment with at least one LL-feature. Shared vertices are not required, as long as the (out)lines overlap completely or partly. If the (out)lines touch in only one point, the SL is not returned as "shares line segment". The following applies:

- If SL and/or LL = polygon: only the outline is considered, regardless of the option **Outlines only**.

- **Parts Inside and Outside:**

Only available if LL is a polygon layer and SL is a line layer or polygon layer

The SL-feature lies partly inside and outside of at least one LL-polygon. A LL-polygon's outline counts neither as inside nor outside. So, if a SL-feature lies inside or outside a LL-polygon, touches its outline but does not cross it, it is not returned as "parts inside and outside".

- **Centroid Intersects:**

Available for all geometry types without restrictions

The centroid of the SL-feature intersects at least one LL-feature.

The centroid of a feature can be determined independently of the geometry type. For points, it coincides with the point. For lines and polygons, it can be outside the feature geometry, depending on the shape of the geometry. For each feature exactly one centroid is determined, also for multipart features (= features with multiple geometry parts; see e.g. chapter 5.3.2.1). For multipart features the centroid is therefore usually located between the geometry parts.

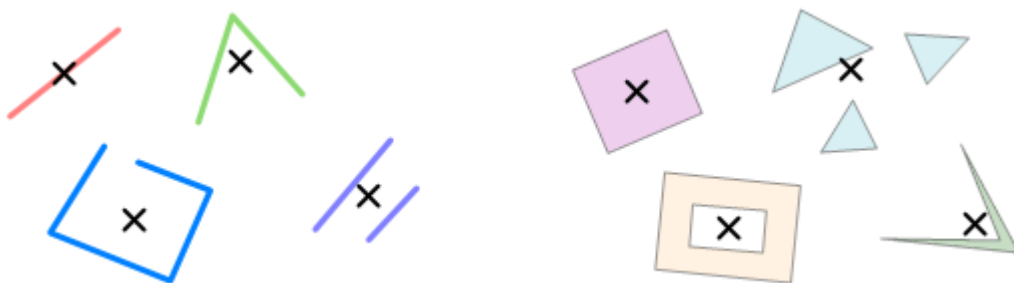


Figure 145: **Select by Location** - examples of centroids for lines and polygons

- **DE-9IM Relation:**

Available for all geometry types without restrictions

The spatial relation between the SL- and the LL-feature is defined according to the DE-9IM model (see below).

Enter the desired relation in the adjacent input field.

For all relations applies:

- **!** By default (without the **Union** option), a SL-feature is selected as soon as it fulfills the given relation with **a single LL-feature**, also if it does not fulfill it with another LL-feature. The latter may be relevant, for example, in relations such as **Completely within** if one SL-feature lies completely within a LL-feature but intersects another one, or if certain spatial relations are explicitly excluded in the **DE-9IM relation** (e.g. "no intersection with the polygon ring"). In both cases, the mentioned feature would be selected!
- If not stated otherwise, touching points between features do not require a shared vertex to be identified as such. The decisive factor is whether a point or a vertex is snapped to an (out)line.
- You can also select z-aware layers as SL and/or LL. Note, however, that the height is ignored (exception: **Identical**; see above).

DE-9IM Relation

The **DE-9IM model** (Dimensionally Extended 9-Intersection Model) is a standard used to define topological relations between two geometries with regard to the three areas

- **Interior** (= the entire geometry without its boundary),
- **Boundary** (= the outlines/rings(s) of polygons and the endpoints of lines; points have no boundary), and
- **Exterior** (= the area outside the geometry, including its boundaries).

Geometry Type	Interior	Boundary	Exterior
Point			
Line			
Line ring			
Polygon			

Figure 146: **DE-9IM model**: Interior, boundary, and exterior of different geometry types (indicated in red)

With the **DE-9IM relation**, you can specify exactly whether and with which dimension the three areas of the source layer feature (**SF**) and location layer feature (**LF**) must intersect in order for the SF to be selected. For this purpose, a matrix is used that compares all three areas of both features with each other:

	Interior GF	Boundary GF	Exterior GF
Interior QF	1	2	3
Boundary QF	4	5	6
Exterior QF	7	8	9

Figure 147: **DE-9IM model**: Intersection matrix. The numbers indicate the position in the DE-9IM expression.

The matrix, read from top left to bottom right, is given as a simple sting with nine places:

DE-9IM-Formel: **123 456 789**

where **1** stands for "Interior SF intersects Interior LF", **2** for "Interior SF intersects Boundary LF", **3** for "Interior SF intersects Exterior LF", **4** for "Boundary SF intersects Interior LF", etc.

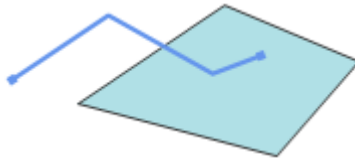
Whether or how the areas intersect is specified in the expression as follows:

- **T** (true): the areas intersect (regardless of how)
- **F** (false): the areas do not intersect
- **0** (zero-dimensional): the areas intersect in a point
- **1** (one-dimensional): the areas intersect in a line
- **2** (two-dimensional): the areas intersect in an area
- ***** (not specified): the relation is not checked / does not matter

! In the expression, the relation must be defined/specified individually for each of the nine places (with T, F, 0, 1, 2, or *). No place may be omitted. Spaces, e.g. inserted for better readability, are ignored.

Examples:

- **Example 1:** All lines that enter a polygon from outside and end inside it are to be selected:



(Line = SF, Polygon = LF)

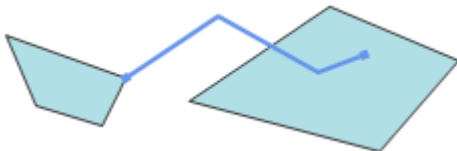
Lines that start inside or outside the polygon and end at the polygon ring, lie completely within the polygon, or do not intersect it at all are not to be selected.

DE-9IM relation:

e.g. **101 0F0 212** or ***** T*T *****

The first approach accurately describes the situation in the illustration above, while the second one is limited to the information that "one endpoint of the line lies within the polygon and the other one outside the polygon". Various other approaches are possible!

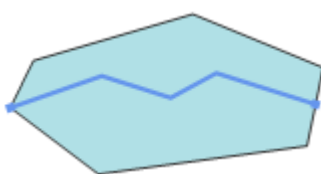
! Note that the SF is selected as soon as it fulfills the relation with **a single LF**, even if it does not fulfill it with another one! With **101 0F0 212**, the following line would also be selected (even though it ends at a polygon ring and "Boundary SF intersects Boundary LF" is explicitly exclude):



If you want to exclude such lines from the selection, you can remove them in a subsequent step (e.g. with ***** *T* ***** and the **Remove from selection** option; see above).

(With the **Union** option, different rules apply; see above.)

- **Example 2:** All lines that lie completely within a polygon and whose both ends lie on the polygon's outline are to be selected:



(Line = SF, Polygon = LF)

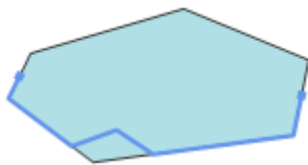
Lines that are not completely within a polygon and/or whose both end points do not lie on the polygon's outline are not to be selected.

DE-9IM relation:

e.g. **1FF F0F 212** or **TF* FT* *****

The first approach accurately describes the situation in the illustration above, while the second one is limited to the information that "the line itself lies completely within the polygon and does not intersect the outline, the endpoints lie on the polygon's outline and not inside it". Various other approaches are possible!

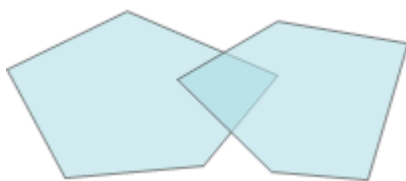
If "the line itself does not intersect the outline" were not explicitly required, i.e. the given relation would be e.g. **1*F F0F 212** or **T** FT* *****, then the selection, unlike the one with the relation given above, would also include lines like this:



(Line = SF, Polygon = LF)

(Lines that run exclusively on the polygon outline would not be included in both cases, as they do not meet the condition "lies within the polygon = intersects the interior of the polygon".)

- **Example 3:** All polygons that overlap with another polygon are to be selected:



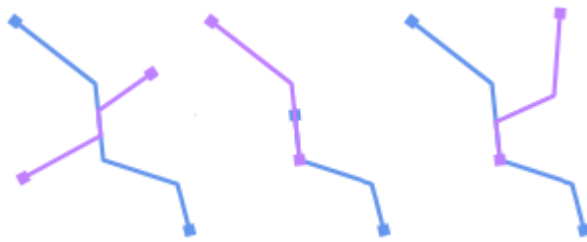
(Polygon = SF & LF, **Exclude self** = checked)

DE-9IM relation:

e.g. **212 101 212** or **T** *** ****

The first approach accurately describes the situation in the illustration above, while the second one selects features whose interior overlaps with that of another feature. Unlike with the first approach, the selection in the second one also includes polygons that are completely within another polygon or contain another polygon, or polygons that are topologically equal or identical. (The first one does not, because here, among other things, "Interior SF intersects Exterior LL in an area" and "Exterior SF intersects Interior LL in an area" is explicitly required.)

- **Example 4:** The lines of a line layer should cleanly end or cross each other with a single intersection point, but should not share a line segment in any case. Therefore, lines such as these are to be found/selected:



(Line = SF & LF, **Exclude self** = checked)

DE-9IM relation:

e.g. **1** *** ****

All lines whose interiors intersect as a line are selected here. If only lines whose interiors intersect were searched for, regardless of how, i.e. if the approach were **T** *** ****, then the selection would also contain lines that cross each other with a single intersection point.

The preentered relation **T*F **F FF*** is equivalent to the relation **Equals Topologically**, which can be selected from the drop-down list (see above).

More information can be found e.g. here: <https://en.wikipedia.org/wiki/DE-9IM>



You can enter the DE-9IM relation directly or open the **DE-9IM Pattern Editor** using the button next to the input field. The editor provides the DE-9IM matrix and all possible intersection types:

	Interior (B)	Boundary (B)	Exterior (B)
Interior (A)	T - Has Intersection	* - Not Checked	F - No Intersection
Boundary (A)	* - Not Checked	* - Not Checked	F - No Intersection
Exterior (A)	F - No Intersection	F - No Intersection	* - Not Checked

OK Cancel

Figure 148: **DE-9IM Pattern Editor** (A = source layer feature, B = location layer feature)

Select the desired intersection type for each combination from the drop-down list and confirm with **OK**. The corresponding DE-9IM relation is then created and transferred to the input field. It can still be edited there.

Tips and notes:

- You can also reach this function directly via the context menu of the vector layer (context menu > **Select by Location**).
- For general information on the topic feature selection, see chapter 4.2.3.1.

5.3.2.1.4 Invert Selection

In **GAFmap Express**: TOC > Layer > Context Menu Vector Layer > Open Attribute Table > Options

Invert Selection lets you invert the current selection. This means that selected features are cleared and vice versa.

Shortcuts, Key Commands, etc.:

- Ctrl+left-click in upper left table corner in display mode All: invert selection

Tips and notes:

- Alternatively, you can also invert a layer's feature selection via its context menu (see chapter 5.3.2.3.4).
- For general information on the topic feature selection, see chapter 4.2.3.1.

5.3.2.1.5 Invert Highlighted Features

In **GAFmap Express**: TOC > Layer > Context Menu Vector Layer > Open Attribute Table > Options

Only active in in display mode Selected (see chapter 5.3.2.1).

Invert Highlighted Features lets you invert the current highlighting. This means that highlighted features are cleared and vice versa.

Shortcuts, Key Commands, etc.:

- Ctrl+left-click in upper left table corner: invert highlighted features

5.3.2.1.6 Copy All/Selected Rows to Clipboard

In GAFmap Express: TOC > Layer > Context Menu Vector Layer > Open Attribute Table > Options

Copy All Rows to Clipboard or **Copy Selected Rows to Clipboard** lets you copy all or only selected rows from the attribute table to the (Windows) clipboard, e.g. to paste them into an Excel or OpenOfficeCalc table for further use. The table is always copied "as seen", which means:

- All currently visible columns are copied in the current order, including column names. So it is taken into account if columns are temporarily moved (see chapter 5.3.2.1).
- All attribute values are copied as currently displayed. This means, for example, that
 - the displayed **decimal separator** (i.e. comma in the German or dot in the English language version; see chapter 3.4.2) or
 - the displayed **date format**is taken over.

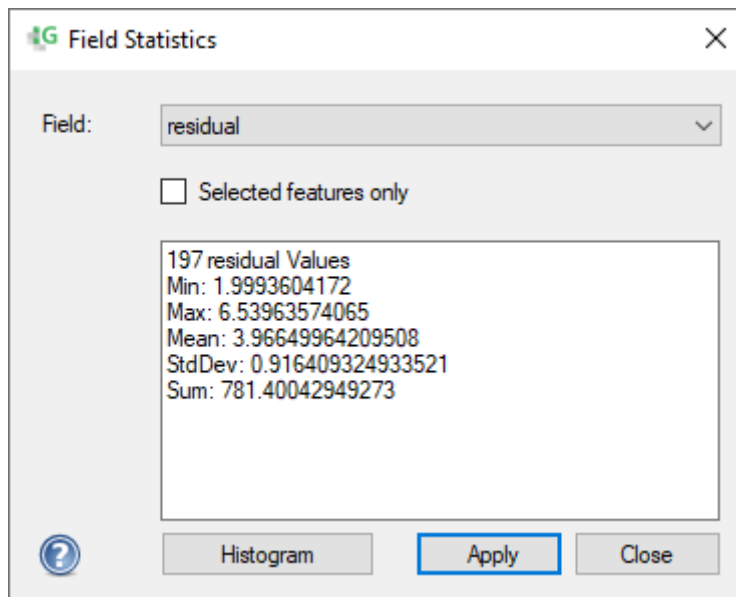
The information about the data type is lost when copying to the clipboard. How the values are interpreted when they are pasted e.g. into an external table, depends on the program used. If you paste the rows into Excel, for example, the (Windows) language settings are relevant for the interpretation of decimal numbers and data in addition to the cell formatting.

5.3.2.1.7 Field Statistics

In GAFmap Express: TOC > Layer > Context Menu Vector Layer > Open Attribute Table > Options

Field Statistics lets you display a simple statistic (number of values, smallest/biggest value, mean value, standard deviation and sum) for numeric attribute fields and/or create a histogram of the attribute values.

First, select the field for which the statistics are to be calculated:

Figure 149: **Field Statistics** - Example

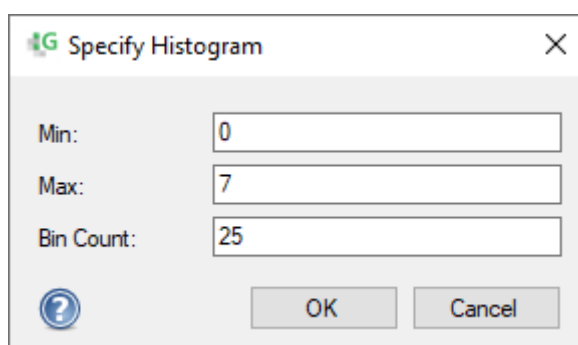
- **Field:** determines the attribute field the statistics are to be calculated for. All numeric attribute fields are available for selection.

☐ opens a drop-down list

Selected features only: if checked, the statistics are only created for selected features. If unchecked, all features are considered, regardless of any existing selection.

With **Apply** the statistics are calculated and displayed in the dialog (as text), **Cancel** closes the dialog without further action.

If you want to create a histogram of the attribute values, i.e. a graphical display of the frequency distribution, press the button **Histogram**. First, the **Specify Histogram** dialog opens. Here you can define the limits and the level of detail for the diagram:

Figure 150: Dialog **Specify Histogram**

- **Min/Max:** determines the lower/upper limit of the Histogram, i.e. the smallest/biggest value displayed. If the attribute field contains values that lie outside the limits, these are not displayed in the Histogram.

- **Bin Count:** determines the number of Bars/Bins displayed in Histogram, i.e. how detailed it is. Between **Min** and **Max** a corresponding number of value classes are then formed, into which the attribute values are grouped. The classes are always equidistant (= same value distance/range). Consequently, the Bars displayed in the Histogram are always the same width.

If you confirm with **OK**, the Histogram is calculated and the **Histogram** window opens:

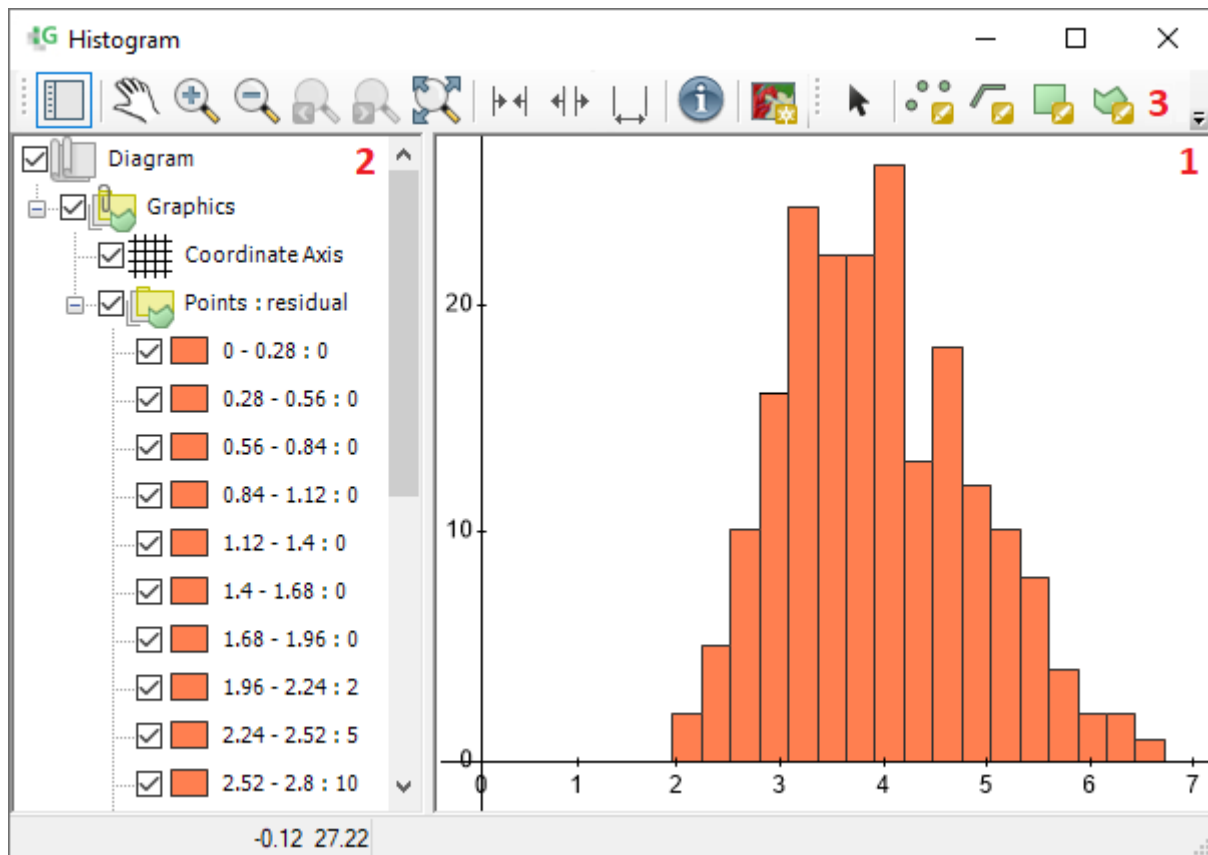


Figure 151: **Histogram** window (attribute values Histogram)

Diagram Viewer (1)

In the **Diagram Viewer** on the right, the histogram, i.e. the frequency distribution of the attribute values is displayed graphically. The X-axis shows the attribute values, the Y-axis the number of features that fall into the displayed value classes. Limits and level of detail correspond to the entries in the **Specify Histogram** dialog (see above).

In the **Status Bar** below the diagram viewer, the X/Y-coordinates of the current mouse position in the diagram are displayed.

Table of Content (2)

In the **TOC** to the left all elements contained in the diagram are listed under **Diagram > Graphics**. The TOC can contain:













- The **coordinate axes**. You can view and adjust their properties via **Properties** in the context menu of the coordinate axes (e.g. the axes labeling, step size, or position of the origin).
- The folder [name original vector layer] : [name field] contains the displayed **value classes** (bins), each represented as a rectangle graphic. Next to the rectangle symbol the class boundaries and (behind the :) the number of features that fall into the classes are displayed. Always all classes are listed, including those that are empty and therefore cannot be seen in the Diagram window (because the height is 0).

Via **Properties** in the context menu of a rectangle you can view and adjust its properties (e.g. the color or labeling of the bins). For more information on this and on the functions available in the context menu, see chapter 5.2.6.

- All **graphics** added via the toolbar (see below). For more information on their context menus and properties, see chapter 5.2 et seqq.

Toolbar (3)

Via the **toolbar** on the top of the histogram window you can:

-  **Show/Hide the TOC**,
-       adjust the visible extent in the diagram viewer. Alternatively, you can use the common shortcuts to adjust the visible extent (see chapter 4.1.3 et seqq.).
-  adjust the axis ratio stepwise or fit it to the window.
-  **Identify** the layers/elements in the diagram viewer (see chapter 4.1.11),
-  **Export the Diagram** (see chapter 4.5.12),
-  add and edit various graphics (see chapter 4.7.1 et seqq.), or
-  gradually **Undo/Redo** all performed actions. Which action is undone/redone next, is shown in the tooltip.

5.3.2.1.8 Scatter Plot

In GAFmap Express: TOC > Layer > Context Menu Vector Layer > Open Attribute Table > Options

Scatter Plot lets you create a scatter plot (also "point clouds") for a values pair from two attribute fields of a vector layer. First, select the two fields for which the scatter plot is to be created:

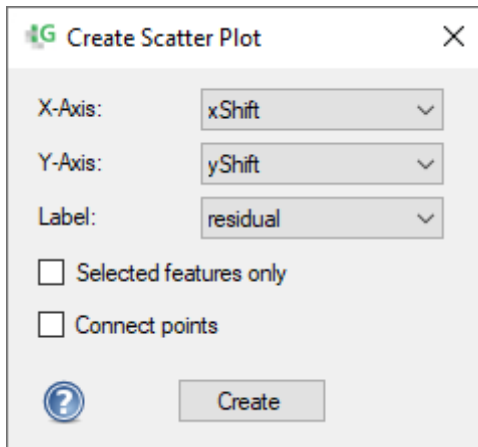


Figure 152: Dialog **Create Scatter Plot**

- **X-Axis:** determines from which attribute field the values for the X-axis of the scatter plot are read. All numeric fields and date fields are available for selection.
▼ opens a drop-down list
- **Y-Axis:** determines from which attribute field the values for the Y-axis of the scatter plot are read. All numeric fields are available for selection.
▼ opens a drop-down list
- **Label:** determines the attribute field the individual point graphics in the TOC of the diagram are named after.
▼ opens a drop-down list
- **Selected features only:** if checked, the scatter plot is only created for selected features. If unchecked, all features are considered, regardless of any existing selection.
- **Connect points:** if checked, the individual points in the scatter plot are connected with a line along the X axis, i.e. a curve is displayed (additionally).

With **Create** the Scatter Plot is created and the **Scatter Plot** window is opened:

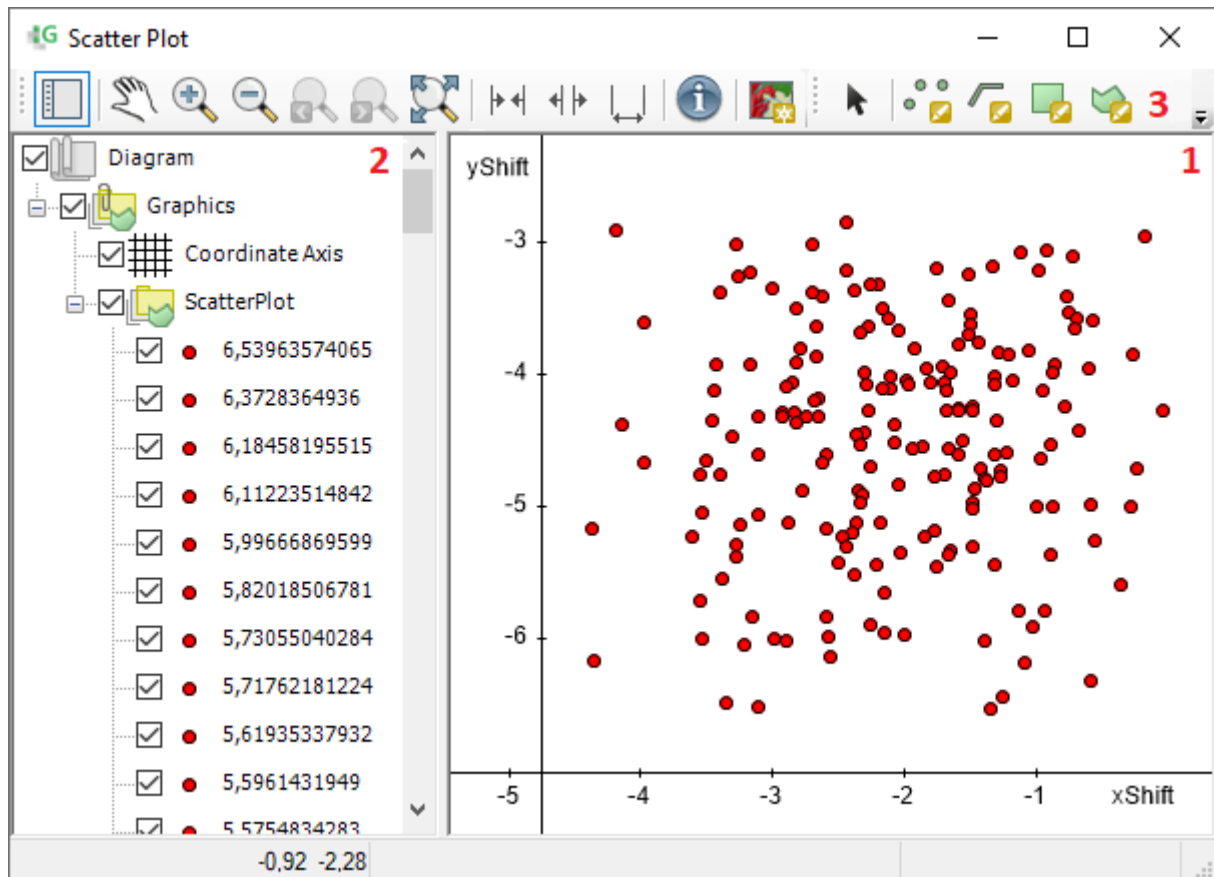


Figure 153: **Scatter Plot** window

Diagram Viewer (1)

In the **Diagram Viewer** to the right the scatter plot is displayed graphically. X- and Y-axis map the two previously defined attribute fields. Each point represents a feature of the vector layer and is located in the coordinate system according to the value pair taken from the two fields (see above). Note that features, for which at least one of the two fields is empty, are missing in the Scatter Plot, since no value pair can be built for them.

In the **Status Bar** below the diagram viewer, the X/Y-coordinates of the current mouse position in the diagram are displayed.

Table of Content (2)

In the **TOC** on the left all elements contained in the diagram are listed under **Diagram > Graphics**. The TOC can contain:

- The **coordinate axes**. You can view and adjust their properties via **Properties** in the context menu of the coordinate axes (e.g. the axes labeling, step size, or position of the origin).

- The folder that has the same name as the original vector layer, contains a point graphic for each displayed **value pair**. Each point represents a feature of the vector layer. The name, i.e. the name of the points behind the point symbol, for each feature corresponds to the value from the attribute field, which was previously defined in the dialog under **Label** (see above).



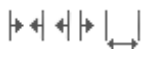




The point symbol is assigned by default for each point graphic so that it corresponds to the original feature. If the vector layer is a point layer, the point symbol matches exactly, for line and polygon layers the color is adopted.

Via **Properties** in the context menu of a point you can view and adjust its properties (e.g. the point symbol). For more information on this and on the functions available in the context menu, see chapter 5.2.4.

- All **graphics** added via the toolbar (see below). For more information on their context menus and properties, see chapter 5.2 et seqq.

Toolbar (3)

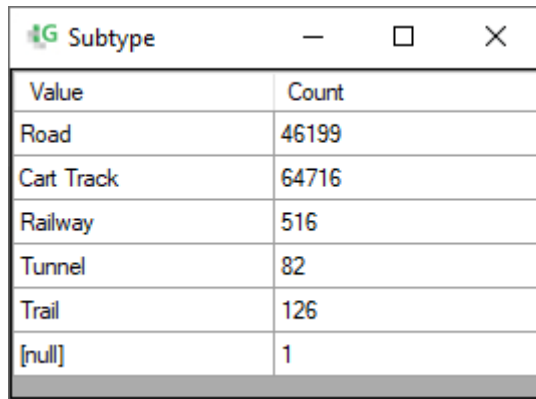
Via the **toolbar** on the top of the **Scatter Plot** window you can:

-  **Show/Hide the TOC**,
-  adjust the visible extent in the diagram viewer. Alternatively, you can use the common shortcuts to adjust the visible extent (see chapter 4.1.3 et seqq.).
-  adjust the axis ratio stepwise or fit it to the window.
-  **Identify** the layers/elements in the diagram viewer (see chapter 4.1.11),
-  **Export the Diagram** (see chapter 4.5.12),
-  add and edit various graphics (see chapter 4.7.1 et seqq.), or
-  gradually **Undo/Redo** all performed actions. Which action is undone/redone next, is shown in the tooltip.

5.3.2.1.9 Unique Value Count

In GAfmap Express: TOC > Layer > Context Menu Vector Layer > Open Attribute Table > Options

Unique Value Count creates a list of all values appearing in a chosen attribute field including their count, regardless of a field's data type.



Value	Count
Road	46199
Cart Track	64716
Railway	516
Tunnel	82
Trail	126
[null]	1

Figure 154: **Count Unique Values** - Example**Note**

- that for text fields the unique value count is case sensitive.
- that unique values deactivated in the TOC are not taken into account.

By default, the order of the unique values in the list equals the order of their appearance in the attribute table (current sorting). However, you can always sort the list ascending or descending by **Value** or **Count** by clicking the respective column header.

Shortcuts, Key Commands, etc.:

- Ctrl+A: select all rows
- Ctrl when selecting: add selection to current selection. Already selected features / rows will be deselected when they are selected twice
- Shift when selecting: select several consecutive rows at once
- Ctrl+C: Copy selected rows to the Clip Board

5.3.2.1.10 Resize Columns

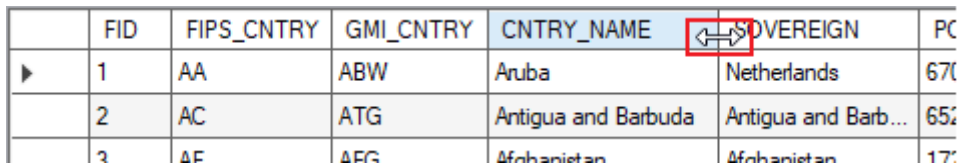
In GAFmap Express: TOC > Layer > Context Menu Vector Layer > Open Attribute Table > Options

Resize Columns lets you optimize the (currently displayed) width of all columns in the attribute table at once. The width of each column can be adjusted to

- the **Content**,
- the **Header**, or
- to **Content & Header**.

You can always adjust the width of a column in the table manually by moving the mouse pointer over the separator between two column headers until a move arrow appears, grab-

bing the separator with the left mouse button, dragging it to the desired position, and releasing the mouse button. Double-clicking with the move arrow active adjusts the width of the (left-hand) column to content and header.



	FID	FIPS_CNTRY	GMI_CNTRY	CNTRY_NAME	SOVEREIGN	PC
▶	1	AA	ABW	Aruba	Netherlands	670
	2	AC	ATG	Antigua and Barbuda	Antigua and Barb...	652
	3	AF	AFG	Afghanistan	Afghanistan	170

Figure 155: Manually adjusting the width of columns in the attribute table

Shortcuts, Key Commands, etc.:

- Double-click on separator between two column headers (with move arrow active): adjust width of (left-hand) column to content and header

5.3.2.2 Close Attribute Table

In **GAFmap Express**: TOC > Layer > Context Menu Vector Layer

Only available if an attribute table is open for at least one selected layer

Close Attribute Table closes the attribute tables of all layers selected in the TOC. Alternatively, attribute tables can be closed (individually) via the X button at the top right of the table.

5.3.2.3 Selection

5.3.2.3.1 Select All Features

In **GAFmap Express**: TOC > Layer > Context Menu Vector Layer > Selection

Select All Features lets you select all features of the source layer. The feature selection of other layers remains unchanged.

Tips and notes:

- In the **Attribute Table** (see chapter 5.3.2.1) you can select all features with a left-click in the upper left corner of the table or by pressing Ctrl+A.
- For general information on the topic feature selection, see chapter 4.2.3.1.

5.3.2.3.2 Clear Selection

In GAFmap Express: TOC > Layer > Context Menu Vector Layer > Selection

Only available if any features of at least one source layer are selected

Clear Selection lets you deselect all features of the source layer(s). The feature selection of other layers remains unchanged.

Tips and notes:

- If you want to deselect all features of all layers, use for example **Clear Selection** in the Toolbar for Features (see chapter 4.2.4).
- For general information on the topic feature selection, see chapter 4.2.3.1.

5.3.2.3.3 Clear Selection of Other Layers

In GAFmap Express: TOC > Layer > Context Menu Vector Layer > Selection

Clear Selection of Other Layers lets you deselect all selected features of all layers but the source layer. Only the feature selection of the source layer is preserved.

Tips and notes:

- If you want to deselect all features of all layers, use for example **Clear Selection** in the Toolbar for Features (see chapter 4.2.4).
- For general information on the topic feature selection, see chapter 4.2.3.1.

5.3.2.3.4 Invert Selection

In GAFmap Express: TOC > Layer > Context Menu Vector Layer > Selection

Invert Selection lets you invert the current selection within the layer. That means that selected features are deselected and unselected features are selected. The feature selection of all other layers remains unchanged.

Tips and notes:

- You can also invert a layer's feature selection in its Attribute Table either via Options > **Invert Selection** (see chapter 5.3.2.1.4) or with Ctrl + left-click in the upper left table corner.
- For general information on the topic feature selection, see chapter 4.2.3.1.

5.3.2.3.5 Select by Attribute

In GAFmap Express: TOC > Layer > Context Menu Vector Layer > Selection

This command refers to **Select by Attribute** in the Attribute Table (menu Options). For more information, see chapter 5.3.2.1.2.

5.3.2.3.6 Select by Location

In GAFmap Express: TOC > Layer > Context Menu Vector Layer > Selection

This command refers to **Select by Location** in the Attribute Table (menu Options). For more information, see chapter 5.3.2.1.3.

5.3.2.4 Create Height Profile

In GAFmap Express: TOC > Layer > Context Menu Vector Layer

Only available for point layers, z-aware line layers, and non-z-aware line layers in combination with a DEM



Create Height Profile lets you create

- for point layers: a (height) profile for the layer and
- for line layers: a (height) profile for a selected line.

Simply click the corresponding command on the context menu of the layer. The (Height) Profile dialog opens.

For informationen on the (Height) Profile dialog, see chapter 4.1.14.

Height Profile of a point layer

For a point layer, the heights used to create the profile are read from either the Z-coordinates of the points or an attribute field. The following priority applies:

- If the layer has **Z-coordinates**, these are used to create the profile.
- If the layer has no Z-coordinates, the **attribute field Height** is used.
- If neither Z-coordinates nor a field Height exists, it is queried which attribute field should be used instead. **All numeric fields** are then available for selection.

For the height profile, the points are virtually connected to form a line. The order in which the points are connected always results from the current sorting of the features in the attribute table (first point is the topmost in the table, second the second topmost, etc.):

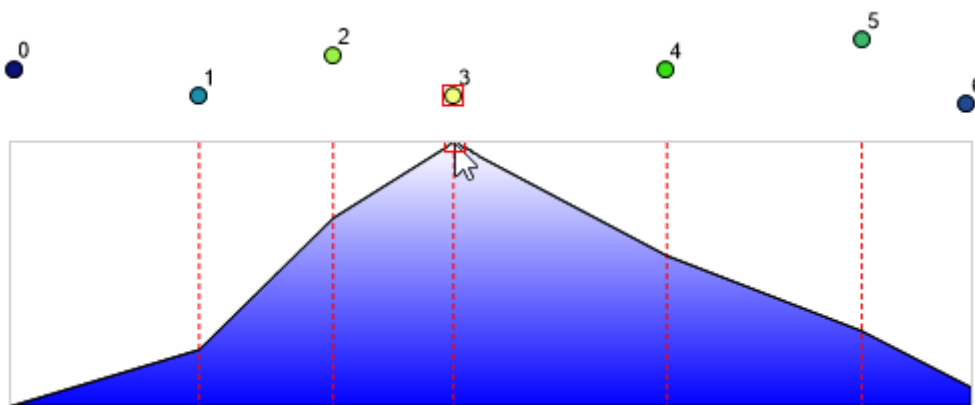


Figure 156: Height Profile of a point layer, example. The points are colored according to their height (color range from dark blue=deep to yellow=high) and are labeled with their FID (order in the tables ascending by FID)

If at least two points are selected, the selection is taken into account, i.e. the profile is then only created for selected features. Here, too, the point order results from the current sorting of the attribute table.

Height Profile of a Selected Line Feature

If a single line is selected for a line layer, a Height Profile can be created for this line. The prerequisite is that either

- the line vertices have Z-coordinates or
- the line intersects a digital elevation model (DEM, see chapter 5.3.4), from which the heights underlying the vertices can be taken.

The profile displays the elevation course of the individual line vertices (order corresponds to the ID of the vertices; see chapter 4.2.2).

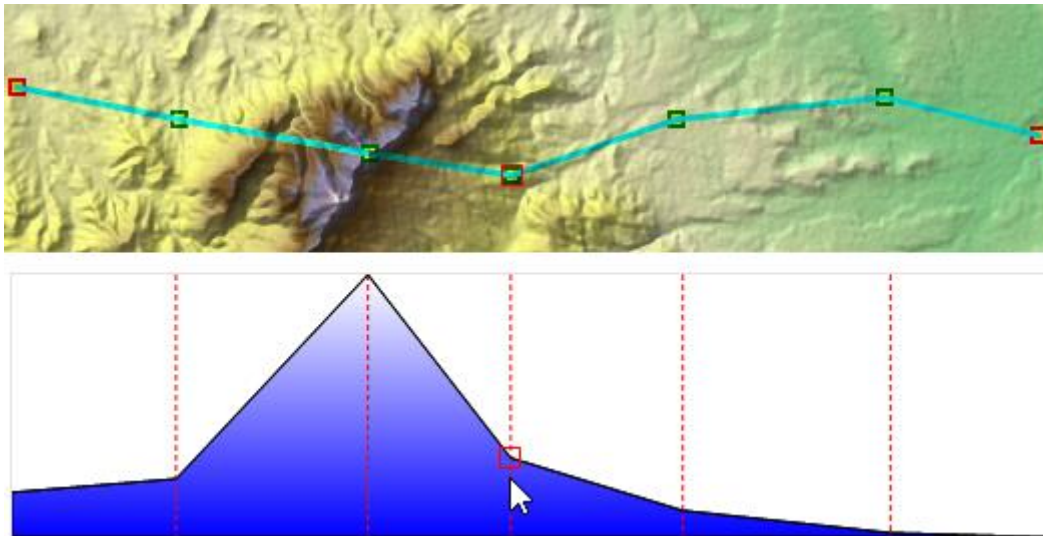


Figure 157: Height Profile of a line feature, example: Height Profile of a line without Z-coordinates with heights from DEM (direction of editing line from left to right)

If no height information is available for the line features and/or a single line feature is not selected, the command is not available in the context menu of the layer.

Tips and Notes:

- If you want to use an existing line to create a terrain section across a DEM, in which the heights are taken and displayed along the entire line and not only at the vertices, use a line graphic (see chapter 5.2.5.3).

5.3.2.5 Properties

In GAFmap Express: TOC > Layer > Context Menu Vector Layer





Via **Properties** you reach the Properties window where all essential properties of the selected vector layer are listed.

For vector layers, all properties are read-only (i.e. all properties are grayed out).

In the following, all properties of vector layers are listed. Which properties are actually displayed depends significantly on the underlying dataset, especially on the geometry type, and whether the project contains a (2D) map viewer and/or a 3D Viewer. If multiple layers are selected, only properties available for all selected layers are displayed (combined properties).

Source

- **Layer:** shows the name of the connected vector dataset / feature table.

- **Load Condition** (*only visible if a load condition was specified when adding the vector dataset*): shows the used load condition. The project then only contains features that meet this condition.
- **Z-aware**: shows whether the vector layer supports Z-coordinates (**On**) or not (**Off**).
 If a vector layer is z-aware, this is indicated in the TOC with a Z to the right above the layer icon.
- **Measured**: shows whether the vector layer supports M-coordinates (**On**) or not (**Off**).
- **On-the-fly Projection**: shows whether the dataset is reprojected on-the-fly (i.e. temporarily in the background) in the map viewer (**On**) or not (**Off**). A reprojection is necessary if the layer spatial reference differs from the map spatial reference.
- **Editable**: shows whether the connected vector dataset is editable (**On**) or not (**Off**). Note that with GAFmap® Express, vector layers are never editable.
- **Spatial Reference**: shows the layer spatial reference.
 opens a window with more detailed information on the layer spatial reference
- **Layer Info**: if available, additional information about the layer can be viewed here (e.g. a legend, the data source, other metadata, etc.)

 opens the Layer Info window


If a layer info is entered, it can alternatively be called up via **Show Layer Info** command in the layer context menu (see chapter 5.3.1.7); texts with HTML syntax are then usually displayed formatted (here always as source text).

Case Sensitive

- **Case Sensitive**: shows whether upper/lower case is considered for **Definition Query** (see below), **Select by Attribute** (see chapter 5.3.2.1.2), and sorting in the **Attribute Table** (see chapter 5.3.2.1) (**On**) or not (**Off**).

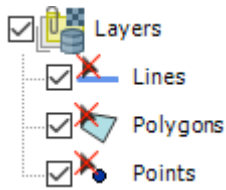
Definition Query

- **Query Condition**: shows whether certain features of the vector layer have been filtered out spatially and/or by attribute. If a condition is displayed here, only features that meet this condition are contained in the project.

You can identify filtered layers (in the TOC) by the  filter icon above the layer icon and in the attribute table by the additional information "number of unfiltered features" in the footer.

Selection

- **Features Selectable:** if **On**, the features of this layer are selectable with the tools **Select Feature** or **Select with Polygon** (see chapter 4.2.3). If **Off**, the features cannot be selected with these tools. The layer is then be marked accordingly in the TOC:



Via the attribute table (see chapter 5.3.2.1) or the submenu **Selection** (see chapter 5.3.2.3) features can always be selected, regardless of these properties

Scale Range

- **Scale Range:** determines whether a vector layer activated in the TOC is only displayed in the map viewer if the zoom level of the map is within a certain scale range (**On**) or always, regardless of the zoom level (**Off**).

If **On**, you can specify the valid scale range, i.e. the desired lower/upper limit, under **Min. Scale / Max. Scale**.

If the vector layer is used as a texture in the 3D viewer, it is only displayed within the valid scale range. The reference is then the **Texture Map Scale** (see chapter 5.3.4.1).

Labeling

- **Show Label:** if **On**, the features of this layer are labeled in the (2D) map viewer. Various properties regarding the labeling style are then displayed, e.g.
 - **(Other) Labeling:** shows the label style, i.e. font, text size, color, etc.

Note: If the renderer types **UniqueValue** or **ClassBreaks** are used (see below), the label style is set individually for each defined value or class. In this case, the style set here only applies to all "other" values.

- **Label Field:** shows the attribute field the features are labeled with.

Instead of an attribute field in [square brackets], an expression of any complexity in C# syntax can be entered, e.g. if features are labeled with multiple attribute fields or with attribute fields + free text, or if features with different attributes are to be treated differently.

- **Labeling per Class/Unique Value** (*only for renderer type = Unique Value or Class Breaks*): shows whether all features of the layer are labeled with the same label style, namely the one specified above at **Labeling (Off)**, or whether the label style is set individually for each unique value / class (**On**).

- **One Label per Feature:** shows whether for multipart features all geometry parts are labeled (**Off**) or always only the largest geometry part (**On**)
 - **Allow Label Shifting:** shows whether the labels are offset for better readability if necessary (**On**) or not (**Off**).
 - **Label Placement Mode:** shows how the label is placed along lines or inside polygons.
 - **Label Scale Range:** shows whether the labels are displayed only within a certain scale range (**On**) or scale-independent (**Off**), and if **On**, which scale range is valid.
- etc.

Symbology

- **(Other) Point Symbol / Line Pen / Fill Brush:** shows which symbol is used to display the features in the (2D) map viewer.

If the renderer types **Unique Value** or **Class Breaks** are used (see below), the symbol set here is only used for "other" features, i.e. for features for which no unique value is defined or which are not covered by any of the defined classes.

- **Symbol Scale:** shows with which factor the features are scaled in the (2D) map viewer. At 1, the symbols are drawn in the set original size/width, at values > 1 / < 1 , they are enlarged / reduced by the corresponding factor.
- **Transparency [%]:** shows the degree of transparency the layer is displayed with in the map viewer (0 = non-transparent/opaque, 100 = fully transparent/invisible).
- **Composite Transparency:** shows whether (with a specified transparency) the individual features of a vector layer are drawn transparently (**Off**), or the layer as a whole (**On**). If **Off**, features in the background shine through in case of overlaps, otherwise they do not.

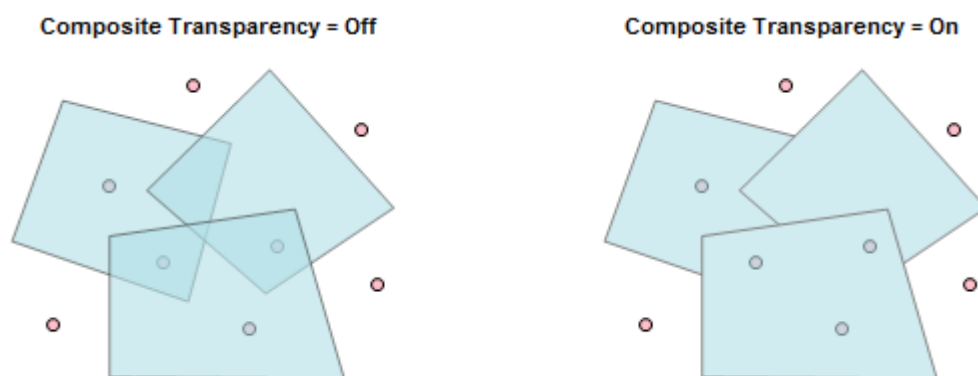
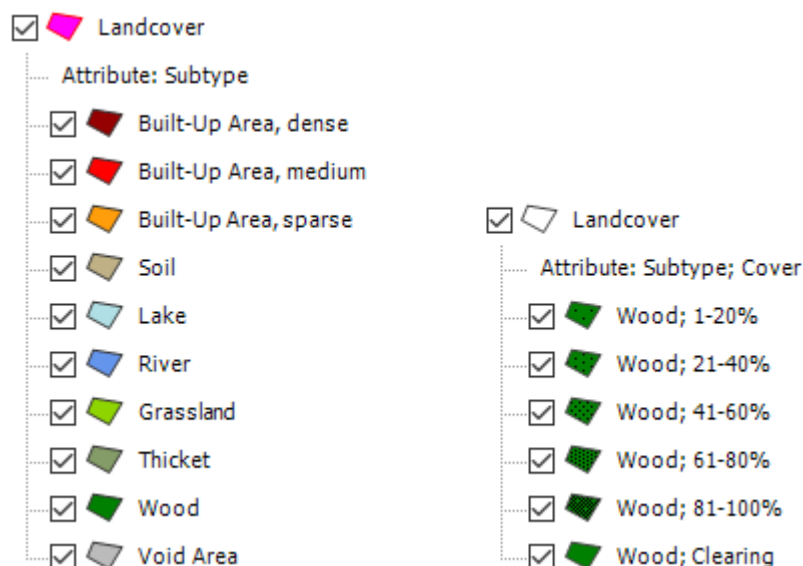


Figure 158: Example: Transparent polygons without and with enabled **Composite Transparency**

- **Renderer Type:** shows which method is used to display the features. They can either all be drawn the same way (with the symbol set above) or differently depending on their attributes (with individually set symbols). Possible are:
 - **Normal:** if displayed, all features are displayed with the same (point/line/fill) symbol set above, regardless of their attributes.
 - **UniqueValue:** if displayed, the (point/line/fill) symbol is set individually for each feature, depending on one or multiple attributes, i.e. different feature classes/subtypes have been formed which are displayed differently. The attribute(s) according to which the distinction is made can be taken from the property field **Renderer Field(s)** or the TOC (above the unique values), the number of unique values from the property field **Unique Value Symbols**.


The unique values are displayed in the TOC when the vector layer is expanded:



Features that do not fall into any of the specified classes are represented with the symbol specified at the top of the Properties window at **Other Point Symbol / Line Pen / Fill Brush**.

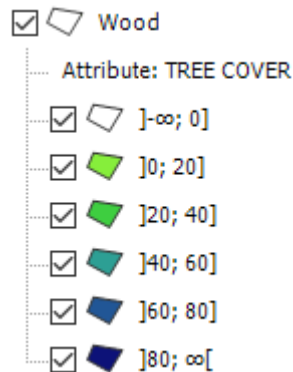
Drawing Order by Unique Values shows whether the sorting of the unique values in the TOC dictates the drawing order of the features in the map viewer (**On**) or not (**Off**), i.e. whether features with unique values that are on top in the TOC are drawn over features with unique values that are on bottom in the TOC.

In the **TOC** you can activate/deactivate unique values individually by checking/unchecking them. If you deactivate one or multiple unique values, the respective features are filtered out and are therefore also missing in the attribute table.

You can identify filtered layers (in the TOC) by the  filter icon above the layer icon and in the attribute table by the additional information "number of unfiltered features" in the footer.


- **ClassBreaks:** if displayed, the values entered in a certain attribute field are grouped into classes. Then, to each class an individual symbol is assigned. The attribute field used for classification can be taken from the property field **Renderer Field** or from the TOC (above the classes), the number of classes from the property field **Class Break Symbols**.

The classes are displayed in the TOC when the vector layer is expanded:



Features that do not fall into any of the specified classes are represented with the symbol specified at the top of the Properties window at **Other Point Symbol / Line Pen / Fill Brush**.

In the **TOC** you can activate/deactivate the classes individually by checking/unchecking them. If you deactivate one or multiple classes, the respective features are filtered out and are therefore also missing in the attribute table.

You can identify filtered layers (in the TOC) by the  filter icon above the layer icon and in the attribute table by the additional information "number of unfiltered features" in the footer.

- **Shift Vector** (*only for point layers*): if displayed, a shift vector is attached to the defined **Point Symbol**, whose length and direction depends on the pair of numbers in the two attribute fields entered at **Shift Vector-X/-Y Field**.

Instead of numeric attribute fields in [square brackets], an expression of any complexity in C# syntax can be entered, e.g. if features with different attributes are to be treated differently or if non-numeric attribute fields are used as source.

The (length) unit of the values depends on the map's spatial reference; the actual length of the vector depends on the **Scale Factor** with which the read values are multiplied. At **Vector Line** the line symbol used to draw the vector line is shown.

- **Ellipse** (*only for point layers*): if displayed, an ellipse is drawn around each point, whose two half-axes and rotation depend on a triple of numbers in the three attribute fields entered at **Ellipse X-/Y-Axis Field** and **Ellipse Rotation Field**.

Instead of numeric attribute fields in [square brackets], an expression of any complexity in C# syntax can be entered, e.g. if features with different attributes are to be treated differently or if non-numeric attribute fields are used as source.

The (length) unit of the values depends on the map's spatial reference; the actual length of the half-axes depends on the **Scale Factor** with which the read values are multiplied. At **Vector Line** the line symbol used to draw the ellipse line is shown.

- **Additional Scaling** (*only for point and line layers*): shows whether the size/width with which the individual points/lines of a layer are displayed in 2D is determined individually for each feature, e.g. by using a numeric attribute field. If **Off**, the symbols are not scaled additionally, otherwise the higher the entered value, the larger/wider the symbol.

The following modes can occur:

- **Absolute Size**: if displayed, each feature is drawn with the absolute size or width that is read from the attribute field entered at **Additional Scaling Field** (in meters, regardless of the map coordinate system).
- **Relative Scaling**: if displayed, the size or width the symbols are drawn with is calculated by multiplying the original symbol size with the factor that is read from the attribute field entered at **Additional Scaling Field**.
- **Defined Scaling**: if displayed, the symbol size is scaled linearly between the smallest and biggest found value in the attribute field entered at **Additional Scaling Field**. Features with the smallest value are scaled with factor 1, i.e. are displayed with the original symbol size, features with a biggest value with "symbol size times **Max. Scale Factor**"

Instead of a numeric attribute field in [square brackets], an expression of any complexity in C# syntax can be entered, e.g. if features with different attributes are to be treated differently or if non-numeric attribute fields are used as source.

- **Additional Rotation**: (*only for point layers*): shows whether the specified point symbol is rotated by a certain angle for each feature in 2D (**On**) or not (**Off**). If **On**, the rotation angle is read from the attribute field entered at **Additional Rotation Field**. The specified angle is interpreted geographically, i.e. 0° = north, 90° = east, etc.

Instead of a numeric attribute field in [square brackets], an expression of any complexity in C# syntax can be entered, e.g. if features with different attributes are to be treated differently or if non-numeric attribute fields are used as source.

- **Reference Scale Rendering**: if **Off**, the defined layer symbols and labels are always drawn in the specified symbol/text size in the (2D) map viewer, independent of the

map scale. If **On**, the size only applies at the **Reference Scale** specified below. If you change the map scale, symbols and labels are scaled up/down accordingly.

3D Height Mode

Only available if the project contains a 3D window

- **Base Height Mode:** shows, which heights are used for the vertical location of the features in 3D space.

The following modes can occur:

- **Vertex Z Values:** if displayed, the Z-coordinates of the vertices/points are used as height. Each vertex/point then has its individual base height.
- **Feature Min Z Value / Feature Max Z Value:** if displayed, the smallest/largest Z-coordinate of each feature is used as its height. Each feature then has its individual base height; the individual features lie flat/horizontally in 3D space.
- **Default Value:** if displayed, all features are set to the entered **Default Height**. All features then have the same base height. The whole layer lies flat/horizontally in 3D space.
- **Attribute Value:** if displayed, the height to which the features are set is determined by feature attributes. Each feature then has its individual base height and lies flat/horizontally in 3D space.

The attribute field from which the height is read is entered at **Base Height Attribute**. Instead of a numeric attribute field in [square brackets], an expression of any complexity in C# syntax can be entered, e.g. if features with different attributes are to be treated differently or if non-numeric attribute fields are used as height source. Features for which no height value is found are set to the **Default Height**.

- **Height Offset Attribute** (*only for line and polygon layers*): If an attribute field is entered here, the value read is added to the vertex Z value. In case of positive values, the vertices are then offset upwards by the corresponding value starting from their Z-coordinate, in case of negative values they are offset downwards.

Instead of a numeric attribute field in [square brackets], an expression of any complexity in C# syntax can be entered, e.g. if features with different attributes are to be treated differently or if non-numeric attribute fields are used as source.

- **Extrusion Height Mode** (*only for line and polygon layers*): If an entry \neq **Off** is shown here, the features are extruded vertically, i.e. stretched perpendicularly upwards or

downwards from the baseline. Vertical extrusion turns lines into (dimensionless) vertical plains and polygons into simple blocks.

The following modes can occur:

- **Feature Z Range:** if displayed, each feature is stretched vertically up from the baseline by the difference of its Z-values (i.e. largest Z-coordinate - smallest Z-coordinate). Each feature then has an individual extrusion height.
- **Default Value:** if displayed, all features are stretched by the value entered at **Default Extrusion Height**. All features then have the same extrusion height.
- **Attribute Value:** if displayed, the value by which each line is stretched is determined by feature attributes. Each feature then has an individual extrusion height.

The attribute field from which the extrusion height is read is entered at **Extrusion Height Attribute**. Instead of a numeric attribute field in [square brackets], an expression of any complexity in C# syntax can be entered, e.g. if features with different attributes are to be treated differently or if non-numeric attribute fields are used as source. Features for which no value is found are stretched by the **Default Extrusion Height**.

- **Extrusion Width Mode** (*only for line layers*): If an entry \neq **Off** is shown here, the features are extruded horizontally, i.e. stretched/buffered perpendicularly outwards from the baseline. Horizontal extrusion turns lines into (dimensionless) horizontal planes.

The following modes can occur:

- **Default Value:** if displayed, all features are stretched by the value entered at **Default Extrusion Width**. All features then have the same extrusion width.
- **Attribute Value:** if displayed, the value by which each line is stretched is determined by feature attributes. Each feature then has an individual extrusion height.

The attribute field from which the extrusion width is read is entered at **Extrusion Width Attribute**. Instead of a numeric attribute field in [square brackets], an expression of any complexity in C# syntax can be entered, e.g. if features with different attributes are to be treated differently or if non-numeric attribute fields are used as source. Features for which no value is found are stretched by the **Default Extrusion Width**.

Lines can be extruded both vertically and horizontally. If this is the case, they are displayed (like vertically extruded polygons) as three-dimensional objects.

3D Symbolology

Only available if the project contains a 3D window

- **(Other) 3D Point Symbol** *(only for point layers and points)*: shows the symbol with which the points are drawn in the 3D viewer. The symbol can be a simple solid (e.g. sphere, cylinder, pyramid, etc.) or a 3D model of any complexity.
- **(Other) 3D Line Symbol** *(only for line layers and lines)*: shows the symbol with which the lines are drawn in the 3D viewer. The symbol can be a simple line with a width of one pixel or a three-dimensional tube.
- **(Other) 3D Top Material** *(only for polygon layers and horizontally extruded line layers)*: shows with which surface material the top faces of the polygons or horizontally extruded lines are visualized in the 3D viewer. Available are simple colors or image textures as well as complex material textures.

By default, the selected top material is applied to the top surfaces of all features with an alignment due north. Via **Align Top Material Mode**, it can be aligned individually for each feature according to an attribute field, expression, and/or the first line segment of the feature geometry.

- **(Other) 3D Side Material** *(only for polygon layers and horizontally extruded line layers)*: shows with which surface material the side faces of the extruded polygons or lines are visualized in the 3D viewer. Available are simple colors or image textures as well as complex material textures.

Please note: For the renderer types **Unique Value** and **Class Breaks** (see above), the symbol /material is set individually for each value/class. The symbol/material indicated here is then only valid for "other" values.

- **Additional Scaling** *(only for point layers and points as well as line layers and lines)*: Here, up to three attribute fields can be specified, which contain either an absolute size or a scaling factor in X, Y, and/or Z direction for each feature. The length, width, and/or height of the set 3D point/line symbol is then brought to the read-out (absolute) size for each feature or multiplied by the entered scaling factor.

The following modes can occur:

- **Off**: if displayed, the symbol is not scaled additionally.
- **Relative Scaling**: if displayed, the points or lines are scaled by a certain factor. The scaling factor is read from an attribute field for each feature. The individual point size or line width is then obtained by multiplying the original symbol size by the scaling factor.

Lines are always scaled in one direction only (in width), for points the scaling factor is set separately in X, Y, and Z direction.

The attribute field from which the scaling factor is read is entered at **Scale (X/Y/Z) Attribute**. Instead of a numeric attribute field in [square brackets], an expression of any complexity in C# syntax can be entered, e.g. if features with different attributes are to be treated differently or if non-numeric attribute fields are used as source.

- **Absolute Height** (*only for points*): if displayed, the set 3D point symbol is individually enlarged or reduced for each feature so that it is displayed with a certain absolute height. The original aspect ratio of the 3D point symbol is retained. The absolute height is read from an attribute field.

The attribute field from which the scaling factor is read is entered at **Size Z Attribute**. Instead of a numeric attribute field in [square brackets], an expression of any complexity in C# syntax can be entered, e.g. if features with different attributes are to be treated differently or if non-numeric attribute fields are used as source.

The unit in which the height is measured is specified at **Absolute Unit**.

- **Absolute Size** (*only for points*): if displayed, the set 3D point symbol is individually enlarged or reduced for each feature so that it is displayed with a certain absolute length, width, and/or height. The original aspect ratio of the 3D point symbol is usually not retained, as the symbol is brought to an absolute size in X, Y, and Z direction, and therefore usually has to be compressed or stretched. The target size in X-/Y-/Z-direction is read from an attribute field or determined by an expression (analogous to Absolute Height).

- **Additional Rotation** (*only for points*): Here, up to three attribute fields can be specified, which contain a rotation angle around the X, Y, and/or Z axis for each feature. The set 3D point symbol is then rotated by the entered value for each feature on the corresponding axes.

The angle for the rotation around the X/Y/Z axis is read from the attribute fields specified at **Rotate X/Y/Z Attribute**. If no attribute field is specified for an axis, the original rotation angle is applied there.

Instead of numeric attribute fields in [square brackets], expressions of any complexity in C# syntax can be entered, e.g. if features with different attributes are to be treated differently or if non-numeric attribute fields are used as source.

- **Draw Lines** (*only for polygon and extruded line layers*): if **On**, the polygon outlines are drawn or, in case of horizontally extruded lines, additional (center) lines (both as 3D

lines). For vertically extruded polygons/lines, outlines/lines are drawn both at the top and at the bottom; alternatively, the outlines/lines can be displayed at the **Top Only** or the **Bottom Only**.

For the enabled lines, the same properties are available under category **3D Symbology** as for non-extruded line layers.

- **Draw Points** (*only for line and polygon layers*): If **On**, the vertices of the polygons or lines are drawn (as 3D points). For vertically extruded polygons/lines, the vertices are drawn both at the top and at the bottom; alternatively, they can be displayed at the **Top Only** or the **Bottom Only**.

For the enabled vertices/points, the same properties are available under category **3D Symbology** as for point layers.

3D Labeling

Only available if the project contains a 3D window

- **Show 3D Label**: if **On**, the features are labeled in the 3D viewer. The label text is read from the **Label Field** under category **Labeling** (see above).

The following applies to the display of the labels in the 3D viewer:

- The style of the 3D labels / label boards is indicated at **3D Labeling**, the style of the text on the board corresponds to that of the 2D labels (see category **Labeling** above).
 - The label boards are always anchored centrally to the features (horizontally and vertically). Note that a label may not be visible if the associated feature lies far above/below the DEM.
 - For the renderer types **Unique Value** and **Class Breaks** (see above), the 3D labeling style can be set individually for each value/class. The 3D labeling style indicated here is then only valid for "other" values.
- **Label Priority Expression** (*only relevant if in the Map properties Prevent Overlaps = On; see chapter 5.1.7*): By default, the label that is actually covered, i.e. the one that is further away from the current viewing position, is hidden if 3D labels overlap. This applies both within a layer and across layers. If certain labels are to be displayed preferentially, this can be forced by using **Label Priority**. If 3D labels with different label priority overlap, the label with lower priority is always hidden, even if it is in front.

By default, all 3D labels have priority 0. If a larger/smaller value is entered, the label is prioritized higher or lower accordingly.

For vector layers, instead of a number an expression of any complexity in C# syntax can be entered, e.g. if features with different attributes are to be prioritized differently.

Shadows/View Obstruction

Only available if the project contains a 3D window

- **Shadows/View Obstruction:** If **On**, this layer casts shadows and it is considered as view obstruction when calculating an on-the-fly viewshed in the 3D viewer.

Note that layers for which **Shadows/View Obstruction** is disabled do not participate in the shadow and 3D viewshed at all. This means that they are not only not considered as light or view obstruction, but they also neither reflect shadows cast by other objects nor the result of the 3D viewshed.

For more information on shadows and 3D viewshed, see chapter 4.6.5 et seq.

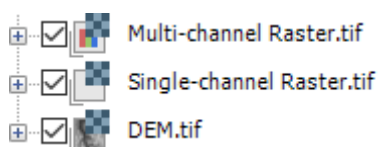
Timeline

- **Use for Time Line:** shows whether the layer is enabled for the time line (see chapter 4.4.5) (**On**) or not (**Off**). If **On**, further properties about for specified **Time Stamp** are shown.
- **Time Stamp Type:** specifies where/how the time information is stored. Possible are **Attribute** or **Layer**:
 - **Attribute:** The time information is stored in an attribute field separately for each feature. When operating the time line, the features of the layer is shown in chronologically order according to their time attribute. **Time Stamp Field** shows, from with attribute field the time information ist taken.
 - **Layer:** A fixed **Time Stamp** is set for the entire vector layer. When operating the time line, the whole layer is shown when this time stamp is reached.

Please note that all times are interpreted as UTC as long as no other information is stored (in the dataset).

5.3.3 Raster Layer

In GAFmap Express: TOC > Layer



A **Raster Layer** is a **layer** (see chapter 5.3) that links to a raster dataset. For raster datasets, the (image) information is stored in a matrix, i.e. in a regular grid

of rows and columns; each grid cell (= pixel) is given an individual numerical value, which is used for the visualization of the raster on the screen.

Typical examples of raster data are:

- scanned/digital (landscape) **maps**
- digital **imagery** of any kind, e.g. aerial or satellite images.

Here, the pixel values represent reflected or emitted radiation values recorded in a specific spectral range.

- digital elevation models (DEMs) or other **gradient rasters** (e.g. for temperature, atmospheric pressure, population density, etc.).

Here, the pixel values represent a certain quantity that changes continuously or gradually over a certain area, e.g. terrain elevation, temperature, population density, etc.

- **classification rasters**, which e.g. show the land use or soil types and that resulted e.g. from analysis/processing of other raster or vector data.

Here, each pixel value represents a certain unique value / a certain category, e.g. a land use class or a soil type.



The position of each pixel inside the raster is defined by the row and column in which it is located. The raster forms a cartesian coordinate system with the rows parallel to the X-axis and the columns parallel to the Y-axis; the origin is located in the bottom left corner. Row and column width, i.e. width and height of the pixels, are stored in the dataset (= resolution in X/Y direction).

Geographically, rasters are located by control points whose position coordinates are known and which can be uniquely identified in the raster. The position of georeferenced rasters is defined by edge coordinates (= X/Y Min/Max), starting from the bottom left corner.

The value of individual pixels can e.g. be queried with **Pixel Info** (see chapter 4.1.12).

Single and multi-channel rasters

Raster datasets can have one or multiple channels / raster bands.

-  **Single-channel rasters** contain exactly one numeric value matrix. Typical examples are black and white images of all kind as e.g. panchromatic aerial or satellite imagery, gradient rasters as e.g. DEMs, and classification rasters.
-  **Multi-channel rasters** contain multiple layers of congruent and identically constructed numeric value matrices. This allows multiple values to be assigned to each pixel, e.g. one radiation value each in the red, green, and blue spectral range. Many

satellite images have multiple bands, each representing a particular part of the electromagnetic spectrum.

Rasters can have any number of channels / raster bands, but only up to four channels can be used for the visualization at once (3 colour bands + 1 alpha band; see **Band Mapping**, chapter 5.3.3.6).

Basic Raster Properties

Besides the number of the channels/bands, rasters are basically defined by the following properties:

- The size of the pixels defines the **resolution** of the raster: the smaller, the higher the resolution / detail of the (image) content.
- The **pixel type** (the bit number) defines the possible value range of the pixels (e.g. binary, integer, or floating point numbers): the bigger, the bigger / more precise the value range. It also determines whether only positive or also negative values are possible (signed/unsigned).

If the raster contains areas for which no data is available (= NoData areas), e.g. at the edge due to the rectangular shape, these are marked with the **NoData** value and drawn fully transparent by default.

All parameters mentioned are stored directly in the dataset. For more information on the raster properties, see chapter 5.3.3.6.

Raster Pyramids - Special Features / Method in GAFmap®

For performance reasons, GAFmap® always works with pyramids for rasters above a certain size, regardless of whether they physically exist or not. Pyramid level 1 always has half the resolution of level 0 (= full resolution), level 2 has half the resolution of level 1, etc. Pyramids are created up to the level at which both edge lengths are smaller than the block size, i.e. usually 256 pixels (depending on the pixel type). Usually, pyramids are created/calculated in GAFmap® as soon as one raster edge exceeds 3602 pixels.

Physically existing pyramid levels can usually be used directly. If (single) levels are missing, they are calculated on-the-fly from the next higher existing level (in the last instance from the full resolution). On-the-fly pyramids are also used in special cases where physically existing pyramid levels are not created with a resolution factor of 2.

Physically existing pyramid levels are shown in the raster properties under **Metadata** (see chapter 5.3.3.6). Please note that the numbering of the pyramid levels in GAFmap® does not

necessarily match the physically existing ones for the above-mentioned reason (e.g. if level 1 does not exist).

Context Menu

Right-clicking on one or multiple selected raster layer(s) in the TOC opens the raster layer context menu. In the following, only the functions that appear exclusively in the context menu of raster layers/groups are explained. For (general) functions that are available for all layers and layer groups irrespective of their type, see chapter 5.3.1.

5.3.3.1 Zoom to Actual Pixels (Full Raster)

In GAFmap Express: TOC > Layer > Context Menu Raster Layer



Zoom to Actual Pixels (Full Raster) zooms the map to the scale at which the raster's pixels are displayed 1:1 on the screen. This results in the raster dataset to be displayed with the best possible resolution on the screen. Interpolation artefacts are avoided, the drawing speed is increased.

Shortcuts, Key Commands, etc.:

- Ctrl when starting the command: zooms the map to the upper left corner of the dataset.

Tips and notes:

- If a raster has a pixel size of 1 m, it is displayed with a scale of 1 : 3,780 at full resolution. In the calculation, a screen resolution of 96 dpi at 100% DPI scaling under Windows is presumed (0.0254:96 corresponds to approx. 1:3780).

5.3.3.2 Zoom to Current Pyramid Level (x)

In GAFmap Express: TOC > Layer > Context Menu Raster Layer



Zoom to Current Pyramid Level (x) zooms the map to the scale at which the pixels of the nearest pyramid level (shown in brackets) are displayed 1:1 on the screen. This results in the respective raster pyramid to be displayed with the best possible resolution on the screen. Interpolation artefacts are avoided, the drawing speed is increased.

The command is only available if the raster has different pyramid levels and if the nearest pyramid level is not level 0 (= full resolution).

Shortcuts, Key Commands, etc.:

- Ctrl when starting the command: zooms the map to the upper left corner of the data-set.

5.3.3.3 Zoom to Specified Pyramid Level

In GAFmap Express: TOC > Layer > Context Menu Raster Layer



Zoom to Specific Pyramid Level zooms the map to the scale at which a specific pyramid level of the raster is displayed in the best possible resolution. The pyramid level to be displayed is queried after calling up the command:

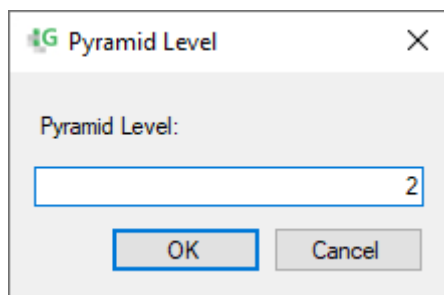


Figure 159: Dialog **Pyramid Level**

Enter the desired pyramid level and confirm with **OK**. If you enter a non-existent level, the map is zoomed to the nearest existing level.

Please note that the pyramid levels in GAFmap® can differ from any physically existing pyramid levels. In GAFmap®, pyramid level 1 always has half the resolution of level 0 (= full resolution), level 2 has half the resolution of level 1, etc. For more information, see chapter 5.3.3.

Tips and Notes:

- If a very low **Pyramid Level Quality** is used (see chapter 5.3.3.6) this command is not usable and therefore grayed out.

5.3.3.4 Download TMS Cache

In GAFmap Express: TOC > Layer > Context Menu Raster Layer

Only available for WMS, TMS or WMTS raster layers

Download TMS Cache lets you download data of the web service for a selected area, store it locally, and thus make it available offline for later purposes.

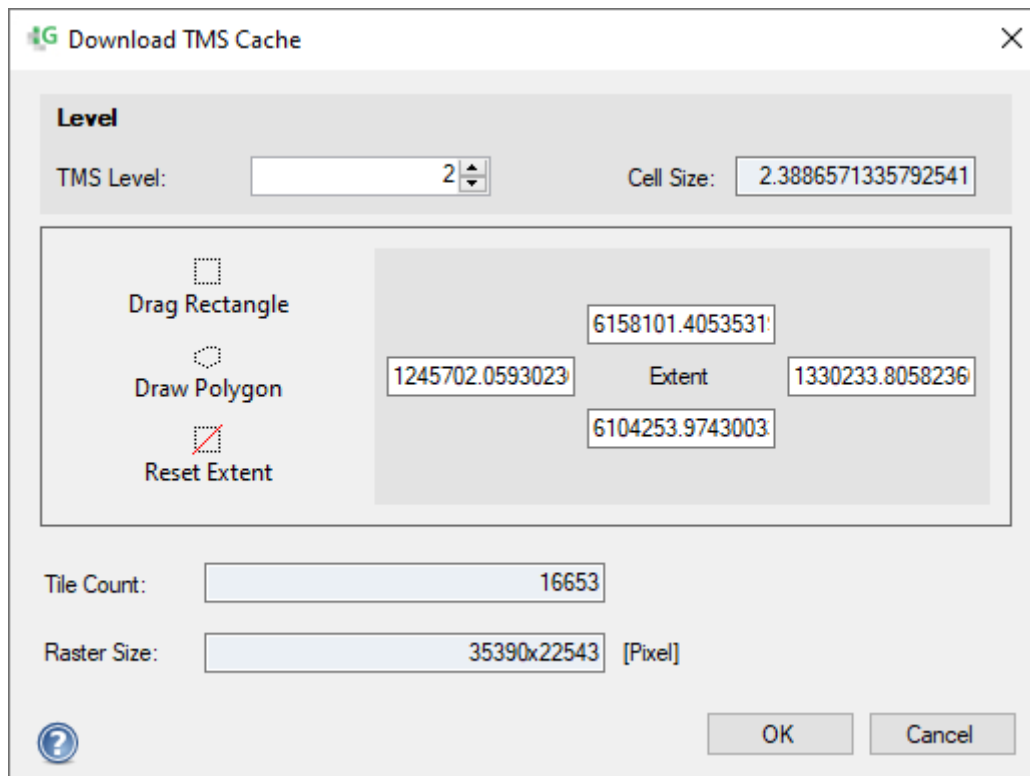


Figure 160: Dialog **Download TMS Cache**

- **TMS Level:** specifies the zoom/pyramid level the tiles are to be downloaded for. 0 represents the highest resolution. All tiles of zoom levels with a lower resolution are downloaded as well.
- **Cell Size:** shows the cell size of the raster in the selected level. The unit of the given value depends on the layer's spatial reference.
- **Extent:** Here, you can limit the area for which the map tiles are downloaded by dragging a rectangle, manually entering the outermost coordinates, drawing a polygon (= extent of this polygon), or selecting a layer (= extent of this layer). The downloaded dataset then contains all map tiles that intersect the defined rectangle. Preentered is the extent of the extent currently visible in the map viewer. If the map service does not cover the set area, the entire extent of the service is used instead.
- **Tile Count:** shows how many tiles are downloaded based on the current settings.

- **Raster Size:** shows the resulting number of pixels for the specified area and TMS level.

OK starts the download. The data is stored as tiles in the Temp Directory (see chapter 3.4.1.8).

5.3.3.5 Show Histogram

In GAFmap Express: TOC > Layer > Context Menu Raster Layer



Show Histogram lets you display the histogram of the raster, i.e. a graphical representation of the pixel value distribution, per raster band.

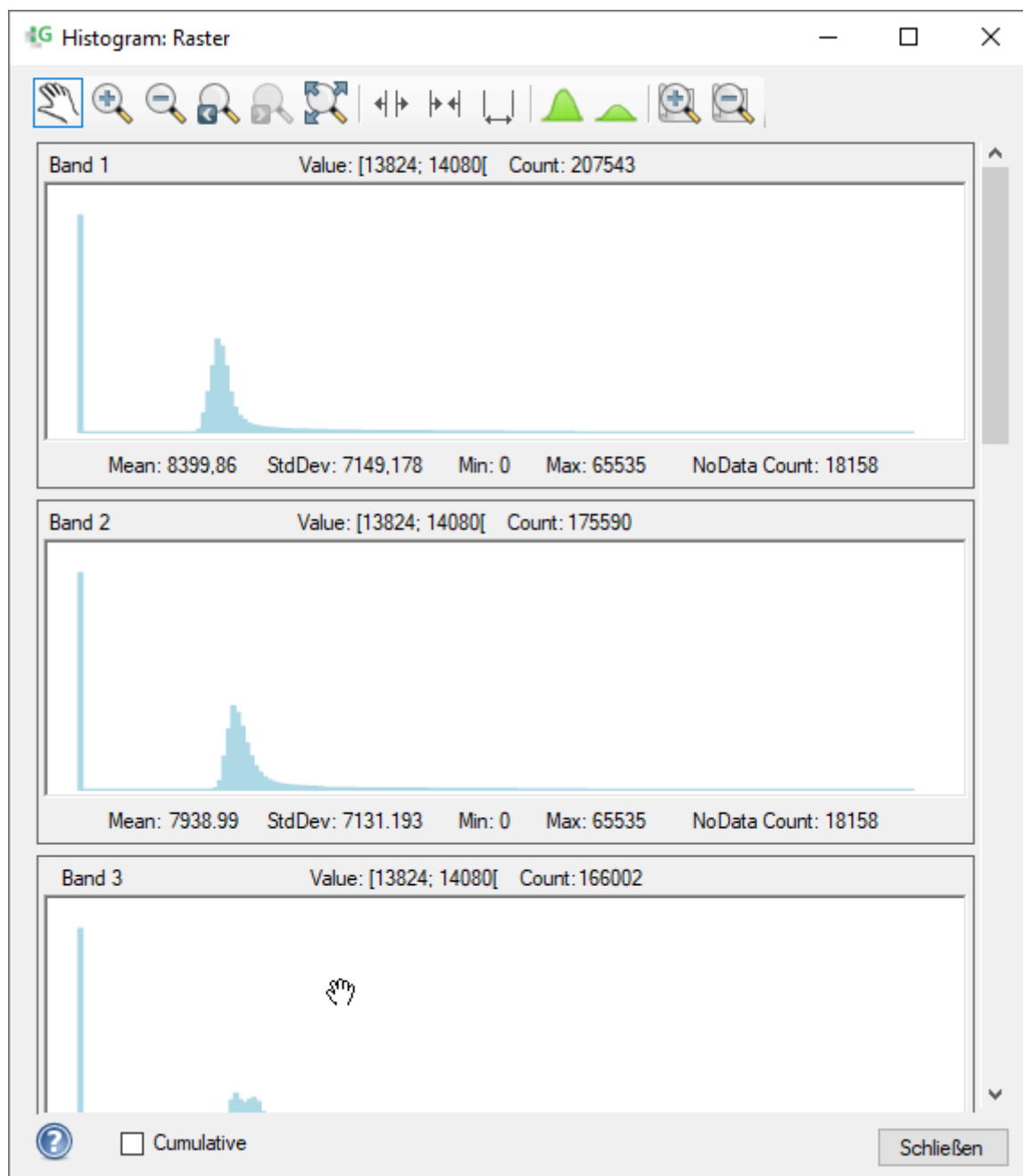



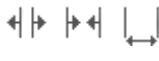


Figure 161: **Histogram** window

In the dialog, the histograms of all loaded raster bands are displayed below each other. The following can be seen:

- In the **Diagram Field**: the distribution of the original pixel values (light blue curve)
The X-axis represents the pixel values of the raster. For the histogram, the values are classified equidistantly, i.e. columns/bins of equal width are formed. The height of a column indicates how many pixels fall into these value classes (Y-axis).
- Below the Diagram Field: the **Band Statistics**
 - **Mean**: mean value
 - **StdDev**: standard deviation
 - **Min/Max**: minimum/maximum value
 - **NoData-Count**: count of NoData values
- Above the Diagram Field: the values at the current mouse position in the histogram.
 - **Value**: value range of the class / bin at the current mouse position
 - **Count**: the number of pixels that fall into this class / bin

If **Cumulativ** is checked, the pixels are added up. I.e. not the absolute number of pixels per value class/bin are displayed, as described above, but the number of pixels up to a certain value.

You can adjust the display of the histogram in the **toolbar** at the top of the dialog:

-  adjust the visible extent. Alternatively, you can use the common shortcuts to adjust the visible extent (see chapter 4.1.3 et seqq.).
-  **Increase/Decrease/Define Width**: compressing/extending the X-axis in steps or to a certain value range.
-  **Increase/Decrease Exaggeration**
-  **Increase/Reduce the height** for all diagram fields

Tips and notes:

- Special case mosaic layer (see chapter 5.3.6): note that for the histogram of a mosaic layer only activated rasters within the mosaic layer are considered (i.e. those checked in the TOC). Not activated rasters are not considered.

5.3.3.6 Properties

In GAFmap Express: TOC > Layer > Context Menu Raster Layer



Via **Properties** you reach the Properties window where all essential properties of the selected raster layer are listed.

For raster layers, the properties are in general read-only (i.e. all properties are grayed out).

In the following, all properties of raster layers are listed. Which properties are actually displayed depends significantly on the underlying dataset and whether the project contains a (2D) map viewer and/or a 3D viewer. If multiple layers are selected, only properties available for all selected layers are displayed (common properties).

Source

- **Width/Height:** shows the number of columns/rows.
- **Cell Size X/Y:** shows the width/height of the pixels in the layer spatial reference. For a geographic coordinate system like WGS84 the relation is: 1 = 1°. For a metric coordinate system like UTM the relation is: 1 = 1m.
- **Band Count:** shows the number of bands available. In case the layer has two or more bands they can be combined individually for the raster's representation (see below **Band Mapping**).
- **Pixel Type:** shows the bit depth of the raster.
- **NoData Value:** shows the raster value representing areas without valid data.
- **On-the-fly Projection:** shows whether the dataset is reprojected on-the-fly (i.e. temporarily in the background) in the map viewer (**On**) or not (**Off**). A reprojection is necessary if the layer spatial reference differs from the map spatial reference.
- **Spatial Reference:** shows the layer spatial reference.



opens a window with detailed information on the layer spatial reference


- **Metadata:** shows further meta information, mainly information that is stored in the dataset itself (e.g. in the header or enclosed XMLs, e.g. DMAP XMLs).

Which information is shown depends on the dataset. Possible are e.g.: resolution, physical pyramid level, date of creation, type of compression, block size, etc.



opens the Metadata window

- **Layer Info:** : if available, additional information about the layer can be viewed here (e.g. a legend, the data source, other metadata, etc.)

 opens the Layer Info window

If a layer info is entered, it can alternatively be called up via **Show Layer Info** command in the layer context menu (see chapter 5.3.1.7); texts with HTML syntax are then usually displayed formatted (here always as source text).

Extent

- **X/Y Min** and **X/Y Max**: shows the extent of the raster in the set map coordinate system.

Scale Range

- **Scale Range**: determines whether a raster layer activated in the TOC is only displayed in the map viewer if the zoom level of the map is within a certain scale range (**On**) or always, regardless of the zoom level (**Off**).

If **On**, you can specify the valid scale range, i.e. the desired lower/upper limit, under **Min. Scale / Max. Scale**.

If the raster layer is used as a texture in the 3D viewer, it is only displayed within the valid scale range. The reference is then the **Texture Map Scale** (see chapter 5.3.4.1).

Band Mapping

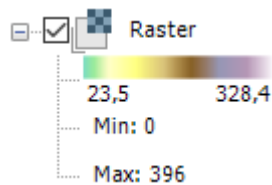
Only available for multi-channel rasters

- **Red/Green/Blue/Alpha Channel**: shows which raster bands are used for displaying the raster.

Symbology

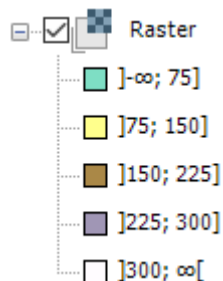
- **Transparency [%]**: shows the degree of transparency the layer is displayed with in the map viewer (0 = non-transparent/opaque, 100 = fully transparent/invisible).
- **Renderer Type**: shows the method with which the pixels of a raster are rendered according to their values, i.e. according to which logic a raster is visualized. Possible are:
 - **Direct**: if displayed, the original pixel values of the raster are used for visualization and are distributed over the 8-bit value range of the screen. For single-channel rasters, you obtain a black/white image; the value of a pixel directly determines its gray-scale value. For multi-channel rasters, a composite color image is created (e.g. RGB or NRG).
 - **Color Ramp**: if displayed, a predefined color ramp is used to visualize the raster. The result is an image with a continuous color gradient from the lowest to the highest pixel value.

The color ramp including the smallest and largest value is also displayed in the TOC when the raster layer is expanded:



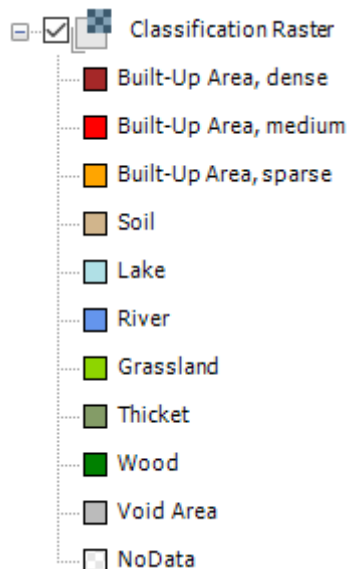
- **Class Breaks:** if displayed, the raster pixels are grouped into the number of value classes displayed at **Class Breaks** and are then usually visualized with a predefined color ramp. The result is an image with graduated colors from the lowest to the highest pixel value. Alternatively, each class can be assigned an individual color.

The individual classes are displayed in the TOC when the raster layer is expanded:



- **Unique Value:** if displayed, each pixel value of the raster is assigned an individual color. This mode is usually only used for classification rasters.

The unique values are displayed in the TOC when the raster layer is expanded:



- **Contour Levels:** this renderer type is designed for the visualization of digital elevation models (DEMs). It corresponds to the renderer type **Class Breaks** (see above), with the difference that predefined height classes are used.

- **Slope Levels:** this renderer type is designed for the visualization of digital elevation models (DEMs). If displayed, the (terrain) slope [%] of each raster pixel is calculated in the background. The calculated slope values are then grouped into slope classes (see **Class Breaks** above).
- **Stretch Type** (*only available if Renderer Type = Direct or Color Ramp*): shows if and how a raster is stretched to the 8bit value range of the screen. Possible are:
 - **None:** if displayed, no stretching is applied. The pixel values of the raster are used directly for the display on the screen. Pixel values that are not within the 8bit range are clamped to these values for screen display ("clamp"), i.e. negative pixel values are set to 0, values > 255 to 255.
 - **Standard Deviation:** if displayed, the standard deviation of all pixel values of the raster is determined to determine the limits for stretching excluding extreme values. Within this interval, the values are then stretched linear. Pixel values which are below or above the interval, are displayed as 0 or 255. If the limit values are below/above the minimum/maximum, the minimum/maximum is used as the limit value.

Additionally the sub-properties **Standard Deviation Factor**, **Gamma** and **Stretch Statistics Type** are displayed.
 - **MinMax:** if displayed, the lowest or highest pixel value of the raster is used as lower and upper limit for the stretch, linear interpolation is performed inbetween.

Additionally the sub-properties **Gamma** and **Stretch Statistics Type** are displayed.
 - **Custom:** if displayed, an individual transfer function is used for the stretch.
- **Background Value:** here, a particular raster value can be set as background value for a raster layer (usually only relevant if the NoData value is not or incorrectly set). All pixels with a Background Value +- the **Background Tolerance** are then displayed with the NoData Color (usually fully transparent, see below).
- **NoData Color:** shows the color used for NoData pixel and/or pixels with **Background Value** +- **Background Tolerance** (usually fully transparent).
- **Interpolation Mode:** shows the interpolation method used for drawing the raster layer on the screen.
- **Use Dynamic Pyramid Levels** (*only for on-the-fly projected rasters (see above) and only relevant for very large rasters, e.g. worldwide TMS*): shows whether the pyramid level to be used is determined dynamically, i.e. individually for each tile of the target raster (**On**), or once for the entire target raster (**Off**).

Using dynamic pyramid levels reduces the amount of (downloaded) data and significantly increases the performance when displaying the raster, but can lead to breaks in content if the content of the raster pyramids is not the same.

- **Pyramid Level Quality:** shows at which priority the available pyramid levels are used for rendering the current display of the raster layer. Available are:
 - **High:** the raster's visualization is always downsampled from the higher resolution pyramid level (best resolution but can be slow).
 - **Normal:** the visualization is usually downsampled from the higher resolution pyramid level. However, the lower level is upsampled if the scale is close to that level.
 - **Low:** the visualization is always upsampled from the lower resolution pyramid level.
 - **Very Low:** the visualization is usually upsampled from the lower resolution pyramid level. However, if the scale approaches that level, the next lower level is used (resolution is correspondingly worse, but very performant).
- **Minimal Pyramid Level:** shows which pyramid level of the raster is displayed at best. At 0 the raster is displayed in full resolution (if the scale is high enough), at 1 at best the first pyramid level, at 2 the second, etc.
- **Selection Line:** defines with which line symbol a raster is framed/highlighted in the map viewer if it is selected (highlighted in blue) in the TOC.
- **Use Specific Diagram Symbol:** if **On**, the spectral curve of the raster in the spectral diagram (see chapter 4.4.5) is always plotted with the line symbol shown at **Specific Diagram Symbol**. If **Off**, a default line symbol is used; the color of the line/curve changes with each click into the raster.

RPC

Only visible for raster layers with RPC parameters

- **Use RPC:** if **On**, the RPC parameters are used for the on-the-fly orthorectification.
- **DEM:** A digital elevation model specified here is used for the RPC based orthorectification in order to additionally eliminate the terrain's effect on the exact location of the satellite data.
- **DEM is geoidal:** if **On**, the heights of the elevation model are converted from geoidal to ellipsoidal. If **Off**, the (ellipsoidal) heights are used directly.
- **Line Shift/Row Shift:** If values $\neq 0$ are entered here, the raster is shifted on-the-fly by the corresponding number of pixels in X/Y direction. This may be necessary, for example, to improve the absolute position of the raster or its position relative to the DEM and/or the relative position of the raster to other (raster) data.



Rasters with RPC parameters can be identified in the TOC by the R above the raster icon.

For more information on raster with RPC parameters ("RPC Textures"), see chapter 5.3.5.

DEM

Only available for single-channel raster layers

- **Use as DEM:** if **On**, the raster is marked as digital elevation model ("DEM"); its pixel values are interpreted as (terrain) heights.



Raster layers marked as DEM are represented with the DEM symbol in the TOC.

DEMs are used as height sources for various functions, e.g. for **Create Profil** (see chapter 4.1.14) or for a **Viewshed** (see chapter 4.5.6).

If multiple single-channel rasters are marked as DEMs, they are virtually mosaicked to form a (continuous) **base DEM/terrain** (see chapter 5.3.4).

If **Off**, the raster is not interpreted as DEM, but as (black and white) image.



Single-channel rasters not marked as DEM (incl. 3D surfaces) can be recognized in the TOC by the simple b/w raster symbol.

- **Use As 3D Surface** (*only if the project contains a 3D window and if Use as DEM = Off*): if **On**, the raster is not interpreted as DEM, but recognized as elevation model in the 3D Viwer and displayed as 3D surface (independent from the base terrain). If **Off**, the raster is not interpreted as an elevation model even in 3D.

For more information on digital elevation models and special 3D properties only available for DEMs and 3D surfaces, see chapter 5.3.4.

Common DEM Texture

Only for DEMs and if the project contains a 3D window

For information on the properties in this category, see chapter 5.3.4.

Common DEM Properties / 3D Surfaces Properties

Only for DEMs or 3D surfaces and if the project contains a 3D window

For information on the properties in this category, see chapter 5.3.4.

GCPs

Only available for rasters with stored GCPs (Ground Control Points)

- **Has GCPs = On** indicates that GCPs (= Ground Control Points) are stored in the dataset for the raster layer. These are then automatically used for a georeferenced screen display (i.e. for on-the-fly georeferencing).

TMS Caching

Only for WMS-, WMTS, or TMS

- **Use TMS Caching:** if **On**, the tiles required for the currently displayed map section are downloaded and saved in the temporary TMS directory (see chapter 3.4.1.8). If a cached map section is called up again, the data is no longer requested from the server each time, but is taken directly from the directory and displayed. Only tiles that are called up for the first time are then loaded from the server. This usually results in a better performance when displaying web services.

If **Off**, the data is not cached.

- **Use Offline Mode:** if **On**, data is prevented from being requested from the server. In this case only already cached data will be displayed.

WMS Rendering

Only for WMS-, WMTS or TMS

- **Prefer Direct WMS Mode:** if **On**, the direct WMS mode is used whenever possible. In direct mode, a separate request is sent to the server for each map extent, exactly for the current extent with the current resolution. If **Off** or if direct mode is not possible, tile by tile a fix raster/pyramid structure is filled/retrieved.

Timeline

- **Use for Time Line:** shows whether the layer is enabled for the time line (see chapter 4.4.5) (**On**) or not (**Off**). If **On**, further properties about for specified **Time Stamp** are shown:
- **Time Stamp Type:** shows the format the time information is available in.
 - **Layer:** A fixed **Time Stamp** is set for the entire raster layer. When operating the time line, the layer is shown when this time stamp is reached.
 - **Band:** A time stamp is assigned to each raster band individually. At **Time Stamp**, the time stamp for band 1 is shown. For all other bands, it is determined automatically with a constant time interval. The time interval is specified at **Band Time Interval** and **Band Time Interval Unit**. When operating the time line, the raster bands are shown one after the other in ascending order with this time interval.

- **Source:** The time information is stored in a (non-visible) source file. The layer or bands are then displayed during the timeline animation according to the time information stored there.

Please note that all times are interpreted as UTC as long as no other information is stored (in the dataset).

5.3.4 Raster Layer - Special Case "Digital Elevation Models"

In GAFmap Express: TOC > Layer

A digital elevation model is a single-channel raster in which each pixel represents a specific height. In 3D, this height information can be used directly for a 2.5D display of the raster:

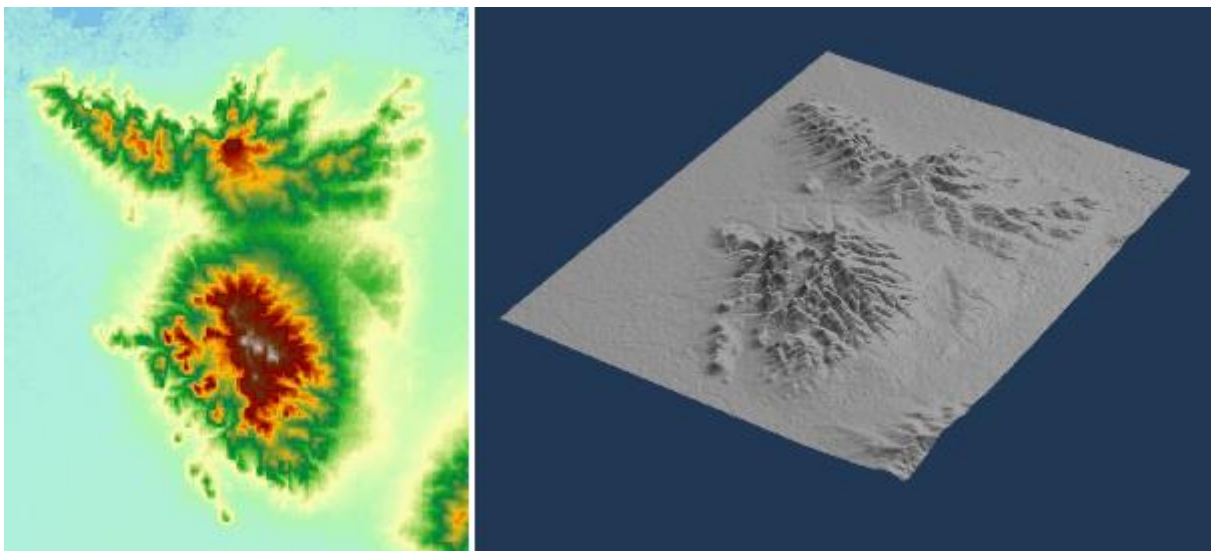


Figure 162: Digital Elevation Model - (2D) map viewer (left) and 3D Viewer (right)

For a single-channel raster to be interpreted as digital elevation model in GAFmap®, it has to be marked as **DEM** or **3D surface** (see also chapter 5.3.4.1):

- If the raster property **Use as DEM** is **On**, a single-channel raster serves as the DEM. The pixel values are then interpreted as (terrain) heights.



Raster layers marked as DEM are represented with the DEM symbol in the TOC.

DEMs serve as a height source for various functions, e.g. for various on-the-fly analysis functions such as a **Viewshed** (see chapter 4.5.6) or **Create Profil** (see chapter 4.1.14).

Any number of single-channel rasters can be marked as DEMs. The individual DEMs are then virtually mosaicked in the background. If DEMs border on each other without gaps or overlap, a continuous DEM mosaic is created (= "base DEM" or "base terrain"). In

case of overlaps, the sorting of the rasters in the TOC is decisive: the height information is always derived from the raster on top in the TOC; NoData areas are excluded.

! In 2D, always all DEMs are included, i.e. regardless of whether they are checked in the TOC and therefore visible in the map viewer or not. In 3D, only those DEMs that are checked in the TOC are included.

In 2D, you can see/check the **base DEM** if you uncheck the **Map** in the TOC and then enable the on-the-fly lighting/shading (see chapter 4.5.4):

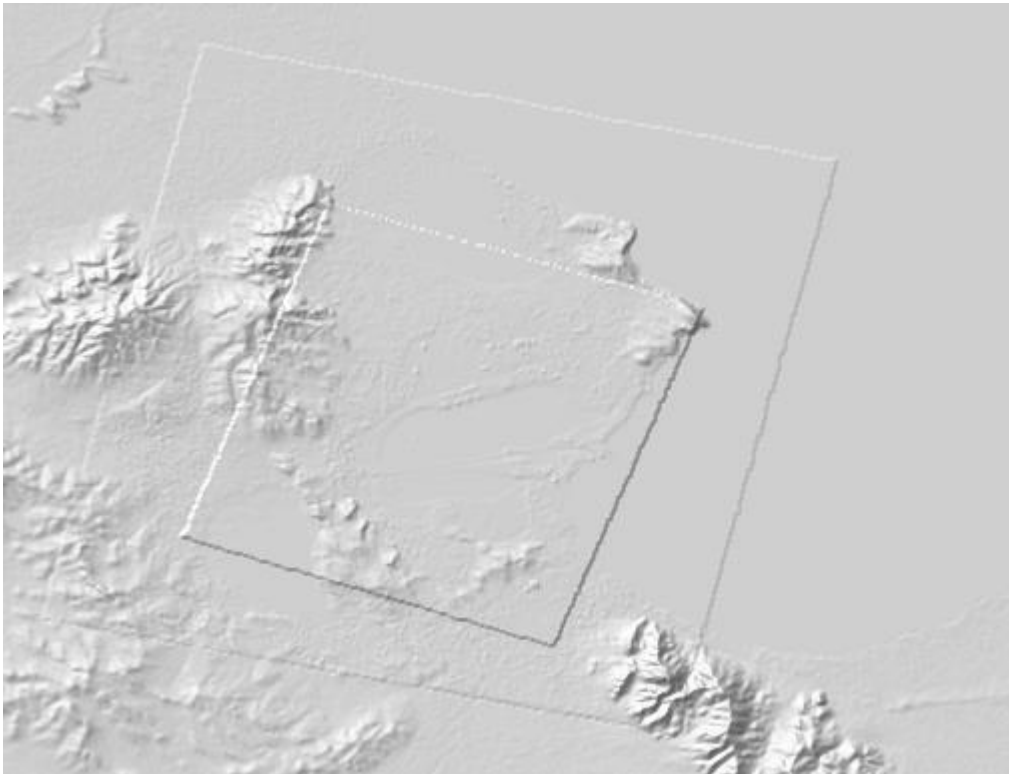


Figure 163: 2D base DEM



Single-channel rasters not marked as DEM (incl. 3D surfaces) can be recognized in the TOC by the simple b/w raster symbol.

- If the raster property **Use As 3D Surface** is **On** (*only possible if the project contains a 3D window and if Use as DEM = Off*), a single-channel raster is also recognized as digital elevation model. However, it does not serve as a height source for other functions then and is always considered "individually", i.e. it is not integrated into the DEM mosaic. This makes it possible, for example, to compare different digital elevation models in the 3D viewer.

Context Menu



A right-click on one or multiple selected digital elevation models in the TOC opens the respective context menu. The context menu of a digital elevation model corresponds to that of a "normal" raster layer. Only if the project contains a 3D window, the properties have special 3D features. Information on all functions in a DEMs context menu and non-3D-specific properties can be found in chapter 5.3.1 et seqq. (for across layers) or chapter 5.3.3 et seqq. (for raster specific).

5.3.4.1 Properties

In GAFmap Express: TOC > Layer > Context Menu Raster Layer - Special Case "Digital Elevation Models"



Via **Properties** you reach the Properties window where all essential properties of the selected digital elevation model are listed. They correspond in large parts to those of a simple raster layer (see chapter 5.3.3.6). In the following, only properties are listed that are displayed only for digital elevation models, i.e. for **DEMs** and **3D Surfaces**. All of these properties are only visible if the project contains a **3D window** and refer exclusively to the 3D viewer.

For general information on digital elevation models, i.e. DEMs and 3D surfaces, see chapter 5.3.4.

Common DEM Texture

Only for DEMs and if the project contains a 3D window

All properties under this category exclusively refer to the 3D viewer.

- **(Auto) Texture Resolution:** The **Texture Resolution** defines the resolution [m] with which textures placed in the DEM are displayed in the 3D viewer. If **Auto Texture Resolution** is **On**, it is determined dynamically and optimally in terms of quality, performance, and memory consumption; if it is **Off**, the displayed texture resolution is fixed.
- **Symbol Scale:** shows the factor with which the symbols, that are defined for the (2D) visualization of vector geometries, are scaled in the 3D viewer when they are used as texture.

Note: the (2D) symbol size of vector geometries is given in pixels (see chapter 5.2.1.10 or 5.3.2.5). In the 3D viewer, the size refers to the texture pixels. The size/width of the symbols therefore depends directly on the **Texture Resolution**.

- **Texture Map Scale:** shows the current texture map scale, i.e. the "reference scale" in 2D. This information is relevant, for example, if the **Scale Range** in which a layer is

displayed is restricted (see e.g. chapter 5.2.1.10, 5.3.2.5, or 5.3.3.6) or, if vector textures are used, for the symbol size/width.

- **Draw Selection:** shows whether features are only highlighted in the (2D) map viewer (**Off**) or the feature selection is also drawn in the 3D viewer (**On**) if vector layers are used as texture.

Features that are displayed as 3D objects are always highlighted in the 3D viewer if they are selected, i.e. independent off this property.

For information on the difference between 3D data/objects and textures, see chapter 2.2.3.2.

- **Combine Texture:** shows whether areas of the DEM that are loaded but are not covered by the texture are displayed in the 3D viewer (**On**) or not (**Off**). If **On**, all loaded areas of the DEM are fully displayed independent of the activation status of the textures. If textures cover parts of the DEM, the DEM is combined with and without texture. If **Off**, the DEM itself is only displayed if no texture is activated. As soon as one ore more textures are checked in the TOC, only the texture "with terrain" can be seen in the 3D viewer.

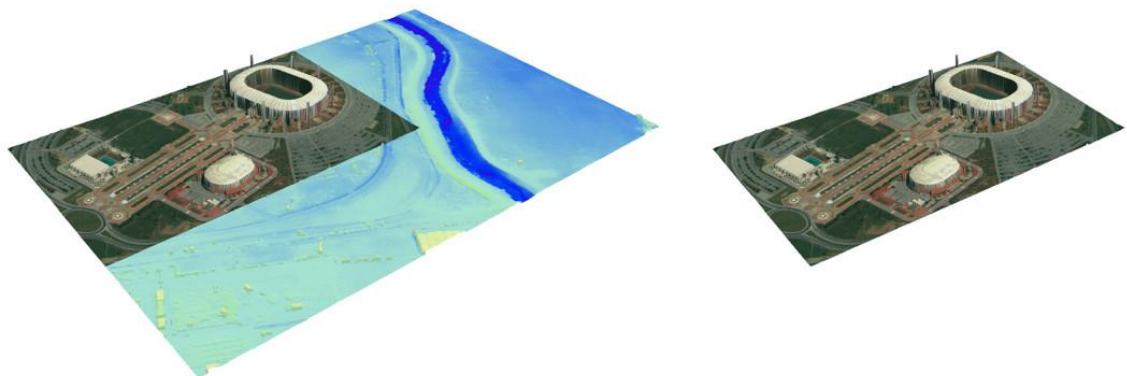


Figure 164: **Combine Textures** = **On** (left) and **Off** (right).

- **Only Show one RPC Texture** (*only visible if at least 2 RPC textures are activated*): shows the rendering method that is used to texture the DEM:

If **Off**, for each pixel of the DEM, i.e. for each screen pixel of the 3D viewer, the best RPC texture is determined on-the-fly by comparing the acquisition angles of the images and the slope of the terrain. The contents of the individual images are then mixed accordingly.

If **On**, the DEM is always textured with a single raster, using the one whose acquisition angle best fits the current viewing angle. If the viewing angle changes sufficiently, the displayed texture switches.

For general information on RPC textures, see chapter 5.3.5.

- **Top Texture Threshold** (*only visible if at least two (RPC) textures are activated and Only Show one RPC Texture = Off*): shows up to which terrain slope the Top Texture is drawn.

For general information on RPC Textures, see chapter 5.3.5.

Common DEM Settings

Only for DEMs and if the project contains a 3D window

All properties under this category refer to the display of the virtual DEM mosaic in the 3D viewer, i.e. they are the same for all loaded DEMs. They all refer exclusively to the 3D viewer.

You can find the same properties in the category **3D Surface Settings**. They then always refer to a single 3D surface only.

- **Shading**: shows whether the DEM is displayed shaded (**On**) or not (**Off**). If **On**, areas facing the light appear lighter and areas not facing the light appear darker. This creates a plastic impression.

The virtual light source is specified for the entire scene in the Map properties (see chapter 5.1.7).

A shading for **DEMs** can also be turned on/off via the button Enable/Disable DEM Shading in the 3D Viewer toolbar (see chapter 4.6.4).

- **Contrast**: shows the brightness contrast in the elevation model, i.e. the difference between the brightest and the darkest point. The higher the value, the higher the contrast.
- **Roughness**: shows the roughness the elevation model is displayed with. The higher the value, the duller and rougher the surface looks.
- **Metallic**: shows how metallic the surface of the DEM is displayed. The higher the value, the more clearly it "reflects" for example the sky.
- **Shadows/View Obstruction**: if **On**, the elevation model casts shadows and it is considered as view obstruction when calculating an on-the-fly viewshed in the 3D viewer.

Note that layers for which **Shadows/View Obstruction** is disabled do not participate in the shadow and 3D viewshed at all. This means that they are not only not considered as light or view obstruction, but they also neither reflect shadows cast by other objects nor the result of the 3D viewshed.

For more information on shadows and 3D viewshed, see chapters 4.6.5 or 4.6.6.

- **Color Mode:** shows which method is used to colorize the DEM in the 3D viewer. Possible are:

- **Konstante Farbe:** if displayed, the DEM is displayed single-colored. The color used is shown at **Color**.

Especially for this setting, it is recommended to enable **Shading** for the DEM (see chapter 4.6.4), as otherwise, the terrain is hardly visible.

- **Color Ramp:** if displayed, the DEM is displayed with a color ramp. The color ramp used is defined under **Color Ramp**.

If **Use Custom Transfer Function** is set to **On**, a **Stretch Function** for the color ramp has been defined when creating the project.

The property **Color Mode** is hidden if the DEM is not visible because it is completely overlaid by the texture.

- **Isoline Mode:** if **On**, isolines are displayed on all elevation models (DEMs). Two modes can occur:

- **Single Line:** One isoline is displayed at a specific height. You can find the height in the property field **Isoline Value**.
- **Multiple Lines:** Isolines are displayed on a predefined height interval. You can find the height in the property field **Isoline Step [m]**.

Isoline Color/Isoline Width displays the color/width the isoline(s) is/are drawn with.

Note that isolines are not visible if the DEM is covered by a texture.

- **Transparency [%]:** shows the degree of transparency all elevation models (DEMs) are displayed with in the 3D viewer (0 = non-transparent/opaque, 100 = fully transparent/invisible).
- **Level of Detail:** shows the level of detail with which the DEM is drawn in the 3D viewer. The smaller the selected pyramid level, the higher the level of detail. At **Pyramid Level 0** the DEM is rendered with maximum level of detail. If **Dynamic LOD** is displayed, it is determined dynamically and optimally (depending on the hardware used).

Note that a higher level of detail is associated with high graphics memory requirements and high computing power. If too high a level of detail has been selected, only part of the DEM can be loaded and drawn. Rendering blocks (see below) in the foreground closer to the viewer are prioritized. The DEM loading stops when the limit is reached. With a higher pyramid level selected, a larger area can be rendered but at a lower resolution.

For **Dynamic LOD** always the entire area is drawn, with the difference that blocks in the foreground closer to the viewer are drawn with the highest or high resolution and blocks in the background are drawn with a lower resolution.

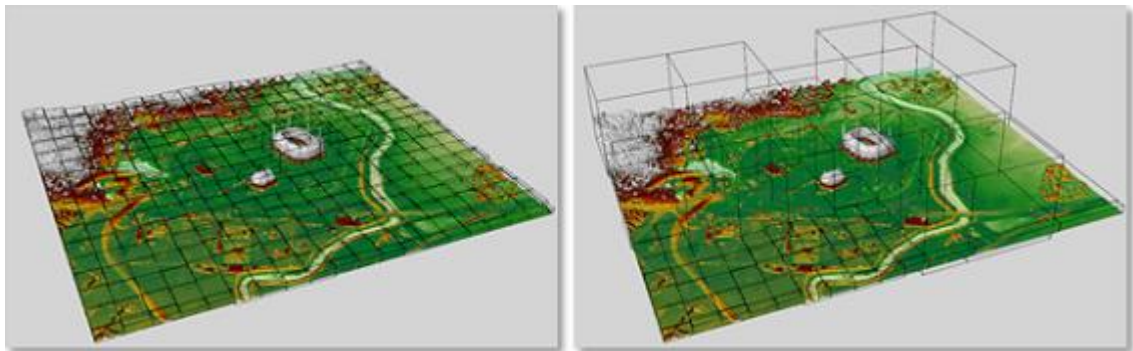


Figure 165: example: left: Pyramid Level 0 (full resolution) and right: Dynamic LOD.

- **Simplify Mesh:** shows whether the triangle mesh of the DEM is simplified depending on the tolerance value set, i.e. whether triangles are combined (**On**), or not (**Off**).
 - **Simplification Tolerance [m]:** shows the vertical tolerance for the simplification of the highest pyramid level. It should be approximately equal to the vertical accuracy of the DEM.
 - **Simplification Tolerance Exponent:** shows the factor the **Simplification Tolerance** is multiplied with for higher levels.

If **Auto Simplify Mesh** is set to **On**, the tolerance values for the mesh simplification are automatically optimally determined, otherwise they have been entered manually by the creator of the project.

- **Culling Mode:** shows the culling mode the DEM is displayed with.

Culling is a method of 3D computer graphics that excludes surfaces from visualization - e.g. surfaces facing away from the observer - depending on the relationship between observer and an object's surface (consisting of triangles). As a result, an additional increase in performance can be achieved.

The following modes can occur:

- **Double Sided:** No culling is applied. All triangles defined as "double sided" show a different shading depending on the viewing side (facing away or towards the observer). Since the virtual light source is above the DEM, the bottom is less brightly illuminated than the top when using this mode.
- **One Sided:** Excludes all triangles that have a clockwise rotation direction after being projected into the screen plane. Therefore, only the top of the DEM is displayed. This setting is recommended if you want to increase performance.

- **Double Sided Inconsistent:** No culling is applied. All triangles defined as "double sided" display the same shading on each viewing side (facing away or towards the observer).
- **Show Rendering Info:** if **On**, the blocks used for rendering are displayed as transparent cubes within the 3D viewer. In the viewer's lower right corner, you can find information on the number of triangles and tiles that are used.

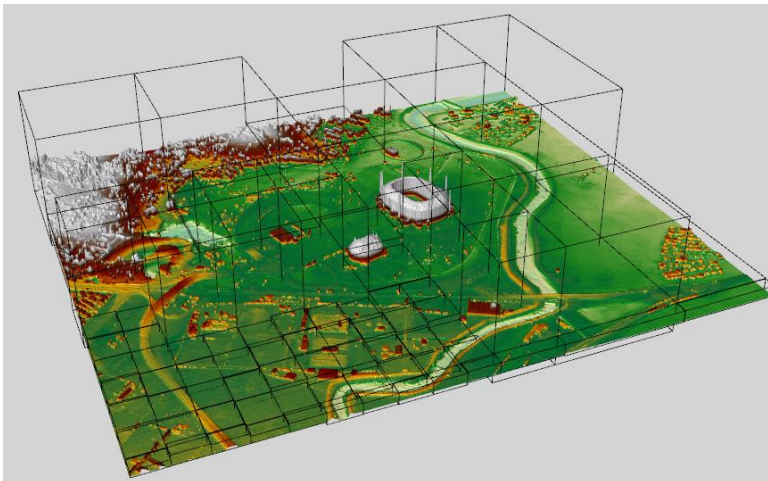


Figure 166: Render Info, example for DEM with Level of Detail = Dynamic LOD.

3D Surface Settings

Only for 3D surfaces and if the project contains a 3D window

The properties in the category **3D Surface Settings** correspond to those under **Common DEM Settings** (see above), but they always only refer to a single 3D surface, i.e. to a single single-channel raster.

5.3.5 Raster Layer - Special Case "RPC Texture"

In GAFmap Express: TOC > Layer

! For information on digital elevation models (DEMs), see chapter 5.3.4, for information on textures in the 3D viewer, see chapter 2.2.3.2.

Usually, layer textures are applied as simple top textures to the base terrain / DEM in the 3D viewer, i.e. they are placed vertically from above on the DEM. If, for example, a satellite image is used as texture, it is displayed 1:1 in areas where the surface is exactly horizontal and flat; if the terrain is inclined and/or relieved, the raster for texturing is distorted accordingly. For vertically sloping walls (e.g. building facades), the raster pixels are "pulled down" vertically.



In addition to simple layer textures, GAFmap® supports RPC textures. They are marked with an R in the TOC. This refers to satellite images, for which an *.rpc or *.rpb file is available that contains the information from which position and which angle the image has been acquired. Based on this exact information about the acquisition geometry, RPC textures can be applied to the terrain exactly opposite to the direction of acquisition. This way, even vertically sloping side surfaces, such as e.g. building facades, can be textured if the acquisition angle is sufficiently inclined ("RPC-based side views"):



Figure 167: left: Side view with a nadir image / right: RPC-based side textures with nadir image and two side images (north, south). (© GAF AG, contains Airbus DS-Material)

If the views are to be displayed for all viewing directions, i.e. "on all sides", five textures from five different shooting directions are required. Ideally these are:

- **4 side views**, taken from four cardinal points with the most inclined angle possible. The side views must be RPC textures.
- **1 top texture** / nadir image, showing the view from above. This can be either
 - another RPC texture for which the property **Is Top RPC** is **On**, or
 - one or multiple simple layer textures, which are then (automatically) combined to one top texture. Layer textures have a higher priority than Top RPCs, i.e. they are drawn in the 3D viewer even if they are listed below an RPC texture in the TOC.

If less side views are displayed or if the constellation is less favorable, the sides are textured "distorted" with less suitable image content for certain viewing angles and the result appears less realistic.

Only a maximum of five different RPC/raster textures can be displayed: either 5 RPC textures or 4 RPC textures + any number of simple layer textures.

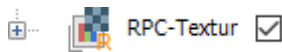
Rendering

Usually, it is calculated on-the-fly which RPC texture is best suited for this pixel for each location of the DEM, i.e. for each individual screen pixel of the 3D viewer, it is calculated on-the-fly which RPC texture is best suited for this pixel. This is done by comparing the acquisition angles of the images and the inclination of the terrain.

Since the appropriate texture is determined individually for each pixel, the image contents are mixed more or less strongly depending on the situation. The smaller the differences between the textures as well as between texture and DEM, the smoother the overall image appears.

Exception: if the DEM property **Only Show one RPC texture** is **On** (see chapter 5.3.4.1), the DEM is then textured with only a single raster, the one with the best acquisition geometry for the current viewing direction. Note that with this setting, the texture may "skip" clearly visible in transition areas even if the viewing direction is only slightly changed.

Context Menu



A right-click on one or multiple selected RPC Textures in the TOC opens the respective context menu. It corresponds in large parts to that of a "normal" raster layer. In the following chapters only functions and properties that are either RPC texture specific or for which special features are to be considered in regards to RPC textures are discussed. Information on all other functions and properties can be found in chapter 5.3.1 et seqq. (for across layers) or chapter 5.3.3 et seqq. (for raster specific).

Tips and notes:

- Since the use of RPC textures makes high demands on the hardware, the PC used should have a current CPU, a fast data storage (preferably SSD), sufficient RAM (at least 16GB) and especially a very good graphics card (GPU) with dedicated memory.
- RPC information available for satellite images can be used not only for displaying side views in the 3D viewer, but also for an on-the-fly orthorectification in the (2D) map viewer.

5.3.5.1 Align View by Shooting Angle

In GAFmap Express: TOC > Layer > Context Menu Raster Layer - Special Case "RPC Texture"

Only available if the project contains a 3D window

Align View by Shooting Angle changes the viewing angle in such a way that it matches the acquisition angle of the RPC texture, i.e. the "optimal viewing angle" is used for the image.

For general information on satellite images with RPC parameters ("RPC Textures"), see chapter 5.3.5.

Shortcuts, Key Commands, etc.:

- Alt + click on a RPC texture's layer name in the 3D TOC: Align View by Shooting Angle

5.3.5.2 Properties

In GAFmap Express: TOC > Layer > Context Menu Raster Layer - Special Case "RPC Texture"



Via **Properties** you reach the Properties window where all essential properties of the selected RPC Texture are listed. They correspond in large parts to those of a simple raster layer (see chapter 5.3.3.6). In the following, only properties are listed that are displayed for RPC Textures.

For general information on satellite images with RPC parameters ("RPC Textures"), see chapter 5.3.5.

RPC

The properties in this category affect both the display of the satellite images in the 3D viewer and in the (2D) map viewer:

- **Use RPC / DEM:** if **On**, the RPC parameters are used for an on-the-fly orthorectification of the satellite image in the (2D) map viewer. If for **DEM** a digital elevation model is specified, additionally the influence of the terrain on the display and position of the satellite image data is taken into account. If the specified DEM does not have an ellipsoidal but a geoidal height reference, the flag **DEM is geoidal** is set to **On**.

Note: If a *.rpc/*.rpb file is available for a satellite image, the image is always identified as an RPC texture and used as such. The (2D) property **Use RPC** has no influence here.

- **DEM is geoidal:** Both the on-the-fly orthorectification in the (2D) map viewer (see above) as well as the calculation of RPC textures in the 3D viewer (see chapter 5.3.5)

require a DEM with ellipsoidal height reference. If the DEM used does have a geoidal height reference, this flag is set to **On**. The heights are then converted in the background.

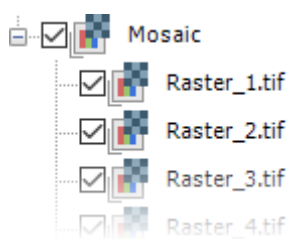
- **Is Top RPC** (*only visible if the project contains a 3D window*): if **On**, this RPC texture is used to texturize terrain with a slope equal to or flatter than the **Top Texture Threshold** specified for the DEM (see chapter 5.3.4.1).
- **RPC-Textur Priorität** (*only visible if the project contains a 3D window*): specifies whether this RPC texture is prioritized relative to all other activated RPC textures, e.g. if it is qualitatively better or more up-to-date. In the area between RPC textures, this texture is then "longer" displayed, i.e. up to a certain degree even if another RPC texture is more suitable for the viewing direction compared to the acquisition geometry (see chapter 5.3.5).

By default, all RPC textures have the same priority (value 0). With a value > 0 the texture has a higher priority, with a value < 0 a lower priority. Always the difference of values between the textures are decisive.

- **Line Shift/Row Shift**: Depending on the initial positional accuracy of a RPC texture, it may be necessary to make adjustments to improve the absolute position or position to the DEM and/or the relative position to other (RPC) textures. Enter the necessary shift in X/Y direction at **Line Shift/Row Shift**. With 0 the initial position of the RPC texture remains unchanged, with positive values it is shifted to the right/up by the corresponding number of pixels, with negative values to the left/down.

5.3.6 Raster Layer - Special Case "Mosaic Layer"

In GAFmap Express: TOC > Layer



A **Mosaic Layer** consists of any number of individual rasters that are displayed on-the-fly in the map viewer as virtually mosaicked image. The individual rasters are bundled within the project and treated as one (total) raster. The individual rasters are still accessible; they are listed under the mosaic layer.

Individual rasters that lie on top in the TOC also lie on top in the map viewer. You can always activate/deactivate individual rasters by checking/unchecking them, e.g. to make an underlying raster visible.

For the display of the mosaic layer, a common stretch statistic is calculated across all activated single rasters and applied to them. This creates a consistent overall image - depending on the data basis without disruptive transitions between the individual images:

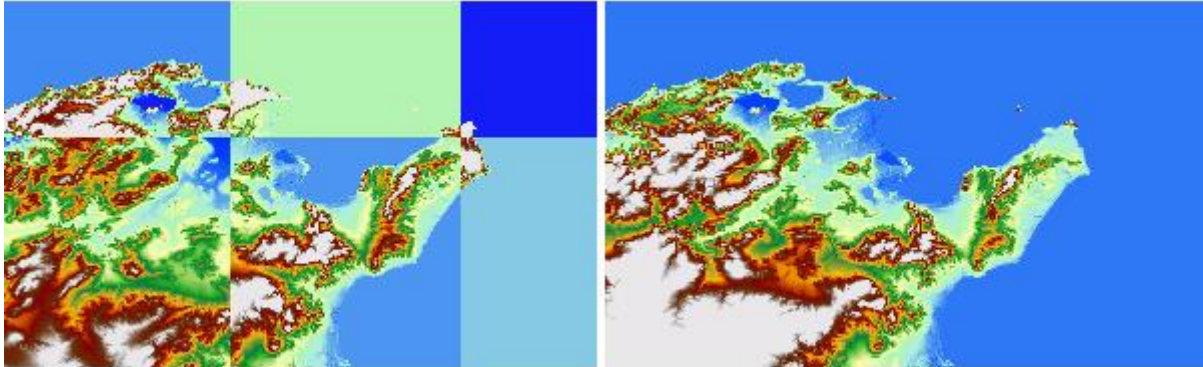


Figure 168: Example left: 6 DEMs individually loaded (with individually determined stretch statistic) and right: the same DEMs loaded as mosaic layer (with common stretch statistic)

Whether and how well the individual rasters can be combined into a homogeneous ("optically pleasing") mosaic, essentially depends on the data basis. Here, for example, the following factors are decisive:

- sensor type
- acquisition time (daily or seasonal differences)
- acquisition angle
- differences in content (e.g. disappearing objects, new buildings, different crops, etc.)

For some mosaic layers, the border between the single rasters was edited manually. The exact course of the border is then comprehensible with a cut-line layer. This is a vector layer, which contains one polygon each for all or individual rasters of the mosaic layer; polygon and raster are linked via the attribute field **RelPath**. If the cut-line layer contains a polygon for a raster, the raster is only displayed inside of the polygon, external areas are (virtually) cut off.

If a cutline layer is used, it is entered in the mosaic layer properties under **Cut Lines** (see chapter 5.3.6.6). You can then find the layer itself in the TOC.

Note: In GAFmap® Express the individual rasters for a mosaic layer are not contained in the Pack&Go Container (*.cmp), but are always only linked. If the original raster files have been deleted, moved or renamed, the mosaic can consequently not be displayed any more.

Context Menu

A right-click on a mosaic layer in the TOC opens the respective context menu. It corresponds in large parts to that of a "normal" raster layer. In the following chapters only functions and

properties that are either mosaic layer specific or for which special features are to be considered in regards to mosaic layers are discussed. Information on all other functions and properties can be found in chapter 5.3.1 et seqq. (for across layers) or chapter 5.3.3 et seqq. (for raster specific).

5.3.6.1 Zoom to Mosaic Layer

In GAFmap Express: TOC > Layer > Context Menu Raster Layer - Special Case "Mosaic Layer"

Only available if the mosaic is selected



Zoom to Mosaic Layer always zooms the map to the extent of the whole mosaic layer, irrespective of the activation state of the individual rasters.

5.3.6.2 Activate Raster in Current View Extent

In GAFmap Express: TOC > Layer > Context Menu Raster Layer - Special Case "Mosaic Layer"

Only available if the mosaic is selected



Activate Raster in Current View Extent activates (checks) all rasters of the mosaic layer that lie completely or partially within the currently visible map extent; already activated rasters that do not lie within the visible map extent are deactivated.

For performance reasons, it is recommended to first zoom to the desired map extent and then activate all rasters for the current view. This ensures that only data that is actually needed is loaded.

5.3.6.3 Deactivate all Rasters

In GAFmap Express: TOC > Layer > Context Menu Raster Layer - Special Case "Mosaic Layer"

Only available if the mosaic is selected



Deactivate all Rasters deactivates (unchecks) all rasters under the mosaic layer.

5.3.6.4 Zoom to Cut Line

In GAFmap Express: TOC > Layer > Context Menu Raster Layer - Special Case "Mosaic Layer"

Only available if a single mosaic raster is selected and a cut line feature is linked



Zoom to Cut Line zooms the map to the extent of the cut line polygon linked with the raster. The command is only available if a **Cut Lines Layer** is defined, i.e. if the boundary between the individual rasters was edited manually when creating the mosaic layer (see chapter 5.3.6).

5.3.6.5 Select Cut Line Feature

In GAFmap Express: TOC > Layer > Context Menu Raster Layer - Special Case "Mosaic Layer"

Only available if a single mosaic raster is selected and a cut line feature is linked



Select Cut Line Feature selects the cut line polygon linked with the raster. The command is only available if a **Cut Lines Layer** is defined, i.e. if the boundary between the individual rasters was edited manually when creating the mosaic layer (see chapter 5.3.6).

5.3.6.6 Properties (Mosaic Level)

In GAFmap Express: TOC > Layer > Context Menu Raster Layer - Special Case "Mosaic Layer"



Via **Properties** you reach the Properties window where all essential properties of the selected mosaic layer are listed. They correspond in large parts to those of a simple raster layer. In the following, only properties that are either mosaic layer specific or have special features regarding mosaic layers are listed. For information on all others, see chapter 5.3.3.6:

Extent

- **X/Y Min / X/Y Max:** shows the layer's extent in the map coordinate system. Please note that the extent of a mosaic layer depends on which individual rasters are activated (i.e. checked in the TOC).

Geometry

- **Cut Lines:** shows whether a Cut Line Layer has been used to manually edit the cutlines between the individual rasters of the mosaic layer. If a layer is specified, its polygons define the extent of the corresponding single rasters.

- **Only Use Rasters with Cut Lines** (*only visible if a Cut Lines Layer is entered above*): shows whether rasters for which the above specified Cut Line Layer does not contain a cut line polygon are treated as "non-existent" (**On**) or as "uncut" (**Off**).
- **Feathering Pixels [px]** (effect only visible where individual rasters overlap): if a value > 0 is entered, the transitions between the individual rasters of the mosaic layer are softened by mixing/blending the pixels at the edge of overlaps. The blend area extends from the edge of the overlap area inwards by the specified number of pixels.

Catalog

- **Pixel Type**: shows the (target) pixel type for the mosaic layer.
- **Target Min/Max**: shows the target range used for the stretch.
- **NoData Value**: shows the NoData value of the mosaic layer.
- **Override Cell Size**: if a value is entered here, the mosaic Layer has this resolution. Otherwise, the mosaic layer has the resolution of the activated single raster with the highest resolution. In both cases the pixels of single rasters with different resolution are resampled accordingly.
- **Override Anchor Point**: if a value is entered here, it is interpreted as anchor coordinate on which the mosaic raster is aligned. 0, for example, is read as 0|0 (origin), 0.5 as 0.5|0.5, etc.

Symbology

- **Stretch Type**: shows how the pixel values of the mosaic layer are stretched over the 8bit value range of the screen. This stretching is applied in addition to the stretching, scaling, and/or offset at the level of the individual rasters (see chapter 5.3.6.7).

5.3.6.7 Properties (Single Raster Level)

In GAFmap Express: TOC > Layer > Raster Layer - Special Case "Mosaic Layer"



On the level of a single mosaic raster, more properties are displayed from which can be read how the respective raster is fitted and/or stretched into the mosaic:

Source

- **File Path**: shows the connection parameters to the connected raster dataset. This can be e.g. a file path or an URL.

Adjustments

- **Custom Value Transfer:** if **On**, an individual transfer function for the raster has been specified in order to better fit it into the mosaic.

If **Custom Transfer** is switched to **Off**, no individual stretching is specified for the raster, but it might be fitted better into the mosaic using the following properties:

- **Scale Factor:** shows the factor by which the original pixel values are multiplied.
- **Offset:** shows the value added to the original pixel value.

The following then applies: New pixel value = original pixel value * scale factor + offset.

5.3.7 Point Clouds

In GAFmap Express: TOC > Layer

A point cloud consists of a multitude of (measurement) points individually located in space. They are obtained e.g. by (laser) scanning objects or terrain.

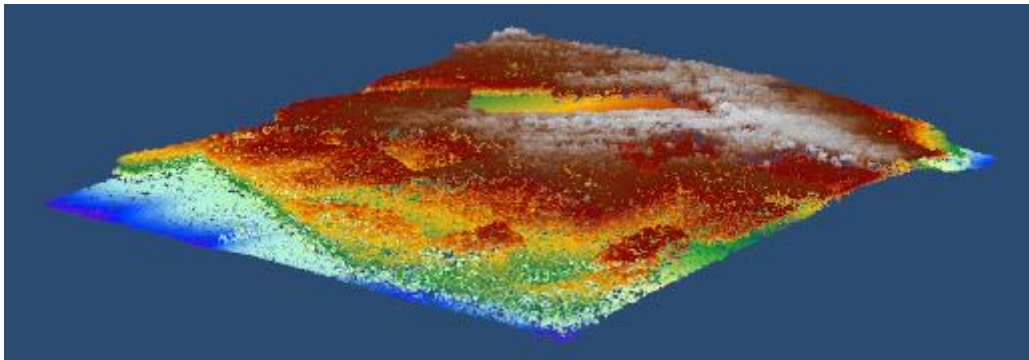
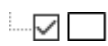


Figure 169: Point cloud, displayed as individual points

Point clouds in GAFmap® can only be visualized in the 3D viewer (as 3D dataset), in the (2D) map viewer only the extent of the point cloud is displayed as rectangle.

Context Menu

 **Point Cloud** A right-click on one or multiple selected point clouds in the TOC takes you to the corresponding layer context menu. It does not contain any point cloud specific functions/commands, only those that are available for all layers irrespective of the type. For more information, see chapter 5.3.1. You can find information on the point cloud properties in chapter 5.3.7.1.

5.3.7.1 Properties

In GAFmap Express: TOC > Layer > Context Menu Point Clouds






Via **Properties** you reach the Properties window where all essential properties of the selected point cloud are listed.

For point clouds, the properties are in general only viewable and cannot be adjusted (i.e. all properties are grayed out).

If multiple layers are selected, only properties that are available for all selected layers (common properties) are displayed.

Source

- **Number of Points:** shows the total number of points the point cloud contains.
- **Spatial Reference:** shows the layer spatial reference.
 opens a window with detailed information on the layer spatial reference
- **Metadata:** shows further meta information that is stored in the dataset itself.
 opens the Metadata window
- **Layer Info:** : if available, additional information about the layer can be viewed here (e.g. a legend, the data source, other metadata, etc.)
 opens the Layer Info window

If a layer info is entered, it can alternatively be called up via **Show Layer Info** command in the layer context menu (see chapter 5.3.1.7); texts with HTML syntax are then usually displayed formatted (here always as source text).

Extent

- **X/Y Min:** shows the X-/Y-coordinate of the bottom left edge of the (rectangular) full extent of the point cloud in the map coordinate system.
- **X/Y Max:** shows the X-/Y-coordinate of the top right edge of the (rectangular) full extent of the point cloud in the map coordinate system.
- **Z Min/Max:** shows the smallest/largest height of the point cloud.

Scale Range

- **Scale Range:** determines whether a point cloud activated in the TOC is only displayed in the map viewer if the zoom level of the map is within a certain scale range (**On**) or always, regardless of the zoom level (**Off**).

If **On**, you can specify the valid scale range, i.e. the desired lower/upper limit, under **Min. Scale / Max. Scale**.

Symbology

The properties in this category affect how the rectangular placeholder that indicates the extent of the point cloud in the (2D) map viewer is displayed. They correspond to the Symbology properties of rectangle graphics. For more information, see chapter 5.2.6.2 or 5.2.1.10.

3D Symbology

- **Level of Detail:** shows how much the number of displayed points is thinned out. Especially for larger amounts of data a reduced level of detail can noticeably increase the performance.

A level of detail = 0 displays all points. The higher the specified value, the more the number of displayed points is thinned out. The reduction of the point density is not the same for all blocks. In the blocks further away from the observer, more thinning is taking place than in blocks that are directly in the field of vision.

- **Point Symbol:** shows the symbol used to display the points in the 3D viewer. Depending on your choice, the points are either displayed as three-dimensional objects (**Box** or **Sphere**) or as simple markings (**Point**, **Cross**, or **Quad**).
- **Eye Dome Lighting** (*only visible if Point Type = Quad*): if **On**, a light-independent on-the-fly hillshade to the point cloud is activated. Compared to the hillshade that relates to a virtual light source, **Eye Dome Lighting** uses a depth buffer. This causes pixels to be colored darker when their neighboring pixels have a smaller depth, i.e. when they are closer to the observer. The greater the difference in depth, the darker they appear. In addition, the **EDL Contrast** is then displayed. It defines the brightness contrast, i.e. the difference in between the brightest and darkest points of an image.

- **Shading** (*only visible if Point Type = Box or Sphere*): if **On**, an on-the-fly shading to the points is applied. Shading causes all surfaces that face the light source to appear lighter, and all surfaces that are turned away from the light source to appear darker. This enhances the spatial impression.

The virtual light source is specified for the entire scene in the Map properties (see chapter 5.1.7).

- **Shadows/View Obstruction** (*only visible if Point Type = Box or Sphere*): if **On**, the point cloud casts shadows and it is considered as view obstruction when calculating an on-the-fly viewshed in the 3D viewer.

Note that layers for which **Shadows/View Obstruction** is disabled do not participate in the shadow and 3D viewshed at all. This means that they are not only not considered as light or view obstruction, but they also neither reflect shadows cast by other objects nor the result of the 3D viewshed.

For more information on shadows and 3D viewshed, see chapters 4.6.5 and 4.6.6.

- **Symbol Size Unit** (*only visible if Point Type \neq Point*): shows which measurement unit is used for (re)sizing the **Symbol Size**. Available are:
 - **Meter [m]**: the symbol size is given in meters. This unit is recommended if the absolute size of the object is decisive for its display.
 - **Scene [‰]**: the symbol size is given in relation to the size of the entire scene. This unit is recommended if a visually appealing result is to be achieved quickly for very large or very small scenes.
- **Symbol Size** (*only visible if Point Type \neq Point*): shows the size of the point symbol. Depending on the selected **Symbol Size Unit** it is displayed in meters [m] or in a per mille share of the entire scene [‰].
- **LOD-Größenskalierung** (*only visible if Point Type \neq Point and Level of Detail \neq 0/-1*): shows the factor with which the size of the points in blocks with a lower **Level of Detail** (see above) is adjusted. In blocks with a full level of detail, the size is not adjusted.

Especially when working with a lower level of detail due to performance reasons, a more homogeneous display of the point cloud can be achieved on the screen by adjusting the LOD Size Scaling.

With LOD Size Scaling = 0 the size of the points is not adjusted, for a value > 0 the point size is adjusted according to the level of detail of a block. The lower the level of detail of a block, the larger the points are displayed.


- **Color Mode**: which method is used to colorize the point cloud in the 3D viewer. The following modes can occur:
 - **Source Colors**: the colors stored in the source file are used.
 - **Height Color Ramp**: the color ramp displayed below based on the points' z-values is applied. Additionally a **Stretch Function** can be specified.
 - **Class Colors**: the points' classification as stored in the source file is used for the color representation. You can view the number of classes in the property field **Class Colors**.
- **Show Rendering Info**: if **On**, the blocks used for the rendering are displayed as transparent cubes in the 3D viewer. Blocks with the same level of detail are displayed in the same color.

At the bottom right of the 3D viewer, the following additional information is displayed:

- Loaded graphics data: amount of data [MB].
- Layer [name as shown in the TOC]: number of displayed blocks; number of points.

5.3.8 Tables

In GAFmap Express: TOC > Layer

 **Table** Simple **Tables** (incl. individually loaded attribute tables of vector layers) are treated like a vector layer without geometry (type) in GAFmap®, i.e. just like the attribute table of a loaded vector layer.

For more information about attribute tables, see chapter 5.3.2.1.

Context Menu and Properties

Right-clicking on one or multiple selected tables in the TOC opens the table context menu. It contains almost exclusively commands/functions as well as properties that are also contained in the context menu of vector layers. For more information, see chapters 5.3 et seqq. (for cross-layer functions), 5.3.2 et seqq. (for vector-specific functions) and 5.3.2.5 (for available (vector) properties).

6 GAFmap® Symbology

In the following chapters, the Symbols dialogs are described, i.e. the dialogs where you can customize the symbols used to display points, lines, and polygons, or to adjust the label style.

You can reach a symbols dialog e.g. via

- the settings of self-created graphics,
- double-clicking on the layer icon in the TOC for self-created graphics, or
- several general settings (e.g. for editing/selection geometries).

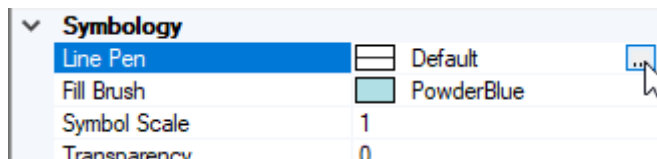


Figure 170: Open Symbols dialog, example

Symbols Dialog - Structure

All Symbols dialogs are structured as follows:

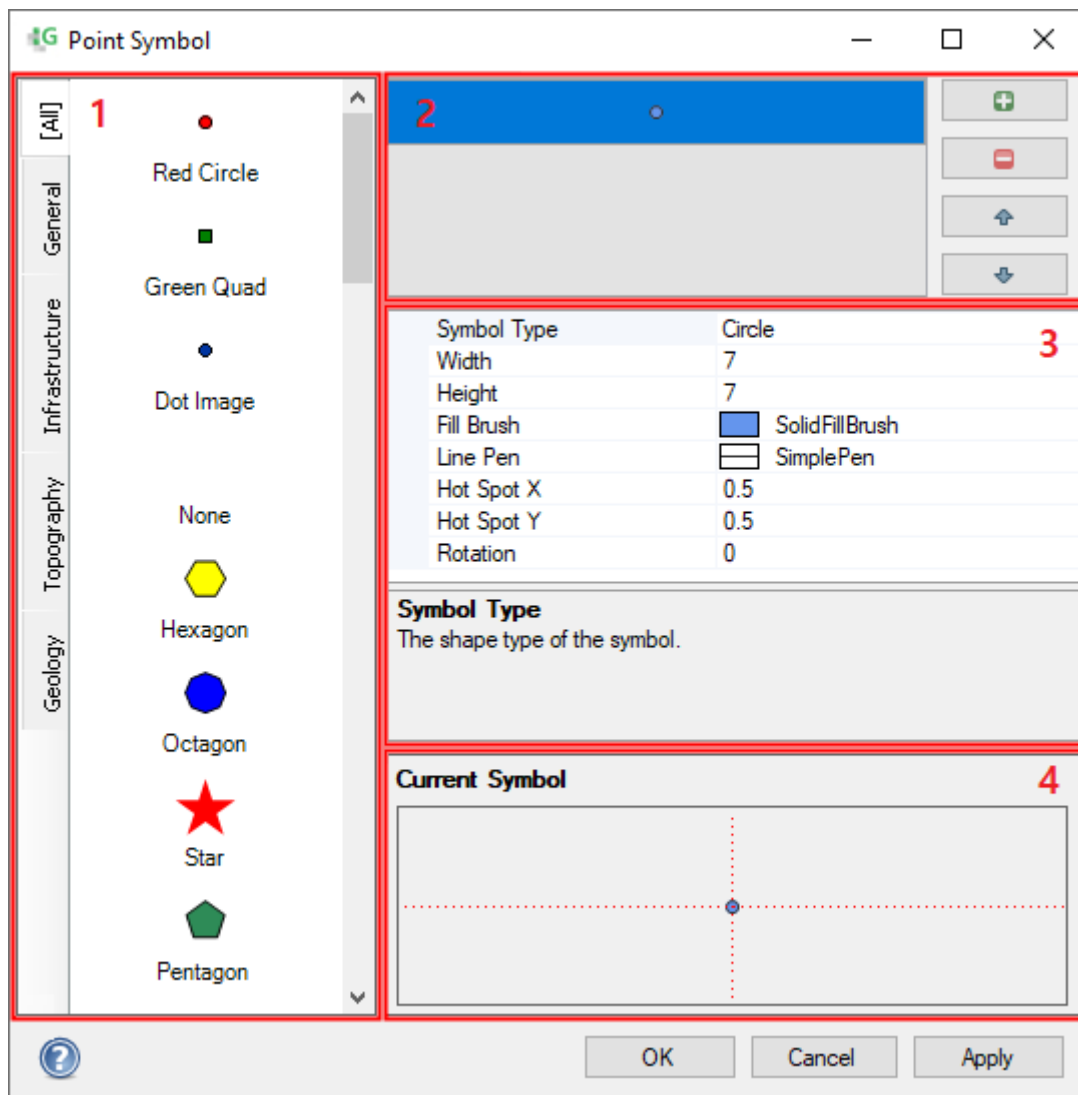


Figure 171: Dialog **Point Symbols**

- **Section 1: Predefined Symbols**

On the left side of the dialog some predefined symbols are listed. Via the tabs on the left, you can select predefined symbols from different categories.

By clicking on one of the predefined symbols, all settings on the right side of the dialog are adopted automatically from this symbol. If desired, you can adjust the symbol in the right part of the dialog (e.g. its size or color; see below).

- **Section 2: Combining Symbols (2)**

(missing for Labeling)

In case of simple (i.e. non-composite) symbols, exactly one symbol and its **Properties (3)** are displayed here:

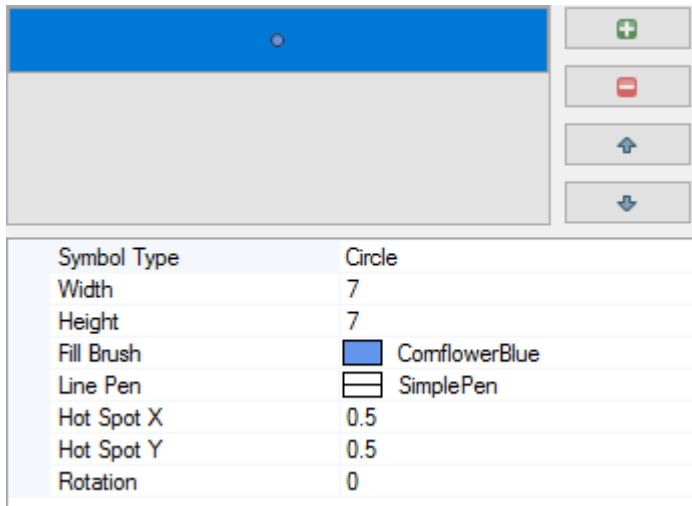


Figure 172: Simple point symbol, example



With the plus button you can add symbols. All symbols are then combined to one (composite) symbol in the order in which they appear in the list. The **Properties (3)** of the individual symbols can be adjusted individually. The resulting composite symbol is previewed under **Current Symbol (4)**.

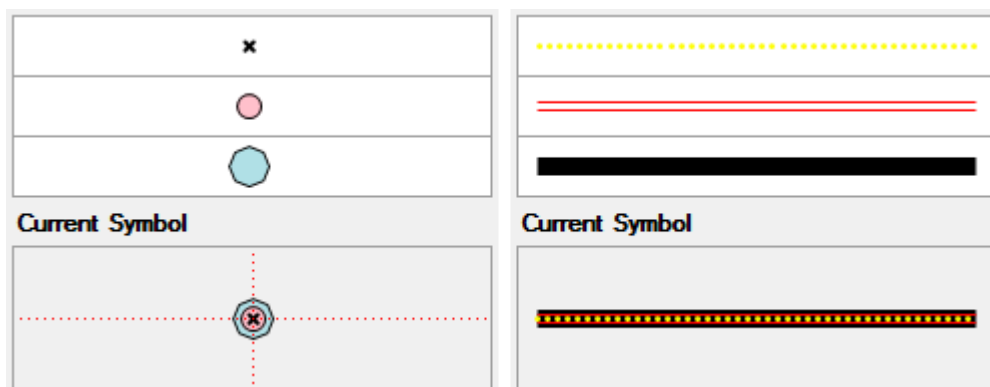


Figure 173: Combined (composite) point symbol (left) and line symbol (right), example



removes the selected single symbol from the list.



moves the selected single symbol stepwise up or down in the list.

- **Section 3: Symbol Properties**

Here, you can view and adjust the properties of the (single) symbol selected above. The properties displayed depend on the (geometry) type of the symbol. They are

individually listed and explained in the corresponding subchapters (see chapter 6.1 et seqq.).

- **Section 4: Current Symbol**

Here, the resulting (composite) symbol is previewed in its original size (see example above).

Shortcuts, Key Commands, etc.:

- Double-clicking on a layer icon in the TOC: opens the dialog for the respective symbol type (Point, Line or Fill Symbol)
- Alt+Double-clicking on a polygon icon in the TOC: opens the Line Pen dialog

Tips and Notes:

- If you want to enlarge or shrink a composite symbol, you can either adjust the size of the single symbols individually or scale the symbol as a whole (see chapter 5.2.1.10). In this case all single symbols are enlarged or shrunken at once and in proportion.
- If a symbol is to contain transparencies, e.g. the filling of a point and/or its surrounding ring is to be (semi-)transparent, you can specify a (semi-)transparent fill or frame color for all or individual elements directly in the Color Picker dialog (see chapter 6.5). Alternatively, you can apply transparencies to the entire symbol afterwards (see chapter 5.2.1.10).

6.1 Point Symbols

With e.g. a double-click a point icon in the TOC or via **Point Symbol** ... in a Properties window, you are taken to the Point Symbol dialog:

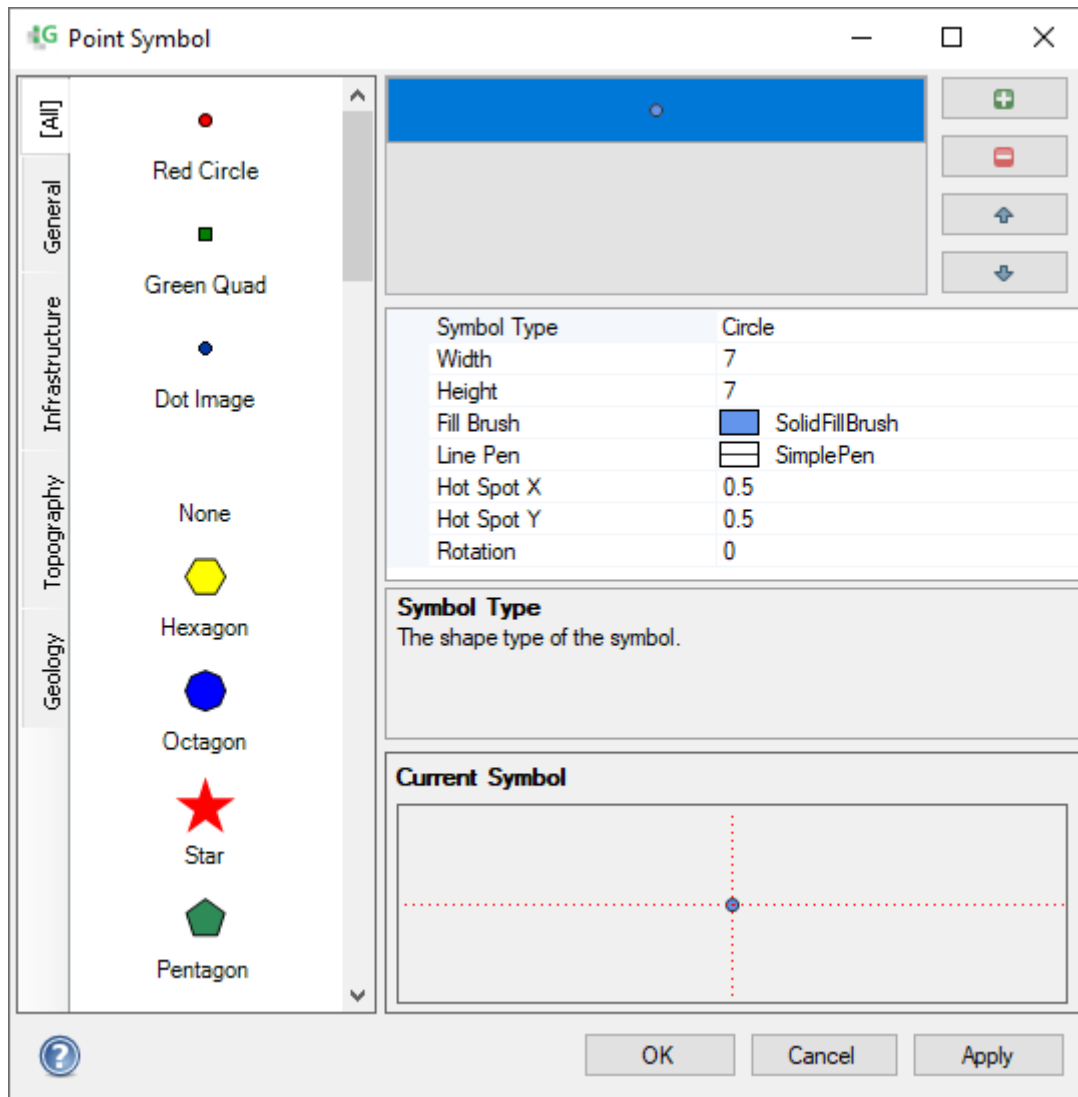


Figure 174: Dialog **Point Symbol**

In the following, only point symbol specific functions/properties are explained. For general information on the dialog and its structure, see chapter 6.

Select or Create Point Symbols

You can select, create, and/or edit a point symbol by

- clicking on a symbol in the **List of Predefined Symbols** on the left side. All settings to the right of the dialog are then automatically adopted by this symbol. You can either keep the selected symbol unchanged or edit it beforehand.

- creating a custom symbol on the right side of the dialog.



Clicking the plus button adds a new point symbol. You can then choose between the following kinds of point symbols:

- **Simple** = a simple geometry (see chapter 6.1.1)
- **Symbol** = a default Windows symbol (see chapter 6.1.2)

If you add multiple point symbols of any kind, all symbols are listed individually and combined to a composite symbol.



You can always delete individual symbols with the minus button or adjust their order (top/bottom) with the arrow buttons.

For more information about composite symbols see chapter 6.

Under **Current Symbol** you can preview the currently selected or created (composite) symbol. The crossing point of the red lines marks the actual point object.

With **OK** or **Apply** the current point symbol is taken over. **Cancel** closes the dialog without further action.

6.1.1 Point Symbol "Simple"

The point symbol **Simple** is a simple geometry. You can specify the shape of the geometry under **Symbol Type** and choose between **Circle**, **Rectangle**, **Regular Polygon**, and **Cross**. Depending on the selected **Symbol Type**, you can adjust the following properties:

- **Width/Height or Size [px]**: determines the size of the symbol.



opens a slider

- **Vertex Count** (*applies only to Regular Polygon*): determines the number of corners of the (always regular) polygon.



opens a slider

- **Fill Brush**: determines how the Point Symbol is filled.



opens the Fill Symbols dialog (see chapter 6.3)

- **Line Pen**: determines the line symbol the symbol / surrounding ring of the symbol is displayed with.



opens the Line Pen dialog (see chapter 6.2)

- **Hot Spot X/Y:** determines how the symbol is positioned relative to the point object. By changing the value, the symbol is moved accordingly in X/Y direction. The value specifies the position of the symbol on the actual point object:
 - At 0|0 the lower left corner of the symbol lies on the point object
 - At 1|1 the upper right corner lies on the point object
 - At 0,5|0,5 the symbol center lies on the point object
 - For values < 0 and > 1, the symbol is shifted by the corresponding amount in the X/Y direction to the point object
- ☐ opens a slider
- **Rotation [°]:** determines the rotation angle of the symbol.
- ☐ opens a slider

6.1.2 Point Symbol "Symbol"

The point symbol **Symbol** is a default Windows symbol. If you select this point symbol type, the following dialog opens:

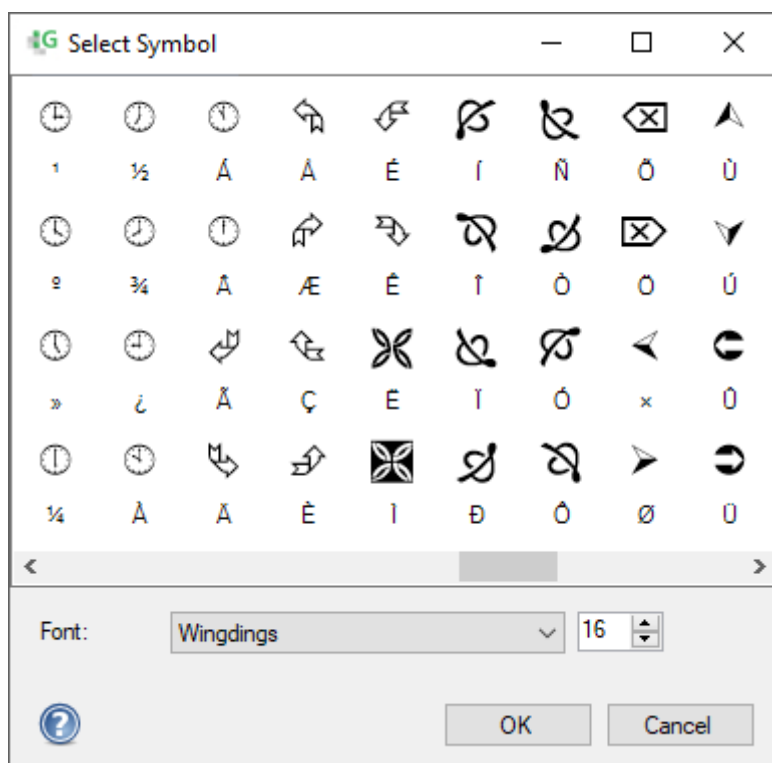









Figure 175: Dialog **Select Symbol**, Example

Which symbols are available, depends on the version of Windows that is being used. Note that (uncommon) symbols may not be displayed correctly on other computers if the corresponding character set is not installed.

Select the desired symbol and confirm with **OK**. You can then adjust the symbol properties:

- **Symbol:** determines the Windows symbol.
 opens the Select Symbol dialog (see above)
- **Font Size [px]:** determines the symbol size.
 opens a slider
- **Color:** determines the symbol color.
 opens the Color Picker dialog (see chapter 6.5)
- **Font Style:** determines the font style for the symbol.
 opens a drop-down list
- **Hot Spot X/Y:** determines how the symbol is positioned relative to the point object. By changing the value, the symbol is moved accordingly in X/Y direction. The value specifies the position of the symbol on the actual point object:
 - At 0|0 the lower left corner of the symbol lies on the point object
 - At 1|1 the upper right corner lies on the point object
 - At 0,5|0,5 the symbol center lies on the point object
 - For values < 0 and > 1, the symbol is shifted by the corresponding amount in the X/Y direction to the point object opens a slider
- **Rotation [°]:** determines the rotation angle of the symbol.
 opens a slider

6.2 Line Symbols

With e.g. a double-click on a point icon in the TOC or via **Line Pen**  in a properties window, you are taken to the Line Pen dialog:

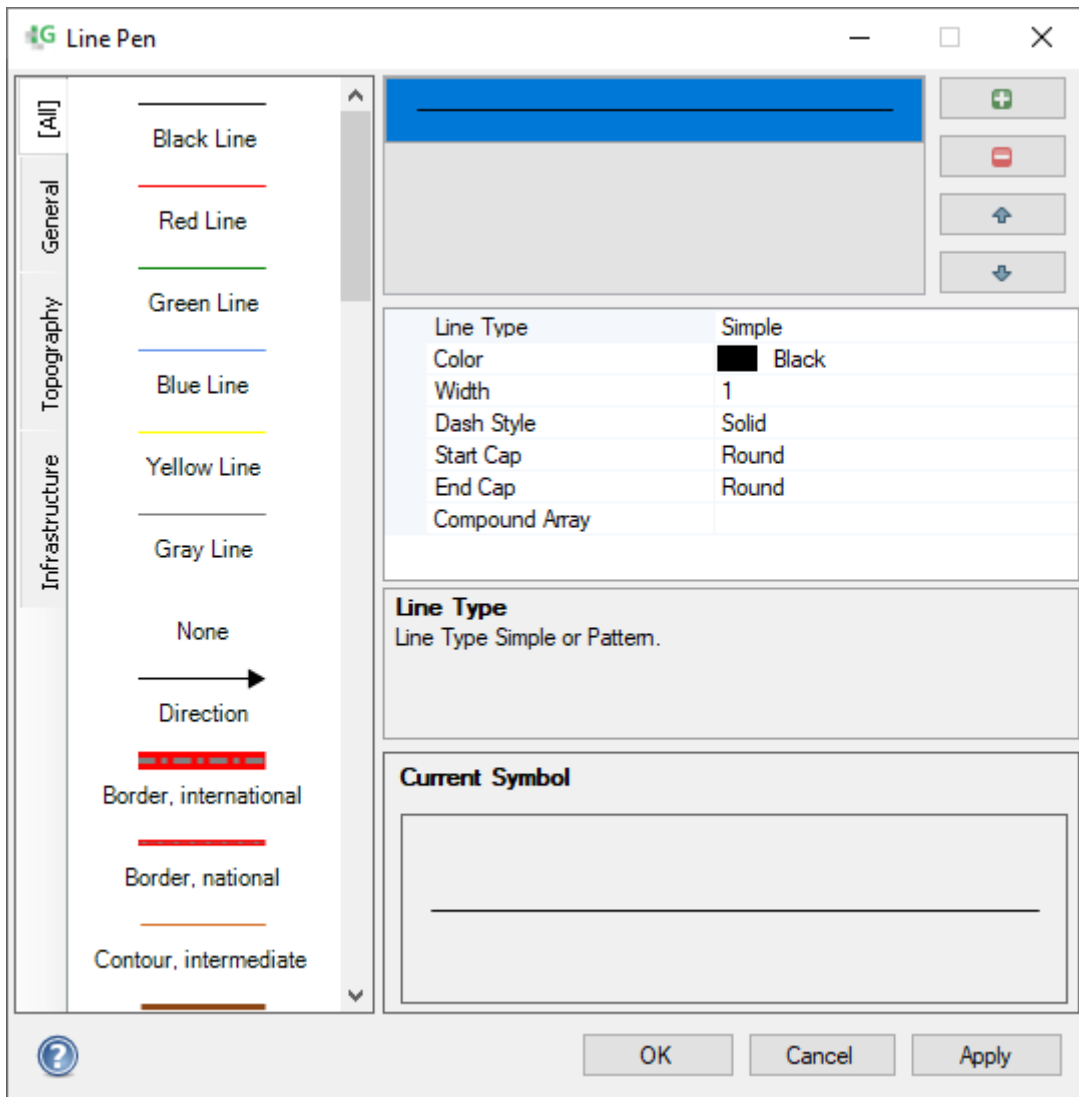


Figure 176: Dialog **Line Pen**

In the following, only line symbol specific functions/properties are explained. For general information on the dialog and its structure, see chapter 6.

Select or Create Line Symbols

You can select, create, and/or edit a line symbol by

- clicking on a symbol in the **List of Predefined Symbols** on the left side. All settings to the right of the dialog are then automatically adopted from this symbol. You can either keep the selected symbol unchanged or edit it beforehand.

- creating a custom symbol on the right side of the dialog.



Clicking the plus button adds new line symbol. By default, a line of the type Simple is created, but you can always change the **Line Type** via the properties below. There, you can choose between:

- **Simple:** a simple continuous or dashed line (see chapter 6.2.1)
- **Pattern:** a line with a complex, user-defined pattern (see chapter 6.2.2)
- **Point Symbol:** lined up point symbols (see chapter 6.2.3)

If you add multiple line symbols of any type, all symbols are listed individually and combined to a composite symbol.



You can always delete individual symbols with the minus button or adjust their order (top/bottom) with the arrow buttons.

For more information about composite symbols see chapter 6.

Under **Current Symbol** you can preview the currently selected or created (composite) symbol.

With **OK** or **Apply** the current line symbol is taken over. **Cancel** closes the dialog without further action.

6.2.1 Line Type "Simple"

With Line Type **Simple** you can create single solid or dashed lines. The display can be adjusted using the following specifications:

- **Color:** determines the color of the line symbol.



opens the Color Picker dialog (see chapter 6.5)

- **Width [px]:** determines the width of the line symbol.



opens a slider


- **Dash Style:** determines whether the line is displayed as a solid line or as a line with a certain (dash-dot) pattern.



opens a drop-down list. Available for selection are:

- **Solid:** shows the line symbol as a solid line
- **Dash:** shows the line symbol as a dashed line
- **Dot:** shows the line symbol as a dotted line
- **DashDot / DashDotDot:** shows the line symbol as a dashed-dotted line

- **Custom:** if selected, you can manually create a custom dash pattern

 opens the Dash Pattern dialog:

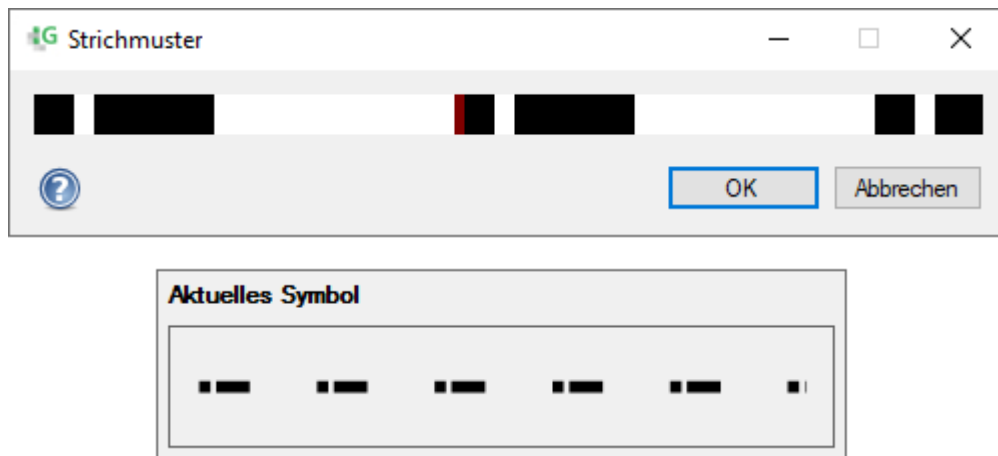


Figure 177: **Dash Pattern** dialog for Dash Style **Custom** (top) and example line (bottom)

You can create a new dash pattern by adding areas to the line with the left mouse button or removing areas from the line with the right mouse button. Black marks drawn areas (dashes), white marks spaces. The red bar marks the start of the dash pattern. Drag the dialog bigger if the red bar is not visible. You can grab the bar with the right mouse button and move it to the right or to the left as you like. Note that you can only edit the pattern on the left of it (before the start point).

Click **OK** to accept the dash pattern. It is then entered as number sequence for **Dash Pattern** and a preview is displayed under **Current Symbol**.

Alternatively, you can enter the pattern directly as number sequence at **Dash Pattern**. The individual numbers must be separated by semicolon and define alternately the length of the dashes and the spaces in between. The first number defines the first dash and must always be > 0 . Then any number of (positive) numbers can be entered.

Possible number sequence using the example above: 1;0,5;3;6



- **Dash Offset** (*not available for Dash Style Solid*): determines the gap between the start of the line and the start of the dash pattern. I.e. the pattern is moved along the line, but remains unchanged otherwise.

 opens a slider

- **Dash Cap** (*not available for Dash Style Solid*): determines how for dashed lines the end caps of the individual dashes are displayed (flat, round, or triangle).

- opens a drop-down list
- **Start Cap:** determines how the beginning of the (entire) line is displayed.

 opens a drop-down list
- **End Cap:** determines how the end of the (entire) line is displayed.

 opens a drop-down list
- **Compound Array:** determines whether a compound array is displayed instead of a single line. A compound array consists of several parallel lines and spaces with different widths.

By default, this field is empty and a single line with the **Width** specified above is displayed. You can, however, manually determine a (cross section) line pattern for the compound array.

opens the Dash Pattern dialog:

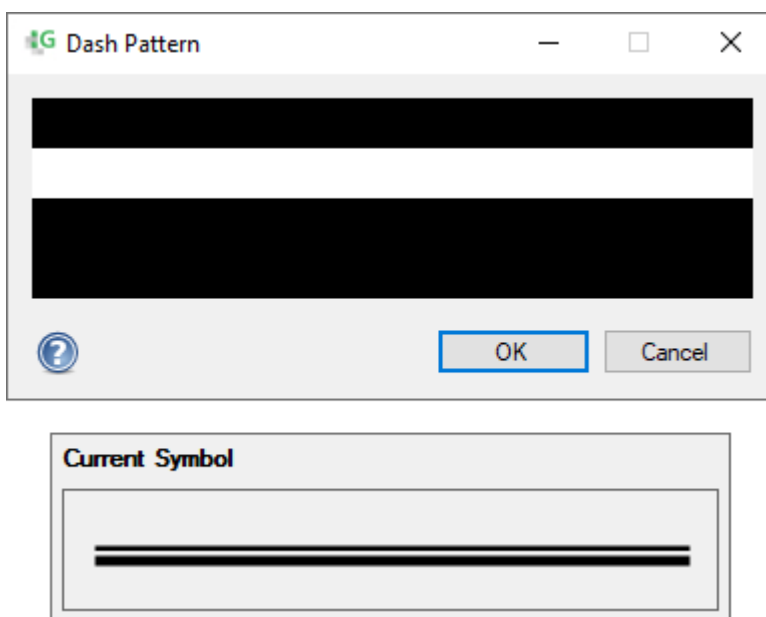


Figure 178: **Compound Array** > Dash Pattern dialog (top) and example line (bottom)

You can create a new compound array pattern by adding areas to the line with the left mouse button or removing areas from the line with the right mouse button. Black marks areas that are drawn (dashes), white marks spaces. The total width of the compound array displayed always corresponds to the **Width** determined for the line symbol.

Click **OK** to accept the compound array pattern. It is then entered as number sequence at **Compound Array** and a preview is displayed under **Current Symbol**.

Alternatively, you can enter the pattern directly as number sequence at **Compound Array**. The individual numbers must then be separated by semicolon and define the

width of the drawn lines and of the spaces in between. Indicated one after the other are: start first line; end first line; start second line; end second line; (...).



Start and end of the lines are given relative to the total width, which is always set to 1. I.e. the numbers must lie between 0 and 1 and rise. Since start and end must be determined for each line, the number of the entered numbers must be even.

Possible number sequence using the example above: 0;0,25;0,5;1




6.2.2 Line Type "Pattern"

With Line Type **Pattern** you can create a line with a manually entered line pattern. The display can be adjusted using the following specifications:

- **Color:** determines the color of the line symbol.
 opens the Color Picker dialog (see chapter 6.5)
- **Width [px]:** determines the width of the line symbol.
 opens a slider

- **Pattern:** here you can create a custom line pattern.

 opens the Line Pattern dialog:

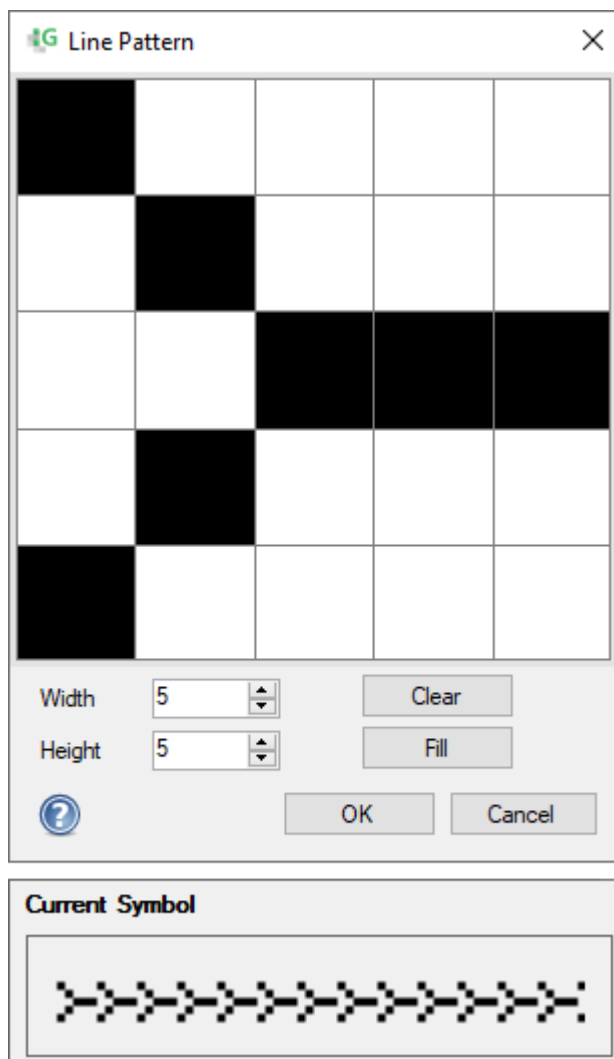


Figure 179: Line Pen dialog > **Line Pattern (top)** and **example line (bottom)**

You can create a new pattern by adding individual squares with the left mouse button or removing them with the right mouse button. Areas marked black are drawn, areas marked white are not. The designed pattern is then constantly repeated along the line.


- **Width:** determines how many squares the pattern is wide.
- **Height:** determines how many squares the pattern is high. The height over all squares corresponds to the **Width** specified for the line symbol.
- **Clear/Fill:** clears/fills all squares, thus sets them to white/black.

Click **OK** to accept the line pattern. It is then displayed as preview under **Current Symbol**.

- **Start Cap:** determines how the beginning of the (entire) line is displayed.

 opens a drop-down list

- **End Cap:** determines how the end of the (entire) line is displayed.

 opens a drop-down list

6.2.3 Line Type "Point Symbol"

With Line Type **Point Symbol** you can create a line formed by a sequence of point symbols.

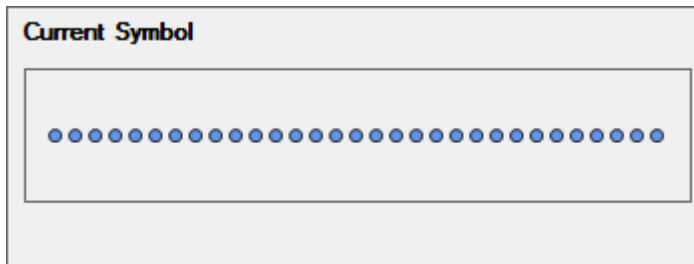



Figure 180: **Line Symbols**, Line Type Point Symbol Example

You can adjust the following specifications:

- **Symbol:** determines the symbol with which the points that form the line are displayed. You can use any point symbol.
 opens the Point Symbol dialog (see chapter 6.1)

- **Anchor at Start/End:** determines whether the point symbol is displayed only at the start and/or end of the line (**On**) or is distributed over the entire line with the selected Point Symbol Distance (see below) (**Off**).
- **Point Symbol Distance [px]:** determines the distance between the individual point symbols. Measurement is taken from the actual point (usually the center of the point symbol).
- **Point Symbol Offset [px]:** determines the distance between the beginning of the line and the first drawn point symbol. The offset never exceeds the point symbol distance, even if a larger value is entered.
- **Symbol Rotation Mode:** determines whether the point symbols are rotated perpendicular to the line and if so, whether the digitizing direction of the line is to be taken into account (Rotated) or not (Rotated Upright).

 opens a drop-down list

- **Clip Line** (only relevant for combined lines, see chapter 6): determines whether all lines above the point symbols are clipped (**On**) or not (**Off**). If **On**, top lines are not drawn through the point symbols, but are interrupted. The point symbols then stand out

more clearly and are easier to recognize. You can define the size of the interruption at the point symbols at **Clip Border** (specified in pixels).

6.3 Fill Symbols

With e.g. a double-click on a polygon icon in the TOC or via **Fill Brush** ... in a properties window, you are taken to the Fill Symbols dialog:

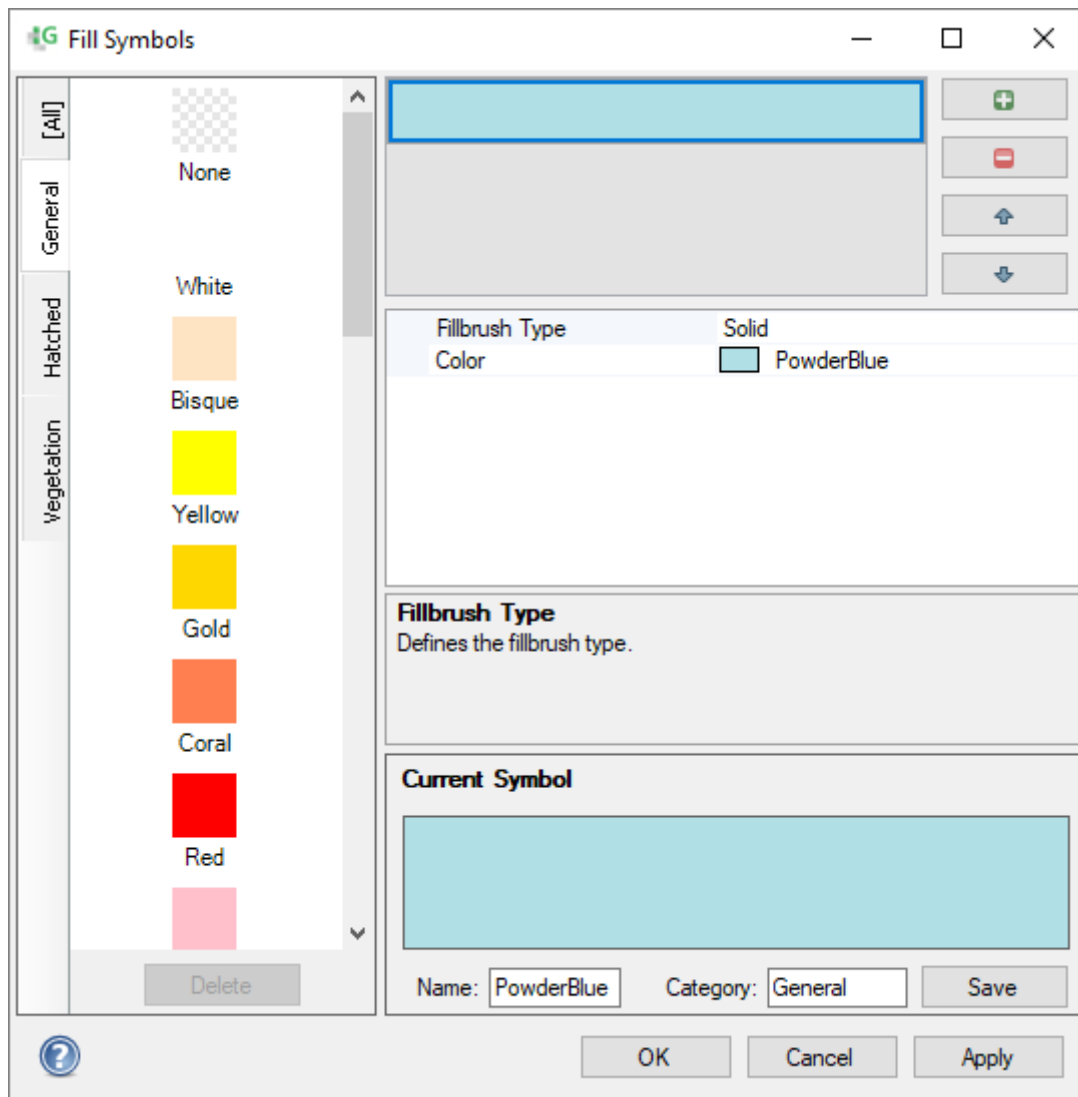


Figure 181: Dialog **Fill Symbols**

In the following, only Fill Symbols specific functions/properties will be explained. For general information on the dialog and its structure, see chapter 6.

Select or Create Fill Symbols

You can select, create and/or edit Fill Symbols by

- clicking on a symbol in the **List of Predefined Symbols** on the left side. All settings to the right of the dialog are then automatically adopted from this symbol. You can either keep the selected symbol unchanged or edit it beforehand.
- creating a custom symbol on the right side of the dialog.



Clicking the plus button adds new fill symbol. By default, a fill symbol of the type Solid is created, but you can always change the fill type via the properties below. There, you can choose between:

- **Solid:** a continuous, single color filling (see chapter 6.3.1)
- **Hatched:** a filling with a simple, predefined dot or line pattern (see chapter 6.3.2)
- **Texture:** a filling with an image texture (see chapter 6.3.3)
- **Symbol:** a uniform and regular filling with any point symbols (see chapter 6.3.4)

If you add multiple fill symbols of any type, all symbols are listed individually and combined to a composite symbol.



You can always delete individual symbols with the minus button or adjust their order (top/bottom) with the arrow buttons.

For more information about composite symbols see chapter 6.

Under **Current Symbol** you can preview the currently selected or created symbol.

With **OK** or **Apply** the current fill symbol is taken over. **Cancel** closes the dialog without further action.

6.3.1 Fillbrush Type "Solid"

If you select the Fillbrush Type **Solid**, the polygon area is filled evenly and with a single color. You can adjust the following properties:





- **Color:** determines the color of the filling.



opens the Color Picker dialog (see chapter 6.5)


6.3.2 Fillbrush Type "Hatched"

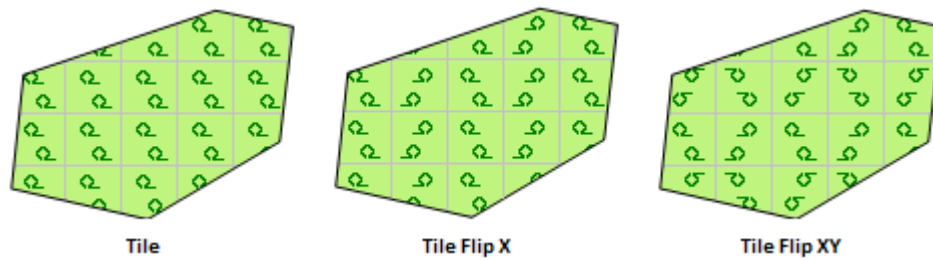
If you select the Fillbrush Type **Hatched**, the polygon area is filled with a predefined line or point pattern, e.g. a hatching. You can adjust the following properties:

- **Hatch Style:** determines the pattern of the filling.
 opens a drop-down list
- **Fore Color:** determines the color of the pattern, i.e. of the lines or points in the front.
 opens the Color Picker dialog (see chapter 6.5)
- **Back Color:** determines the color of the background.
 opens the Color Picker dialog (see chapter 6.5)
- **Rotation:** rotates the filling by the entered value in degrees clockwise (for values > 0) or counterclockwise (for values < 0). At 0 the filling is not rotated.
 opens a slider

6.3.3 Fillbrush Type "Texture"

If you select the Fillbrush Type **Texture**, the polygon area is filled with an image texture (e.g. with a vegetation pattern). Any image in a common image file format (*.bmp, *.jpg, *.png, etc.) can be selected as the texture. You can adjust the following properties:

- **Image DPI:** determines the resolution of the image on the screen / the printed map in DPI.
- **Wrap Mode:** determines the way the polygon area is filled with the image.
 opens a drop-down list
 - If you select **Clamp**, the image is inserted only once and cut off at the polygon edges. This setting usually only makes sense if the selected image is larger than the displayed polygon area.
 - If you select **Tile**, the image is repeated in X/Y direction until the polygon area is completely filled. With **Tile Flip X**, the image is mirrored on the Y-axis with every repetition in the X-direction, with **Tile Flip Y**, it is mirrored on the X-axis with every repetition in the Y-direction; if you select **Tile Flip XY**, both occurs.

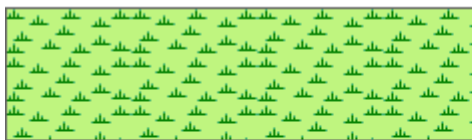






Note: The area is always filled starting from the upper left corner of the polygon extent.

- **Replace Colors:** if **On**, two colors in the texture are replaced by another color each. You can specify yourself which colors are replaced and how:
 - **Replace Color 1:** specifies the color that is replaced by New Color 1
 - **New Color 1:** specifies with which color Replace Color 1 is replaced
 - **Replace Color 2:** specifies the color that is replaced by New Color 2
 - **New Color 2:** specifies with which color Replace Color 2 is replaced

 opens the Color Picker dialog (see chapter 6.5)

original Texture:



Replace Color 1		191; 245; 127
New Color 1		211; 255; 250
Replace Color 2		0; 128; 0
New Color 2		0; 128; 255

Texture with replaced colors:

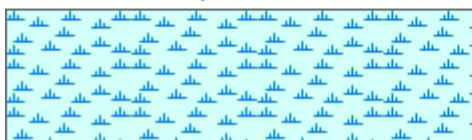



Figure 182: Dialog **Fill Symbols**

If you want to replace colors in the texture, the exact color value of the replace color(s) must be known and specified accordingly in the Color Picker. Always both colors are replaced. If only one color is to be replaced, select a value for the other replace color that does not appear in the texture.

You can also replace a color with fully or semi-transparent colors.

Replacing colors is only recommended for textures without mixed pixels, i.e. only for color-invariant image formats such as *.png or *.bmp

- **Rotation:** rotates the filling by the entered value in degrees clockwise (for values > 0) or counterclockwise (for values < 0). At 0 the filling is not rotated.

 opens a slider

6.3.4 Fillbrush Type "Symbol"

If you select the Fillbrush Type **Symbol**, the polygon area is filled regularly with any point symbol. You can adjust the following properties:

- **Symbol:** specifies the point symbol used to fill the the polygon area. How the area is filled with the symbol can be determined at **Wrap Mode**.



opens the Point Sysmbol dialog (see chapter 6.1)

- **Margin [px]:** determines the distance between the individual point symbols.
- **Back Color:** determines the the background color.



opens the Color Picker dialog (see chapter 6.5)

- **Wrap Mode:** determines the way the polygon area is filled with the point symbols. For more information, see chapter 6.3.3.




opens a drop-down list

- **Rotation:** rotates the filling by the entered value in degrees clockwise (for values > 0) or counterclockwise (for values < 0). At 0 the filling is not rotated.



opens a slider

6.4 Labeling

E.g. with a double-click on a Text Label icon in the TOC or via **Labeling**  in a Properties window, you are taken to the Labeling dialog:

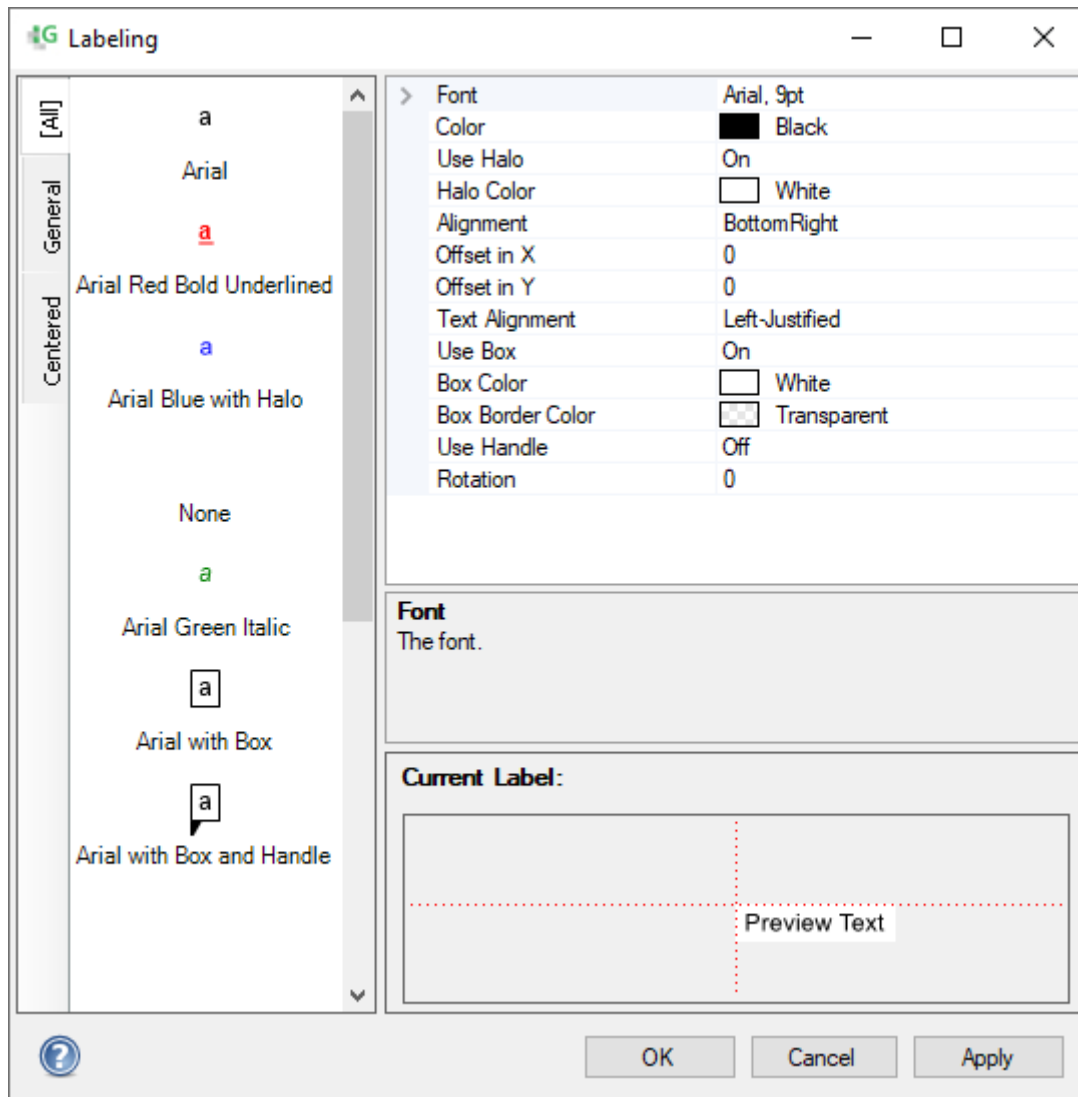


Figure 183: **Labeling** Dialog

In the following, only Labeling specific functions/properties will be explained. For general information on the dialog and its structure, see chapter 6.

Select or Create Label Styles

You can select, create and/or edit a Label by

- clicking on a label in the **List of Predefined Labels** on the left. All settings to the right of the dialog are then automatically adopted from this label. You can either keep the selected style unchanged or edit it beforehand.

- creating a custom label style on the right.

Under **Current Symbol** you can preview the currently selected or created label. The crossing point of the red lines marks the anchor point of the label.

With **OK** or **Apply** the current label style is taken over. **Cancel** closes the dialog without further action.

Labeling Properties

You can adjust the following properties:

- **Font:** determines the font type.
 opens the (windows) Font dialog. There, all fonts installed on the computer are available for selection.
- **Color:** determines the color of the label.
 opens the Color Picker dialog (see chapter 6.5)
- **Use Halo:** determines whether the label is highlighted by a colored silhouette (**On**) or not (**Off**).

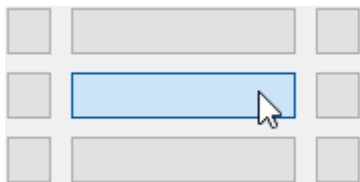
Halo Color: determines the color of the silhouette.

opens the Color Picker dialog (see chapter 6.5)

Halo Width [px]: determines the width of the silhouette. Enter the desired value directly into the field.

- **Alignment:** determines how the label/text box is positioned relative to the anchor point (top right, middle centered, bottom left, etc.).


opens a drop-down. There, you can specify the desired position via buttons:



Note that this property has no relevance for polygons, because the position of the label is defined by the **Label Placement Mode** in the layer properties (see chapter 5.3.2.5).

- **Offset in X/Y:** determines the offset of the label/text box relative to the **anchor point** in X/Y direction. For 0, the label is not offset, i.e., the corner or edge defined under **Alignment** is then placed directly on the anchor point. Positive values offset the label to the right or top, negative values to the left or bottom.

- **Text Alignment:** determines how the text is aligned within the label box for multiline labels. Additionally to **Left-Justified**, **Right-Justified** and **Centered**, **Auto** is available. Here the alignment of the text is selected automatically depending on the **Alignment** of the label: for left/right placed labels the text is aligned right/left, for centered labels the text is also centered.


 opens a drop-down list

- **Use Box:** determines whether the label is given a rectangular colored background (**On**) or not (**Off**).

Box Color: determines the color of the rectangular background.

 opens the Color Picker dialog (see chapter 6.5)

Box Border Color: determines the color used for the border of the rectangular background including the **Handle** (see below).

 opens the Color Picker dialog (see chapter 6.5)

Use Handle (*only for points and lines*): determines whether a handle is displayed from the labeling panel to the (anchor) point (**On**) or not (**Off**)

- **Rotation [°]:** determines the rotation angle of the label (in geographical degrees, i.e. clockwise).

 opens a slider

6.5 Color Picker

The Color Picker dialog appears whenever a color is to be set. You are taken to the dialog e.g. via **Color** ... in a Properties window:

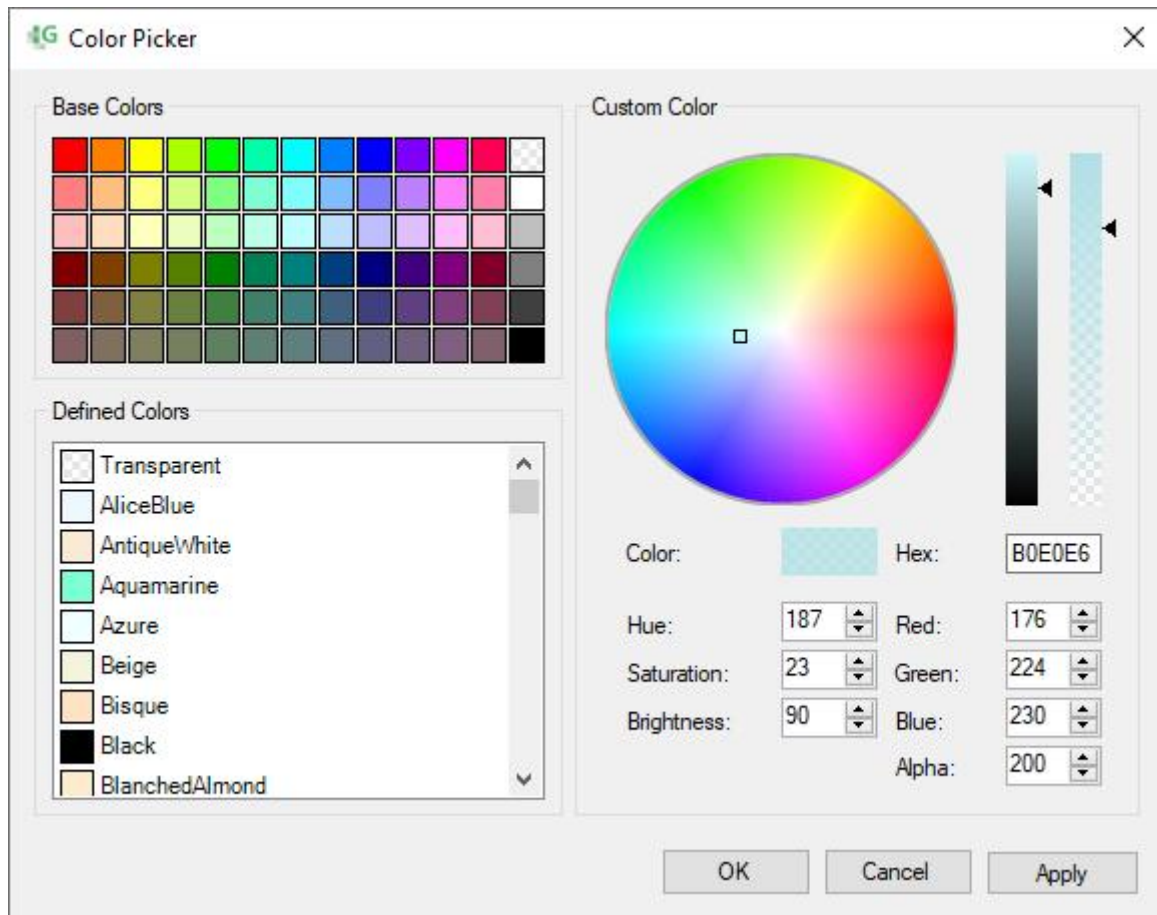


Figure 184: Color Picker Dialog

- **Base Colors** and **Defined Colors**: Here, you can select from various premixed colors. All settings under **Custom Color** are then automatically adopted from the selected color. You can either keep the selected color unchanged or edit it beforehand.
- **Custom Color**: Here, you can mix a custom color by setting the following values manually:
 - **HEX** (hexadecimal color definition according to the scheme RRGGBB),
 - **Hue, Saturation, and Brightness** (HSV color space), or
 - **Red, Green, and Blue** values (RGB color space), and
 - **Alpha**

Brightness (from 0 = maximum light to 100 = maximum dark / black) and **Alpha** (from 0 = opaque to 255 = fully transparent / invisible) can also be set using the sliders on the right edge. The values in the input fields are then adjusted accordingly.

Alternatively, you can select a custom color by clicking directly onto the desired color in the **color wheel** or by clicking in the color wheel, holding the mouse button and moving the mouse pointer to the desired color.

Each selected/mixed color is marked with a small black square in the **color wheel** and previewed at **Color**. This preview is updated on-the-fly.

OK or **Apply** confirms the selection/settings and the color is applied, **Cancel** closes the dialog without further action.

6.6 3D Point Symbols

Only available if the project contains a 3D window

With e.g. a double-click a 3D point icon in the TOC or via **3D Point Symbol** ... in a Properties window, you are taken to the 3D Point Symbol dialog:

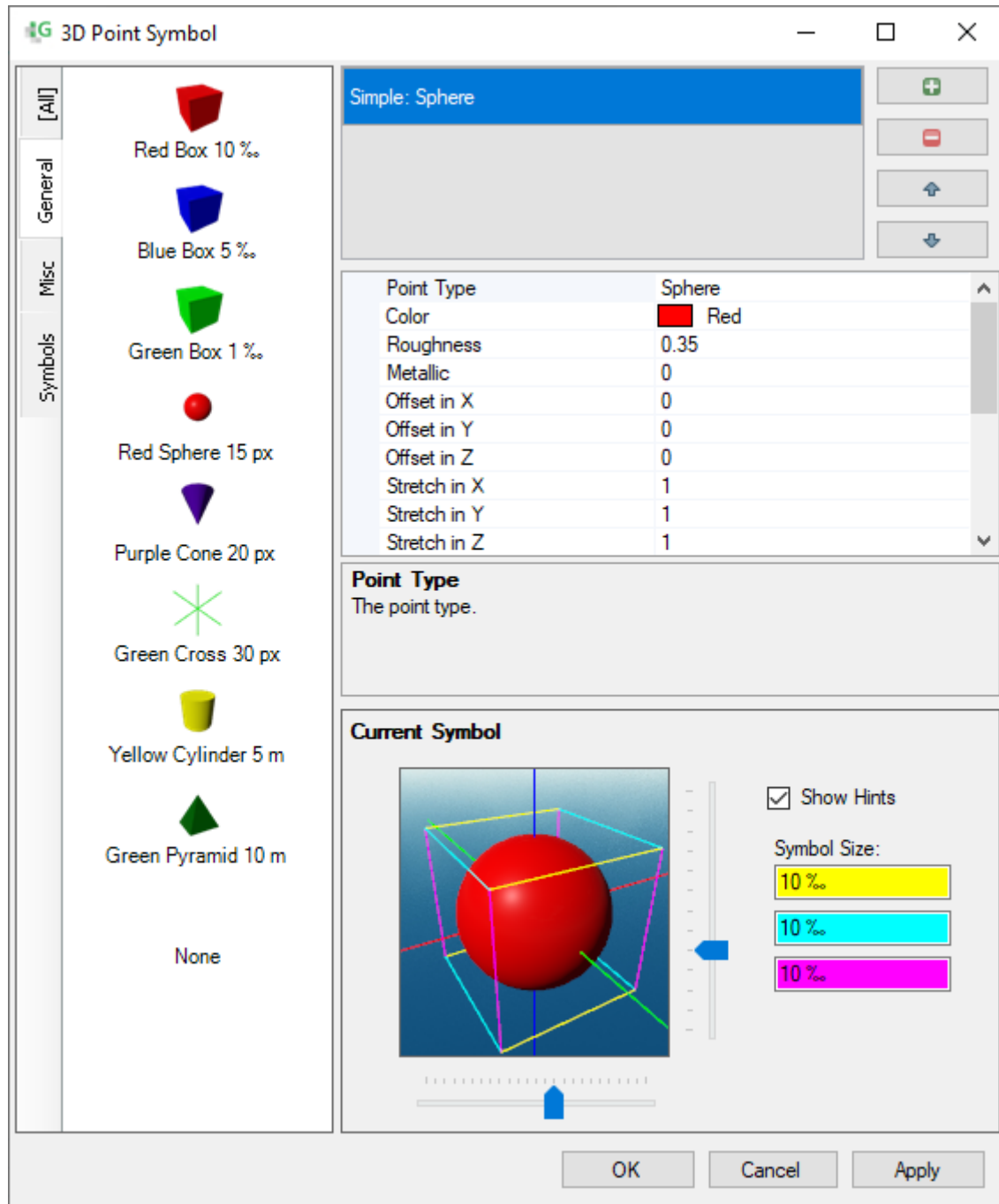


Figure 185: 3D Point Symbol dialog

In the following, only 3D point symbol specific functions/properties are explained. For general information on the dialog and its structure, see chapter 6.

Select or Create 3D Point Symbols

You can select, create, and/or edit a point symbol by

- clicking on a symbol in the **List of Predefined Symbols** on the left. All settings to the right of the dialog are then automatically adopted by this symbol. You can either keep the selected symbol unchanged or edit it beforehand.

-  creating a custom symbol with the **Plus Button** (see above).

If you add multiple point symbols of any kind, all symbols are listed individually and combined to a composite symbol (see chapter 6).

Under **Current Symbol** a preview of the currently selected or created (composite) symbol is displayed.

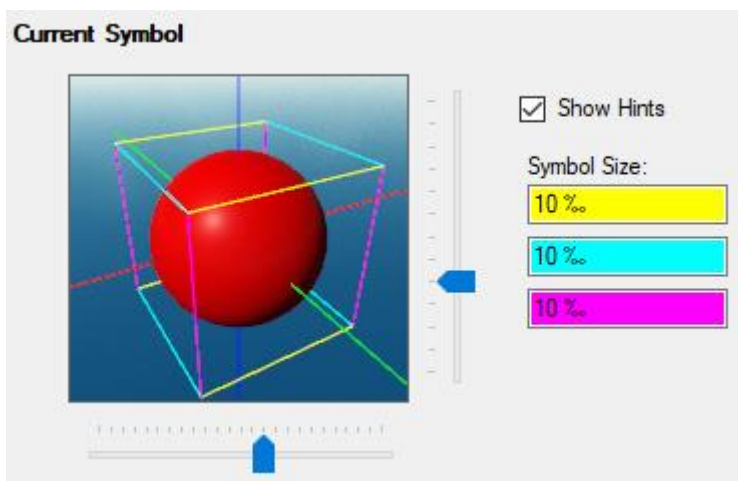


Figure 186: 3D Point Symbol dialog - Current Symbol

- Under **Symbol Size** length, width, and height of the "finished" symbol/model are displayed, i.e. the measurements correspond to the size/scale, stretch, and unit set in the **Symbol Properties (3)**. Using the color scheme, you can assign the sizes to the corresponding symbol/model axes in the preview (X = yellow, Y = cyan, Z = magenta). The **Bounding Box** of the symbol/model is drawn, i.e. the box minimally surrounding it (independent of the rotation angle) from which the model axes result.

In addition to the model axes, the coordinate axes of the 3D Viewer (X = red, Y = green, Z = blue) are displayed in the preview. This helps you in the orientation of the symbol/model in the 3D space, especially if you move it in X/Y/Z direction or change its rotation angle. The intersection point of the coordinate axes marks the actual 3D point object.








If you uncheck **Show Hints**, the orientation aids are hidden.

With the **sliders** at the edge, you can rotate the symbol/model and view it from all sides. The lower slider changes the azimuth angle of the preview (= rotation on vertical axis), the right slider changes the elevation angle (= rotation on horizontal axis).

With **OK** or **Apply** or double-click on the symbol under **Predefined Symbols (1)** the current/selected symbol is applied to the point object(s). **Cancel** closes the dialog without further action.


6.6.1 3D Point Symbol "Simple"

The 3D point symbol **Simple** is a simple solid. You can customize the following properties:

- **Point Type:** determines the shape of the symbol.
 opens a drop-down list
 - **Color:** determines the symbol color.
 opens the Color Picker dialog (see chapter 6.5)
 - **Roughness:** determines how rough the surface of the symbol is displayed. The higher the value, the duller and rougher the surface looks. The lower the value, the greater the effect of the factor set under **Metallic**.
 opens a slider
 - **Metallic:** determines how metallic the surface of the symbol is displayed. The higher the value, the more metallic the surface shines and the more clearly it "reflects" for example the sky.
 opens a slider
- The smoother the surface, i.e. the lower the set **Roughness**, the stronger the effect.
- **Offset X/Y/Z:** moves the symbol along its X/Y/Z axis (before rotation). The shift is relative to the actual 3D point object.
 opens a slider
 - **Stretch in X/Y/Z:** stretches/compresses the symbol along its X/Y/Z axis (before rotation). The stretching factor is specified for each case. The entered value is taken into account for **Scale [m]** or **Size [%]/[px]** below.
 opens a slider
 - **Heading/Tilt/Roll:** determines the rotation angle of the symbol clockwise around the X/Y/Z axis of the 3D viewer.
 opens a slider

A rotation has no effect on the bounding box of the symbol (see above at **Current Symbol**) and therefore no effect on **Stretch in X/Y/Z** or **Scale [m]** or **Size [‰]/[px]**.

- **Scale/Size Unit:** determines the scale/size unit of the symbol.

 opens a drop-down list. Available for selection are:

- **Meter:** the symbol size is given in meters. This unit is recommended if the absolute size of the object is decisive for its display.


With **Scale [m]** you can then specify the size of the symbol in the X/Y/Z direction with **Stretch** = 1 ("original size"). For example, if **Scale [m]** = 10 and **Stretch in X/Y/Z** = 1, the symbol is 10 m long/wide/high. For **Stretch in X/Y/Z** = 2.5, its length/width/height is 25 m, etc.

 opens a slider

- **Scene:** the symbol size is given in relation to the size of the entire scene (in ‰). This unit is recommended if a visually appealing result is to be achieved quickly for very large or very small scenes.

With **Size [‰]** you can then specify how many per mille of the total scene the longest side of the symbol should occupy. The factor entered above for **Stretch in X/Y/Z** is taken into account.


Note that objects with symbol size unit Scene are not considered for the 3D viewshed.

 opens a slider

- **Pixel:** the symbol size is given in (screen) pixels. This unit is recommended if the point symbol should always be displayed in the same size on the screen, regardless of its position in 3D space / distance.


With **Size [px]** you can then specify how many pixels the longest side of the symbol should be. The factor entered above for **Stretch in X/Y/Z** is taken into account.

Note that objects with symbol size unit Pixel are not considered for the 3D viewshed.

 opens a slider

The aspect ratio of the symbol is retained in all settings you make here. The bounding box is always considered (see above at **Current Symbol**).


- **Minimum/Maximum Distance [m]:** determines the minimum/maximum distance to which the symbol is visible to the observer. Symbols that are further / less far away in the 3D space are hidden.

 opens a slider

A value of 0 means that the function is deactivated and the symbols are not shown/hidden depending on the distance.

- **Shading:** determines whether the symbol is displayed with shading (**On**) or not (**Off**). If **On**, areas facing the light appear brighter and areas not facing the light appear darker. This creates a plastic impression.


The virtual light source is specified for the entire scene in the map properties under **Lighting** (see chapter 5.1.7).

 opens a drop-down list


6.6.2 3D Point Symbol "Model"

The 3D point symbol **Model** is a 3D model. They cannot be newly created, but can be selected from the list of predefined symbols. You can then customize the following properties:

- **Offset X/Y/Z:** moves the model along its X/Y/Z axis (before rotation). The shift is relative to the actual 3D point object.

 opens a slider

- **Stretch in X/Y/Z:** stretches/compresses the model along its X/Y/Z axis (before rotation). The stretching factor is specified for each case. The entered value is taken into account for **Scale [m]** or **Size [%]/[px]** below.

 opens a slider

- **Heading/Tilt/Roll:** determines the rotation angle of the model clockwise around the X/Y/Z axis of the 3D Viewer.

 opens a slider

A rotation has no effect on the bounding box of the model (see above at **Current Symbol**) and therefore no effect on **Stretch in X/Y/Z** or **Scale [m]** or **Size [%]/[px]**.

- **Scale/Size Unit:** determines the scale/size unit of the model.

 opens a drop-down list. Available for selection are:

- **Meter:** the model size is given in meters. This unit is recommended if the absolute size of the object is decisive for its display.


For **Scale [m]** you can then specify a factor with which the model is scaled. This factor is applied to the (supplied) original size of the model. Note that the stretch factor entered for **Stretch in X/Y/Z** is also applied.

 opens a slider

- **Scene:** the model size is given in relation to the size of the entire 3D scene (in ‰). This unit is recommended if a visually appealing result is to be achieved quickly for very large or very small scenes.

With **Size [‰]** you can then specify how many per mille of the total scene the longest side of the model should occupy. The factor entered above for **Stretch in X/Y/Z** is taken into account.


Note that objects with symbol size unit Scene are not considered for the 3D viewshed.

 opens a slider

- **Pixel:** the model size is given in (screen) pixels. This unit is recommended if the model should always be displayed in the same size on the screen, regardless of its position in 3D space / distance.

With **Size [px]** you can then specify how many pixels the longest side of the model should be. The factor entered above for **Stretch in X/Y/Z** is taken into account.

Note that objects with symbol size unit Pixel are not considered for the 3D viewshed.

 opens a slider

The aspect ratio of the model is retained in all settings you make here. The bounding box is always considered (see above at **Current Symbol**).

- **Minimum/Maximum Distance [m]:** determines the minimum/maximum distance to which the model is visible to the observer. Models that are further/less far away in the 3D space are hidden.

 opens a slider


A value of 0 means that the function is deactivated and the 3D models are not shown/hidden depending on the distance.

- **Shading:** determines whether the 3D model is displayed with shading (**On**) or not (**Off**). If **On**, areas facing the light appear brighter and areas not facing the light appear darker. This creates a plastic impression .

The virtual light source is specified for the entire scene in the map properties under **Lighting** (see chapter 5.1.7).

 opens a drop-down list

6.7 3D Labeling

Via e.g. **3D Labeling**  in the properties of a 3D Text Label or a 3D Point you are taken to the 3D Labeling dialog:

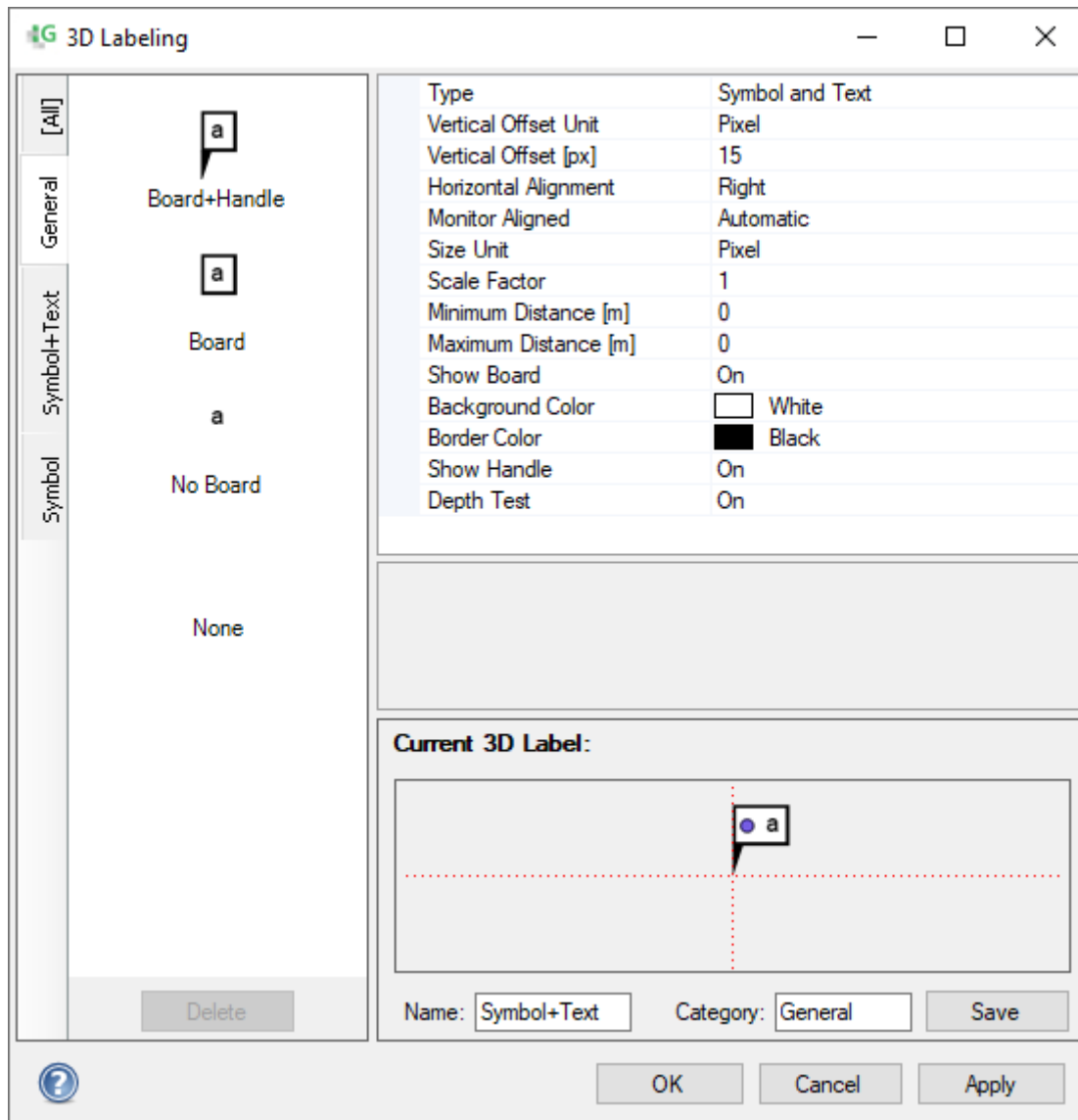


Figure 187: **3D Labeling** dialog

In the following, only 3D Labeling specific functions/properties are explained. For general information on the dialog and its structure, see chapter 6.

Note that any settings you make in the **3D Labeling** dialog affects the appearance of the 3D labels / labeling board. The style of the lettering on the board is determined by the graphics property **Labeling** under the category **Symbology** (see chapter 5.2.1.10 or 6.4).

Select or Create 3D Label Styles

You can select, create, and/or edit a label style for the display of the 3D label / board by

- clicking on a 3D label style in the **List of Predefined Labels** on the left. All settings to the right of the dialog are then automatically adopted from this 3D label. You can either keep the selected 3D label unchanged or edit it beforehand.
- creating a custom 3D label style on the right.


Under **Current Symbol** you can preview the currently selected or created 3D label. The crossing point of the red lines marks the anchor point of the label. The preview also takes into account the labeling style for the lettering on the board specified under **Labeling**.

With **OK** or **Apply** the current 3D label style is applied, with **Cancel** the dialog is closed without further action.


3D Labeling Properties

You can adjust the following properties:

- **Type:** determines the type of the 3D Labeling.
 opens a drop-down list:
 - **None:** no label is displayed.
 - **Icon:** only the 2D point symbol is displayed on the label board. For 3D points this corresponds to the point symbol that is used for the representation of the points in the (2D) map viewer.
 - **Text:** only the label text is displayed on the labeling board.
 - **Icon and Text:** label text and 2D point symbol are displayed on the labeling board.
- **Vertical Offset Unit:** determines the unit in which the vertical offset is specified.
 opens a drop-down list
- **Vertical Offset [m]/[%]/[px]:** determines the vertical position height of the label above the anchor point. Depending on the unit selected above, the offset is given in **meters [m]**, a **per mille share [%]** of the entire scene, or in (screen) **pixels [px]**.
 For negative values, the label is displayed below the anchor point (useful e.g. for air-borne points or geological applications).
 opens a slider
- **Horizontal Alignment:** determines whether the label is displayed to the left/to the right of the object or centered on it.


 opens a drop-down list

- **Monitor Aligned:** determines whether the label is aligned according to the monitor level.

 opens a drop-down list. Available for selection are:

- **Automatic:** The alignment of the labels is automatically adjusted for optimal display in the 3D Viewer or Virtual Reality mode.
- **On:** the label is aligned according to the monitor level. This mode is recommended for the display in the 3D Viewer.
- **Off:** the label is not aligned according to monitor level. This mode is recommended for an optimal display in Virtual Reality mode.

- **Size Unit:** determines the unit in which the size of the label is scaled.

 opens a drop-down list

- **Scale Factor:** determines the factor with which the label is scaled, and thus influences the size of the label. Depending on the **Size Unit** selected, the following applies:

- For **Meter [m]**, the factor is given in meters per pixel. For example, at 10m/px a 15 pixel label will be 150m high.

 opens a slider

- For **Scene [‰]**, the factor is given in per mille of the total scene per pixel. For example, for 1‰/px, a 15 pixel label 15‰ of the entire scene is high.

 opens a slider

- For **Pixel [px]**, the factor is applied directly to the label size/pixel.


 opens a slider

- **Restrict Minimum/Maximum Size** (*only for Size Unit =[m]/[‰]*): determines whether the label is limited to a certain minimum/maximum font size or hidden above a certain minimum/maximum font size.

 opens a drop-down list. Available for selection are:

- **Off:** The label is neither limited to a certain font size nor hidden above a certain font size.
- **Restrict:** the label never falls below/exceeds a certain minimum/maximum font size, regardless of how far away it is.
- **Hide:** the label is hidden above a certain minimum/maximum font size.



With **Minimum/Maximum Size Factor**: you can specify which font size should not be undercut/overcut. For example, if you enter 3 here, the label will never fall below or exceed three times the set font size.

 opens a slider

- **Minimum/Maximum Distance [m]**: determines the minimum/maximum distance to which the 3D labels are visible to the observer. Labels that are further/less far away in the 3D space are hidden.

 opens a slider

A value of 0 means that the function is deactivated and the 3D labels are not shown/hidden depending on the distance.

- **Show Board**: if **On**, the label is displayed on a board. For the board the following additional settings are then available:
 - **Background Color**: determines the background color of the board.
 opens the Color Picker dialog (see chapter 6.5)
 - **Border Color**: determines the border color of the board.
 opens the Color Picker dialog (see chapter 6.5)
 - **Show Handle**: determines whether the board is displayed with a handle towards the anchor point (**On**) or without a handle (**Off**).
- **Depth Test**: if **On**, 3D text labels that are covered by terrain or 3D objects are hidden. If **Off**, covered 3D text labels are drawn in front of the terrain or 3D object.

7 3D Viewer Controls

There are several ways to navigate within the 3D Viewer:

- by mouse
- by 3D mouse
- by keyboard
- by X-Input controller
- by gestures (only for touchscreens)
- by VR touch controllers (only with VR headset), see chapter 8.2

If you use a 3D mouse, please refer to its manufacturer's manual.

7.1 Mouse Controls: Zoom/Move Mode



If the **Toggle First Person Mode** button in the 3D Viewer toolbar is deactivated (see chapter 4.6.20), you are in **Zoom/Move Mode**. You can then perform the following actions with the mouse in the 3D viewer:

- **Move 3D view:** right mouse button

Grab a 3D dataset by pressing and holding the right mouse button and move it in the desired direction.

If the viewing angle is steep ($> 20^\circ$), the 3D view is then shifted horizontally in the corresponding direction to the right/left or back/front

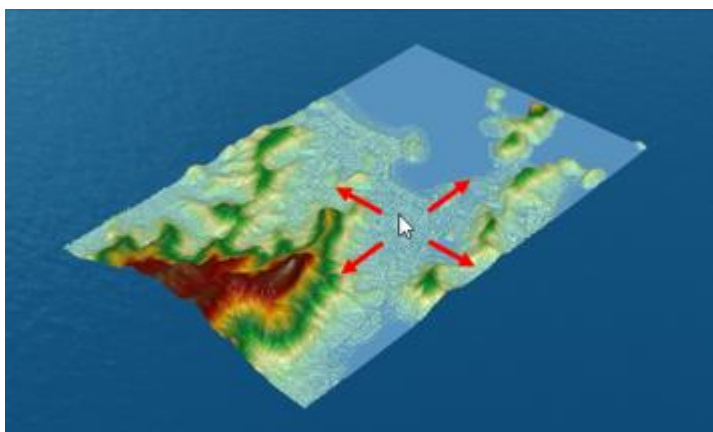


Figure 188: Moving the 3D view at steep viewing angle with the right mouse button

If the viewing angle is flat ($\leq 20^\circ$), the 3D view is shifted to the right/left when moving sideways, and to the top/bottom when moving up/down.

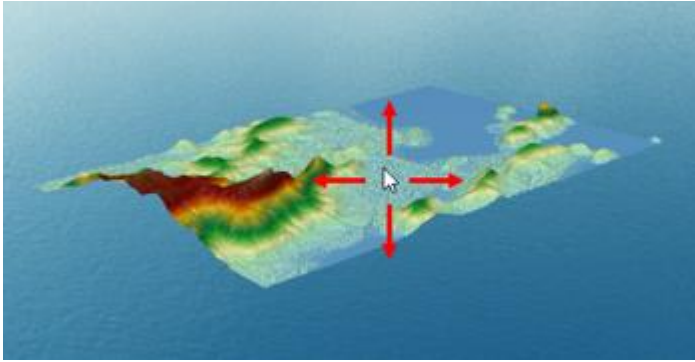


Figure 189: Moving the 3D view at flat viewing angle with the right mouse button

Note that the 3D view is only moved if you grab a 3D dataset and not if you click off a dataset in the "empty space"

- **Rotate 3D view:** pressed mouse wheel and (rotation) movement

First, define the rotation point by clicking on a 3D dataset at any position with the mouse wheel. As long as you hold the mouse wheel, you can freely rotate/tilt the 3D view in all directions around the rotation point by executing the corresponding rotational movement with the mouse.

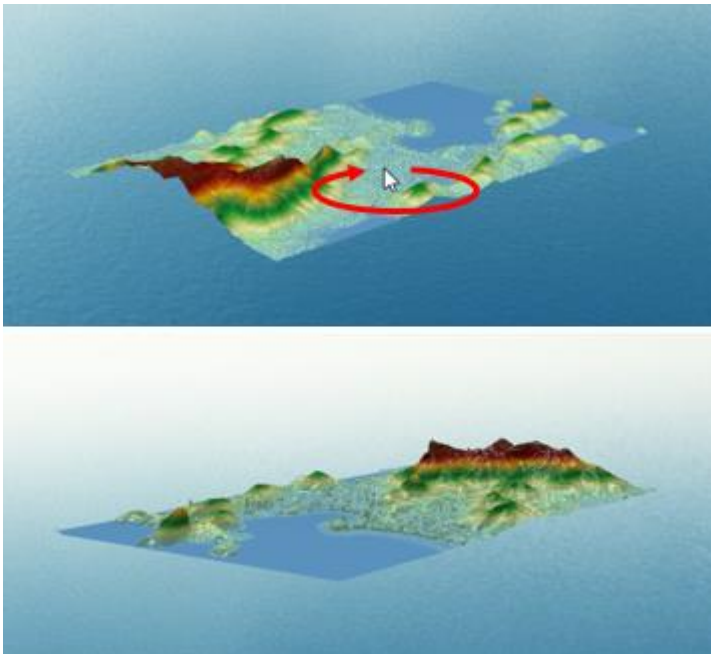


Figure 190: Rotating the 3D view with pressed mouse wheel

Note that the 3D view is only rotated if the rotation point is placed on a 3D dataset and not if you click off a dataset in the "empty space".

You can adjust the turn speed in the input configuration dialog (see chapter 4.6.18) or alternatively with Ctrl + mouse wheel; while you turn the mouse wheel, the current speed is displayed in the status bar:

667713.41m 7466819.36m UTM Zone 23 | Changed Turn Speed to: 42

- **Move to / away from mouse position:** turned mouse wheel

Place the mouse pointer at the position you want to move to and turn the mouse wheel forward/up; you then move towards the targeted position. If you turn the mouse wheel backwards/down, you move away relative to the mouse pointer.

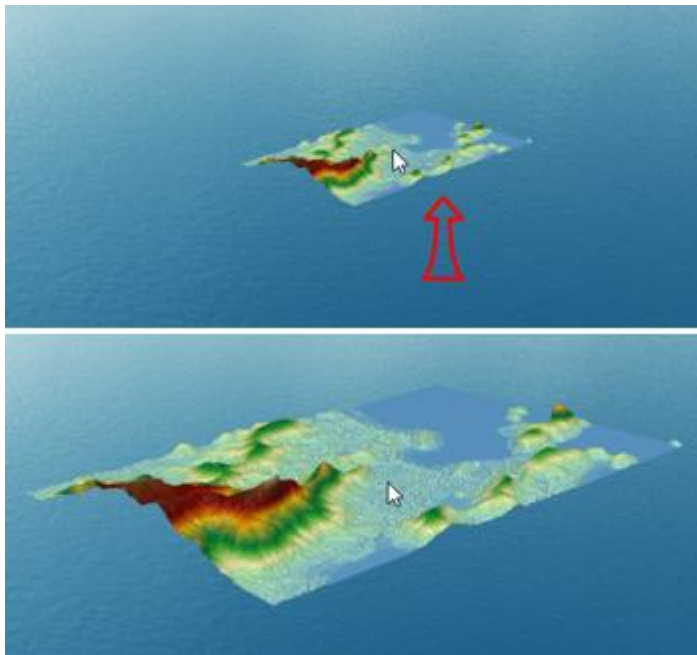


Figure 191: Rotating the 3D view with pressed mouse wheel

The speed at which you move depends on how close you are to the targeted object/terrain: the closer you are, the slower the forward movement. This has the effect that you get progressively closer to the object/terrain, but do not push through it. The move speed, which you can adjust in the in configuration dialog or with Shift + mouse wheel, has no effect here (only on the possibly additional keyboard controls; see chapter 7.3).

The logic of the mouse wheel (forward/backward) can be inverted in the general settings (with **Mouse Wheel Up is Zoom In**; see chapter 3.4.1.8).

- **Change field of view (FOV):** Alt + turned mouse wheel

If you turn the mouse wheel while pressing the Alt key, you zoom the 3D view towards or away from you while keeping the same location. If you turn the mouse wheel forwards/up, you reduce your field of view and thus enlarge the view like with binoculars

or a zoom lens; if you turn it backwards/down, you enlarge your field of view like with a wide angle lens.

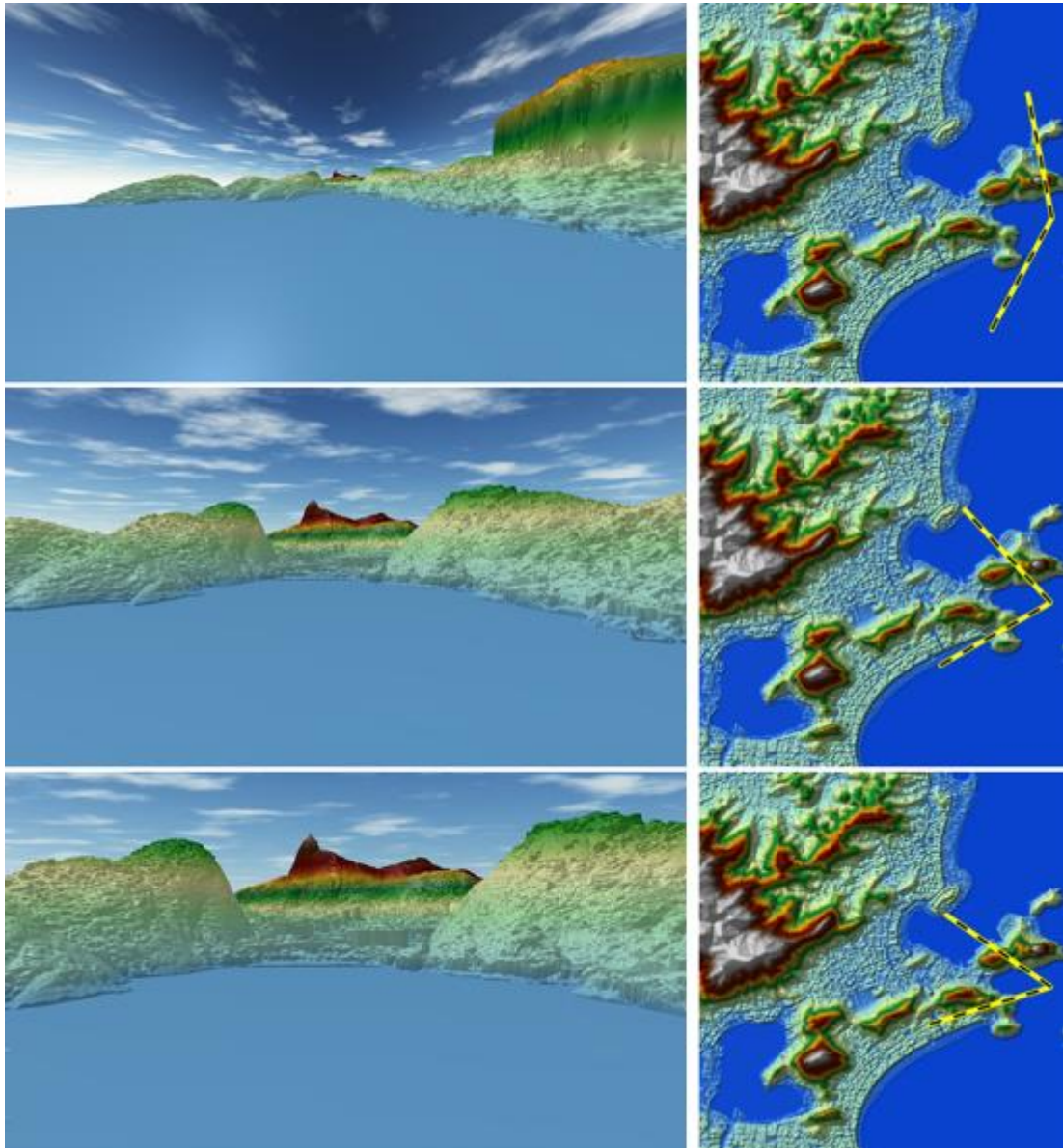
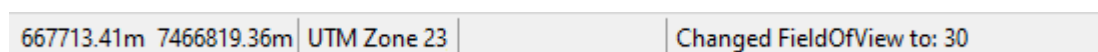



Figure 192: Changing the field of view with Alt + mouse wheel (left: 3D viewer; right: (2D) map viewer)

The logic of the mouse wheel (forward/backward) can be inverted in the general settings (with **Mouse Wheel Up is Zoom In**; see chapter 3.4.1.8). While you adjust the field of view / FOV, the viewing angle is displayed in the status bar:



The mouse controls can always be combined/complemented with keyboard controls. For more information on keyboard controls, see chapter 7.3.

Tips and notes:

- The activation status of the **Toggle First Person Mode** button is saved in your user profile.
-  Via **Show Controls** in the 3D Viewer toolbar you can display a list of all keyboard and mouse commands (for controls) in the 3D view (see chapter 4.6.17).
- With the left mouse button you can perform various other actions - depending on whether or which tool is currently active (e.g. add graphics, select features, query raster pixels, etc.).

7.2 Mouse Controls: First Person Mode



If the **Toggle First Person Mode** button in the 3D Viewer toolbar is deactivated (see chapter 4.6.20), you are in **First Person Mode**. The mouse controls are mainly used to supplement the keyboard controls (see chapter 7.3). The mouse is mainly used for rotation, while the keyboard is used for flying/moving.

In the 3D viewer, you can perform the following actions with the mouse:

- **Rotate 3D view** (around a set rotation point): pressed mouse wheel and (rotation) movement

First, define the rotation point by clicking on a 3D dataset at any position with the mouse wheel. As long as you hold the mouse wheel, you can freely rotate/tilt the 3D view in all directions around the rotation point by executing the corresponding rotational movement with the mouse.

Note that the 3D view is only rotated if the rotation point is placed on a 3D dataset and not if you click off a dataset in the "empty space".

You can adjust the turn speed in the input configuration dialog (see chapter 4.6.18) or alternatively with Ctrl + mouse wheel; while you turn the mouse wheel, the current speed is displayed in the status bar.

The behavior is the same as in zoom/move mode (see chapter 7.1).

- **Rotate 3D view** (around your current position): right mouse button and (rotation) movement

Grab the 3D view by clicking into the 3D viewer at any position with the right mouse button. As long as you hold the button, you can freely rotate/tilt the view around your current location by making the corresponding rotational movement with the mouse.

You can adjust the turn speed in the input configuration dialog (see chapter 4.6.18) or alternatively with Ctrl + mouse wheel; while you turn the mouse wheel, the current speed is displayed in the status bar.

- **Change field of view:** Alt + turned mouse wheel

If you turn the mouse wheel while pressing the Alt key, you zoom the 3D view towards or away from you while keeping the same location. If you turn the mouse wheel forwards/up, you reduce your field of view and thus enlarge the view like with binoculars or a zoom lens; if you turn it backwards/down, you enlarge your field of view like with a wide angle lens.

The logic of the mouse wheel (forward/backward) can be inverted in the general settings (with **Mouse Wheel Up is Zoom In**; see GAFmap® manual, chapter 3.5.1.12).

The behavior is the same as in zoom/move mode (see chapter 7.1).

- **Adjust move speed:** turned mouse wheel


By turning the mouse wheel, you can adjust the speed at which flight movements are executed (via the keyboard) at any time. If you change the movement speed during a flight, it is directly accelerated or slowed down.

While you turn the mouse wheel, the current speed is displayed in the status bar:

667713.41m	7466819.36m	UTM Zone 23	Changed Move Speed to: 23
------------	-------------	-------------	---------------------------

You can also adjust the move speed in the input configuration dialog (see chapter 4.6.18)

Tips and notes:

- The activation status of the **Toggle First Person Mode** button is saved in your user profile.
-  Via **Show Controls** in the 3D Viewer toolbar you can display a list of all keyboard and mouse commands (for controls) in the 3D view (see chapter 4.6.17).
- With the left mouse button you can perform various other actions - depending on whether or which tool is currently active (e.g. add graphics, select features, query raster pixels, etc.).

7.3 Keyboard Controls

When controlling with the keyboard, you can perform the following actions in the 3D viewer:

- **Move horizontally to the right/to the left:** arrow keys right/left or A/D
- **Move horizontally forwards/backwards:** arrow keys up/down
- **Move vertically up/down:** page keys up/down
- **Move forwards/backwards in viewing direction:** W/S
- **Move up/down in its viewing direction:** Space / <>
- **Turn to the right/to the left:** Q/E
- **Turn upwards/downwards:** R/F
- **Zoom to Full Extent:** Home
- **Go to Last Extent:** Back
- **Go to Next Extent:** Insert
- **Horizontal View:** C
- **Align North:** N

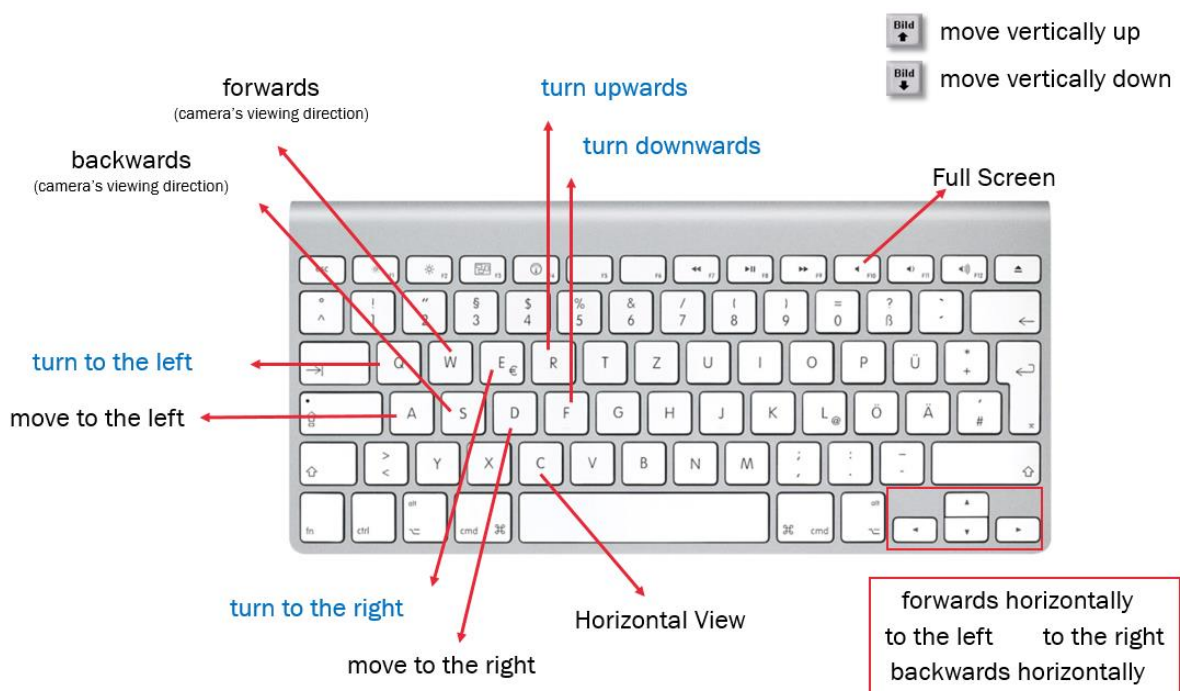



Figure 193: Keyboard Controls in the 3D Viewer

The keyboard controls can always be combined/complemented with the mouse controls. For more information on mouse controls, see chapter 7.1 et seq.

Tips and notes:

-  Via **Show Controls** in the 3D Viewer toolbar you can display a list of all keyboard and mouse commands (for controls) in the 3D view (see chapter 4.6.17).

7.4 X-Input Controller

If an X-Input controller is connected to your PC and ready for operation, you can perform the following actions in the 3D viewer :

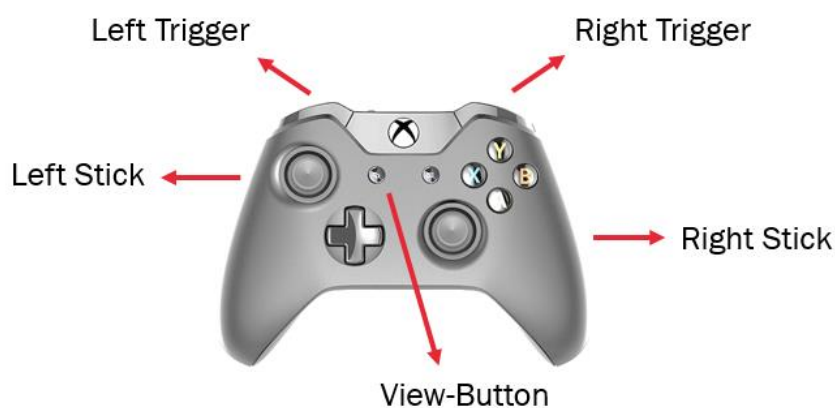


Figure 194: Controls using an X-Input Controller, e.g. the Xbox One Wireless Controller (Source: <https://www3.oculus.com/en-us/rift/>)

- **Move horizontally to the right/to the left:** left stick right/left
- **Move horizontally forwards/backwards:** left stick up/down
- **Move vertically up/down:** right/left trigger
- **Change viewing direction:** right stick
- The viewing direction is turned in the direction in which you press the stick. If you press the stick forward/backward, this results in turning the viewing direction upward/downward
- **Adjust move speed:** A/B
- **Adjust turn speed:** R/F
- **Center world:** View button (*only relevant in VR mode; see chapter 8*)

In the input configuration dialog you can adjust the controller controls (see chapter 4.6.18).

7.5 Gesture Controls: Zoom/Move Mode

When using a touchscreen, you can enable the gesture controls by tapping into the 3D viewer once. In the Zoom/Move Mode the following actions are then possible:

1-Finger Gestures: if you tap with one finger into the 3D viewer area and drag it over the screen, you move the view (pan). Depending on the viewing angle:

- you move it horizontally in the corresponding direction (for a steep viewing angle $> 20^\circ$)
- you move it at the screen level to the left/right and up/down (for a flat viewing angle $\leq 20^\circ$)

2-Finger Gestures:

- **Zoom:** Tap into the 3D viewer with two fingers simultaneously and pull them apart or together. As you pull apart, the camera position approaches the data, as you pull them together, the camera position moves away from the data (both to and from the center point of the gesture).
- **Turn:** Tap with two fingers simultaneously on any layer in the 3D viewer and perform a circular motion. This will rotate the view horizontally around the center point of the gesture.
- **Adjust Viewing Angle:** Tap with two fingers at a time into the 3D viewer and drag them up or down to adjust the vertical angle.

Whether the **Zoom/Move Mode** or the **First Person Mode** is active, can be controlled via the button **Toggle First Person Mode** (see chapter 4.6.20).

7.6 Gesture Controls: First Person Mode

When using a touchscreen, you can enable the gesture controls by tapping into the 3D viewer once. In the First Person Mode the following actions are then possible:

1-Finger Gestures: if you tap with one finger into the 3D viewer area and drag it over the screen, the coordinate system rotates according to your finger movements.

- A horizontal finger movement rotates the coordinate system horizontally. Thus, the geographic direction (azimuth) you are looking at is changing.
- A vertical finger movement rotates the coordinate system vertically. Thus, your line of sight bends up or down. You can also recognize this by the moving horizon line.
- A diagonal finger movement combines both aforementioned effects.

2-Finger Gestures: The three gestures below allow you to modify the view on your data, i.e. the camera position can be adjusted by panning, zooming and rotating without changing the coordinate system's position itself.

- **Pan:** Tap into the 3D viewer with two fingers simultaneously and drag them to any direction. The camera position is moved accordingly.
- **Zoom:** Tap with two fingers simultaneously into the 3D viewer and then drag them apart or pull them together. As you pull apart, the camera position approaches the data, as you pull them together, the camera position moves away from the data (along the current viewing direction).
- **Turn:** Tap with two fingers simultaneously on any layer in the 3D viewer and perform a circular motion. This will rotate the view horizontally around the center point of the gesture.

Whether the **Zoom/Move Mode** or the **First Person Mode** is active, can be controlled via the button **Toggle First Person Mode** (see chapter 4.6.20).

7.7 Controls with Virtual Reality Controllers

For information on Controls with Virtual Reality Controllers, see chapter 8.2.

8 Virtual Reality Mode

GAFmap® supports the Oculus Rift and SteamVR as well as the OpenXR interface (see chapter 4.6.19), so that virtually all VR headsets that can be connected to the PC can also be used with GAFmap®. These include Oculus Rift (S), Meta Quest with Meta Link cable, HTC Vive (Pro) as well as Pimax Crystal (Light/Super) or Pimax Dream Air (SE).

For more information on how to start the VR mode, see chapters 4.6.9 et seqq. or 5.1.7.

8.1 Virtual Reality Requirements

Hardware requirements: For more information concerning hardware requirements for the VR systems, follow the recommendations of the hardware manufacturers.

Required frame rate: For an optimal VR experience, you should first make sure that an image rate of > 90 frames per second is achieved while moving around in the 3D viewer. You can check this using the option **Show frames per second** in the configuration dialog (see chapter 4.6.19).

Guardian system: For safety reasons (risk of injury) and especially when using touch controllers, please make sure that you have sufficient space to move. The manufacturer's tutorial generally addresses this topic when setting up the VR environment, and shows you how to set up a gaming area (guardian system). This area can also be defined later or redefined at any time. As soon as you use the VR headset, the defined area is displayed as a light blue translucent grid in the VR world. This grid is displayed as soon as you, your hand or your VR touch controller get too close to the edge of the defined gaming area's boundary. If you correct your physical position in such a way that you are completely within the gaming area again, the grid automatically turns off.

Simulation sickness: VR applications can lead to the known phenomena dizziness and slight nausea. The main reason for this is the different information that your eyes and inner ears transmit to the brain as soon as you immerse yourself in the VR world. However, whether or not and how strongly a person is affected by sickness is very individual. If you start feeling dizzy, we recommend taking a seated position and avoiding rotating/reverse movements as well as accelerating moves in the VR world.

8.2 Actions with Virtual Reality Controllers

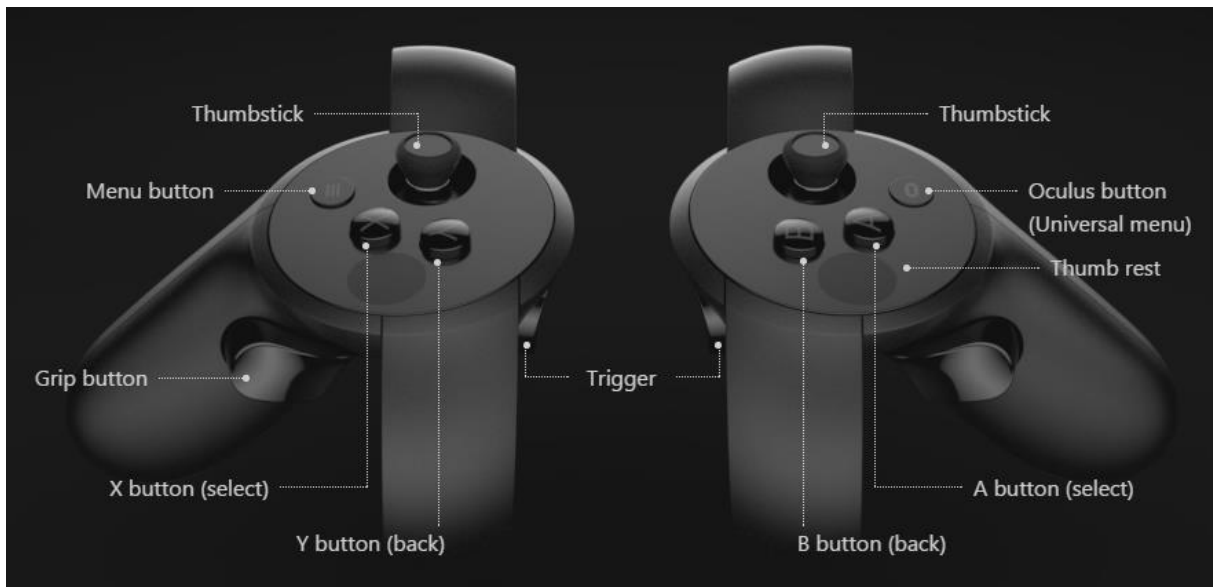


Figure 195: Navigation using VR controllers, e.g. Oculus Touch (source: screenshot from www.oculus.com).

If a VR headset is connected and ready for use, you can perform the following actions in the virtual reality world using the controllers:

- **Centering the world:** simultaneously pressing both menu buttons (with HTC Vive the trigger and the thumb button of the left controller)
- **Holding and moving the world:** pressing a trigger or a grip button and moving the controller

The effect is best visible when you are close to an object.

- **Rotating, moving and scaling the world:** simultaneously pressing both triggers and moving the controller

By pressing the triggers simultaneously, you grab the world at two points. If you now move the controllers in parallel to the right or left, you rotate and move the VR world. By moving the controllers towards / away from each other, you can reduce/enlarge the **Virtual World Scale** (see chapter 5.1.7).

- **Flying:** moving the right thumbstick forward

A red beam indicates your moving direction as soon as you press the stick forward. Now point the controller in the direction you want to move. You can adjust the movement speed by pressing the right trigger (the stronger, the faster).

- **Rotating:** moving the left thumbstick left or right

By default, you rotate stepwise to the left or right (snap-turn). By pressing the left thumbstick, you can activate and deactivate a smooth rotating motion.

- **Enable/disable view beam:** pressing the right thumbstick

With the (white) view beam you can, for example, point to objects to show them to other people. This is particularly useful during a **multi user session** (see chapter 9). The view beam is displayed both in the VR headset and on the screen, so it can also be seen by people standing next to you, for example.

If other functions such as the **overview map** (see chapter 8.3.2) are activated, the color of the beam changes to magenta.

Tip: You can also point in a multi user session without VR. To do this, simply press the P key. Your mouse pointer is then displayed as crosshairs for all to see..

- **Create Sight Line:**

Proceed as follows to create a Sight Line in VR:

- Activate the button **Add Sight Line** in the Graphics toolbar (see chapter 4.7.15) before you put on the headset.
- Put on the VR headset and press the right thumbstick to enable the **view beam**.
- Press the A button (or the upper button of the right controller with HTC Vive) to define the start point of the sight line. Press the button again to set the target point and finish the Sight Line.

For more information on sight lines, see chapter 5.2.18.

- **Teleport to Eye Height:** simultaneously pressing the left grip button and the X button (or the upper button of the left controller with HTC Vive).

The vertical viewing position in VR is then adjusted to correspond to your real viewing position as if you were standing on the ground.

Tips:

- The **Eye Height** can be displayed and adjusted in the general settings under Extras > Settings > Viewing > Viewshed (see chapter 3.4.1.3)
- The **Virtual World Scale** (see chapter 5.1.7) is considered. Set it to **1** (= 1:1) if you want to simulate your view and the size ratio of your surroundings as realistically as possible.

8.3 Actions in the Virtual Reality Menu

In virtual reality (VR) mode a continuous menu with multiple functions is available. Press the X/Y button (or the upper button of the left controller with HTC Vive) to access this menu. If you press the button multiple times, you can "scroll" through different functions of the menu.

8.3.1 Orientation

The **North Arrow** displays your current viewing direction. The **Virtual World Scale** (see chapter 5.1.7) illustrates your size compared to the viewed data.

8.3.2 Overview Map

On the overview map, you can see a yellow-blue arrow that displays your current viewing direction. The map extent displayed in the overview map corresponds to that loaded into the 3D Viewer.

Within the overview map, you can teleport to other locations. This puts you directly in another location without having to move there actively. This may be useful if you are in a large area or have problems with dizziness in the VR Mode.

Proceed as follows to teleport to another location:

- Activate the overview map.
- Point with the **view beam** (see chapter 8.2) in the overview map to the place you want to teleport to.
- Press the A button (or the upper button of the right controller with HTC Vive).

You are then teleported to the clicked position. Your current height above ground is maintained.

If you also want to set the viewing direction for the new location, hold down the A button (or the upper button of the right controller with HTC Vive). Another, smaller arrow showing the viewing direction appears. Adjust the orientation of the direction arrow with the white viewing beam and release the button.

In **Multi User Mode** you can also see the positions and names of the other participants in the overview map (shown as an arrow) if for them **Visible** and **Show Name** is activated in the Multi-User Participant List (see chapter 9.2.3).

8.3.3 3D TOC and 3D Viewer Toolbar

Via the TOC of the 3D window, you can activate and deactivate (i.e. check or uncheck) layers by directing the view beam (see chapter 8.2) to the corresponding checkbox and pressing the A button once (or the upper button of the right controller with HTC Vive).

If you want to select multiple layers, hold down the grip button of the right controller and then select any number of layers by pressing the A button (or the upper button of the right controller with HTC Vive).

By double-clicking on the layer icon, you can perform the following actions:

- **View Point:** teleports you directly to the view point.
- **Flight Line:** starts the flight animation. By clicking on the icon again, you can pause/resume the flight animation, and by double-clicking it again, you can stop it.
- **Other layers:** changes your position so that the entire layer is centered in your field of view.

To the left of the TOC you can find a part of the 3D Viewer toolbar. It contains the following functions:

- **Enable/Disable DEM Shading** (see chapter 4.6.4)
- **Enable/Disable Shadows** (see chapter 4.6.5)
- **Enable/Disable Viewshed** (see chapter 4.6.6)
- **Save Current View Point** (see chapter 4.6.12)
- **Start/Pause Animation, Jump Forward/Backward, and Stop Animation** (see chapter 4.6.13 et seqq.)

You can click/activate the buttons in the same way as the checkboxes in the TOC, i.e. by directing the view beam to the corresponding button and then pressing the A button (or the upper button of the right controller with HTC Vive).

8.3.4 Add 3D Point

If the dialog **Add 3D Point** is displayed, you can create a new 3D Point by directing the view beam (see chapter 8.2) to the desired position in the dataset and pressing the A button (or the upper button of the right controller with HTC Vive). You can then adjust the symbology of the 3D point via the dialog. For more information, see chapter 4.7.11.

Unlike outside VR mode, the 3D Point is not created directly, but only when you click the **Add** button in the dialog. Until then you can still adjust the position of the 3D Point by clicking into the dataset as described above.

Tips and notes:

- You can select predefined 3D symbols and label styles in VR, but you cannot customize them. You can apply predefined symbols directly by double-clicking them.

8.3.5 Multi User Participant List

Only available in Multi User Mode

The **Multi User Participant List** lists all participants in the current session. To make adjustments, use the white beam (see chapter 8.2) and point to the desired function in the **Participant List** and confirm with the A button (or the upper button of the right controller with HTC Vive). Double-clicking on the avatar or name of another participant teleports you to their current position. For more information and settings, see chapter 9.2.3.

9 Multi User Mode

Only available if the project contains a 3D window

The **multi user mode** of the 3D viewer allows individuals in physically separated workplaces or different working locations to connect via a simple multi user communication server and interact in a common 3D environment. The multi user mode supports the following three scenarios:

- All participants use the 3D viewer, without virtual reality (VR) mode.
- All participants use the 3D viewer with VR mode.
- Some participants use the 3D viewer with, others without the VR mode.

It makes no difference whether the participants of a Multi User session use GAFmap® Desktop or GAFmap® Express.

9.1 Multi User Requirements

Joint Project

Ideally all participants of a shared multi user session use the same GAFmap project (*.cmp or *.xmp), and therefore the same coordinate system, data and 3D visualization. However, the same coordinate system is the basic requirement for the multi user session.

Participants not necessarily have to access the same project file (*.cmp or *.xmp). The project file may be located and used on a joint network shared drive. It is also possible that the project file is located as a copy on each individual user's PC.

Shared Multi User Session

For a multi user session, a simple communication server is created and used that exchanges the following information between all participating computers in the background.

- Information on the project, e.g. coordinate system, project name,
- Information on participants, e.g. appearance for an avatar's head and possibly the hands, position, line of sight,
- Information on actions, e.g. user leaves multi user session or a user sends graphics to other users.

This communication server, referred to as a multi user server, is a so-called dedicated server. Therefore, the GAFmap clients do not communicate directly with each other, but always via the multi user server. Communication takes place via UDP ports.

Two operating modes of the Multi User client-server architecture are available.

Mode 1:

A multi user server and a multi user session can easily be created by one of the participants via a button function in the GAFmap® 3D Viewer. After the first participant created the server and session, all other participants can connect to the multi user server and the created session.

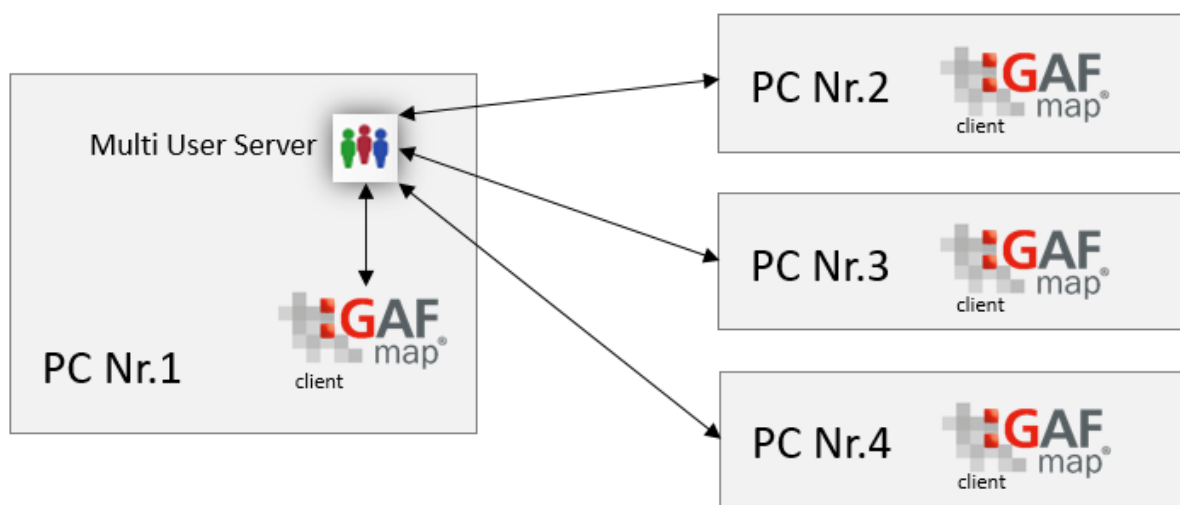


Figure 196: Client-Server architecture with Multi User server on PC.

For more information on creating and connecting to a multi user server, see chapter 9.2.

Mode 2:

A multi user server is created via the GAF.View3D.MultiUser.Server.exe on a Windows server (in Mode 1 the GAF.View3D.MultiUser.Server.exe is automatically launched). All participants can now connect to the multi user server and the created session.

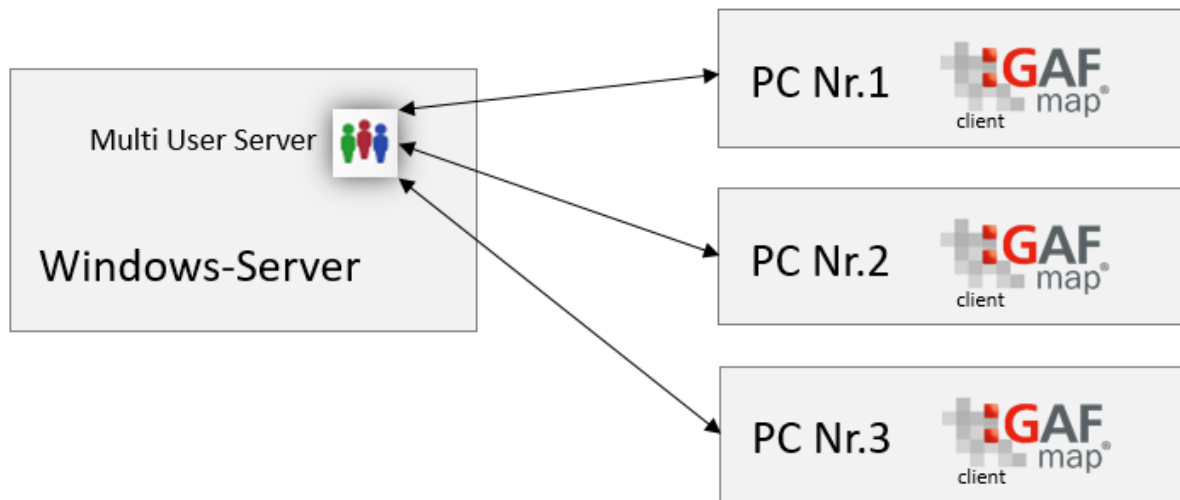


Figure 197: Client-Server architecture with Multi User server on a Windows server.

To create a Multi User server on a Windows server, just copy the folder from [...]GAFmap_*\Extensions\MultiUserServer to the desired location on the server and run it for example via the Windows command line. The command line argument --help (GAF.View3D.MultiUser.Server.exe --help) lists the available commands during launch.

```

C:\Users\    >D:\Users\MultiUserServer\GAF.View3D.MultiUser.Server.exe --help
GAF.View3D.MultiUser 1.0.2.0
Copyright © GAF AG

--sessionname      (Default: View 3D MultiUser Session) The session name.
--port             (Default: 9050) The port.
--disablenatpunch  Whether to disable NAT punch messages.
--disablediscovery Whether the server should ignore discovery requests.
--help             Display this help screen.
--version          Display version information.

```

Figure 198: Commands for GAF.View3D.MultiUser.Server.exe.

For information on connecting to a Multi User server, see chapter 9.2.1.

Note: For the communication server certain UDP Ports (User Datagram Protocol) may have to be enabled for Windows and/or Firewalls. By default, the communication server uses the UDP Ports 9050 and 9051.

9.2 Multi User Actions

In GAFmap Express: 3D Viewer Toolbar



Multi User lets you create a multi user server on your own or connect to a multi user server of other users.

If you are already connected to a multi user server (session), a dialog with a **Participation List** of the current session opens (see chapter 9.2.3).

All relevant information or interactions with the other participants in a session are displayed in the status bar in the 3D viewer or when using VR, as messages in the center of the field of view.

9.2.1 Connect to a Multi User Server

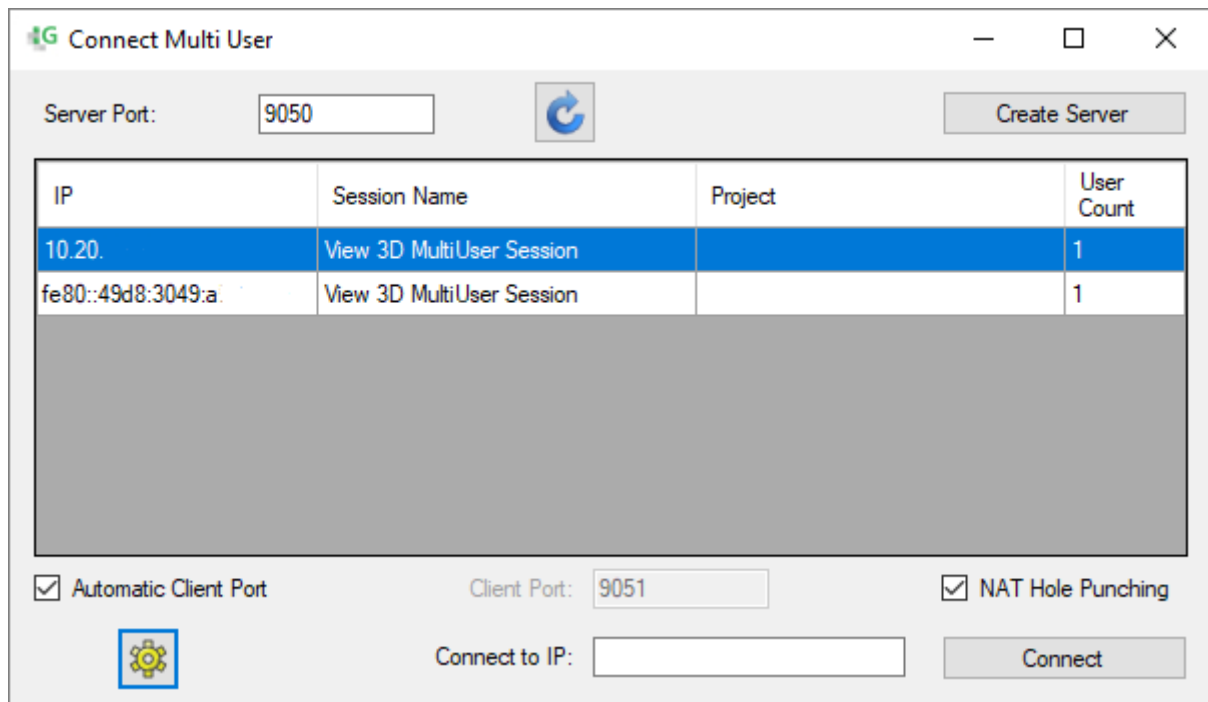
In GAFmap Express: 3D Viewer Toolbar



As long as you are not connected to a multi user server, **Multi User** opens a dialog that lets you create a Multi User server on your own or connect to a multi user server of other users.

If there are already existing multi user servers that you can connect to, they are displayed in the **Dialog List**. If you want to connect to one of these servers, select it in the list and click the button **Connect**.

As soon as you click the button **Connect**, the dialog opens with the **Participant List** of the session. See chapter 9.2.3 for more details.

Figure 199: Dialog **Connect Multi-User**.

Settings in the Multi User Dialog:

- **Server Port:** defines the UDP port used for the multi user mode. Adjust the port if you know that existing multi user servers are communicating via a different port. The server table displays all multi user servers communicating via the set UDP port.



refreshes the server table for the set port

- **Server Table:** lists all visible active server/sessions. Depending on which Internet Protocol Version is utilized; an IPv4 and/or IPv6 entry will appear for the server. If one server, using different protocols, is detected, both entries will lead to the same server.
 - **IP:** shows the IP adress of the Server. Either in IPv4 or IPv6 format.
 - **Session Name:** shows the name of the session.
 - **Project** (*only visible if at least one client is connected to the server*): shows the name of the currently used GAFmap project (*.xmp) in the server as well as the coordinate system used. If no project is loaded, only the coordinate system of the session is displayed.
 - **User Count:** shows the current user count of the session.
- **Automatic Client Port:** if enabled, clients will automatically be assigned to a port. If disabled, a specific port can be assigned manually with **Client Port**.

Note: Manual assigned ports are necessary if a restrictive firewall only allows certain client ports and thus an explicit released port has to be used.

- **NAT Hole Punching:** if enabled, **NAT Hole Punching** is used when connecting to a server. **Hole Punching** is a technique that is used to establish a UDP connection between two computers, even though both are behind restrictive firewalls. For this, however, certain conditions must be met. If disabled, no **NAT Hole Punching** is used.
- **Connect to IP:** specifies the IP address to connect to. By clicking on an existing session in the server table, the server IP address is automatically entered here. In addition, it is also possible to connect with a manually entered address or a domain name.




opens the **Multi User Settings** (see chapter 9.2.4)

- **Connect:** connects you to the currently selected session/project in the server table or the manually entered IP address or domain name.

9.2.2 Create Multi User Server

In GAFmap Express: 3D Viewer Toolbar > Multi-User

As long as you are not connected to a multi user server,  **Multi User** opens a dialog that lets you create a multi user server on your own or connect to a multi user server of another user.

If you want to create a multi user server on your own, click on the button **Create Server**. In the following dialog, you can then specify the settings for your multi user server:

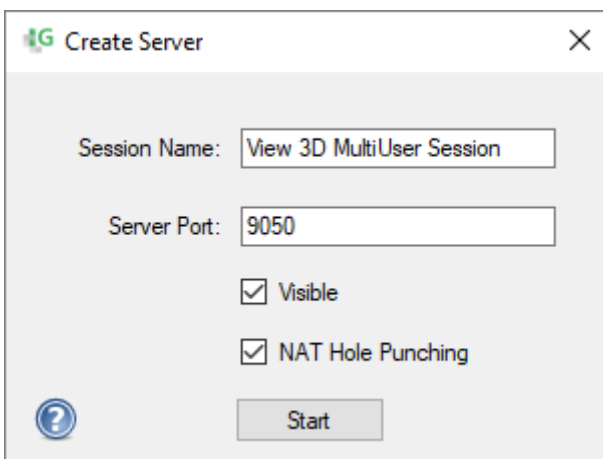


Figure 200: Dialog **Create Server**.

- **Session Name:** specifies the name of the session.
- **Server Port:** specifies the port to be used for the multi user server. To be able to connect to a server all participants have to use the same port.

- **Visible:** if checked, the created server appears in the **Server Table** of the other users. If unchecked, the server does not appear in the list.
- **NAT Hole Punching:** if checked, **NAT Hole Punching** is used for the created server. **Hole Punching** is a technique that is used to establish a UDP connection between two computers, even though both are behind restrictive firewalls. For this, however, certain conditions must be met. If disabled, no **NAT Hole Punching** is used.

Click **Start** to confirm your settings and create the server. The local GAFmap client automatically connects to this server. Therefore, a server window is opened in the background of GAFmap® (see chapter 9.1). The server could also be kept open explicitly when the creator closes GAFmap®. This is a possibility to make your computer available to other users as a server even without a copy of GAFmap® running. The server window remains until you close it manually.

When the Start button is pressed, the server starts and the GAFmap® client opens the session showing the **Participant List** (see chapter 9.2.3).

9.2.3 Multi-User Participant List

In GAFmap Express: 3D Viewer Toolbar > Multi-User

As soon as you connect to a multi user server, the **Participant List** of the current session opens.

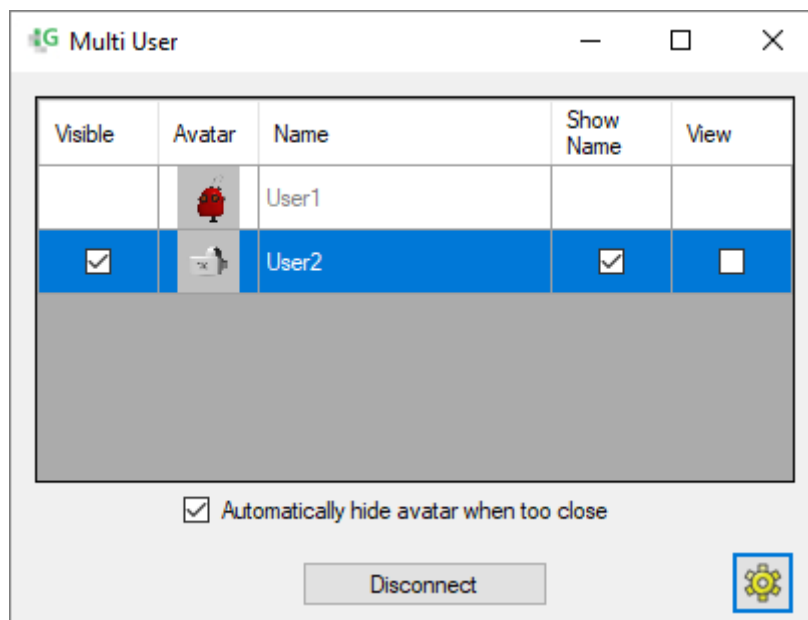



Figure 201: Dialog **Multi User**.

- **Visible:** determines whether the avatar, name, and view beam of the respective participant are visible to you in the 3D viewer / VR (checked) or not (unchecked).
- **Avatar:** shows which avatar the respective participant is currently using. You can alter your own avatar via **Multi User Settings**.
- **Name:** shows which name the respective participant is currently using. You can change your own name via **Multi User Settings**.
- **Show Name:** if checked, the name of the respective participant is displayed above the avatar and in the overview map.
- **Double click on Avatar or Name:** By double-clicking on the avatar or name of another participant, you can teleport to its location. The viewing direction and the **Virtual World Scale** (see chapter 5.1.7) are then adopted from this participant.
- **View:** if checked, the viewing direction of the respective participant is displayed as a visual beam in the 3D viewer / in VR. You can then follow exactly in which direction the other participant is facing. If, e.g. after teleporting, you are at the exact same position as a participant, his or her viewing beam is shown as a point in the 3D viewer.
- **Automatically hide avatar when too close:** if activated, the avatars of the other participants will be hidden as soon as they are too close to your own position. This prevents occlusion of avatar models that can interrupt the immersion in virtual reality mode.
-  opens the **Multi User Settings** (see chapter 9.2.4)
- **Disconnect:** disconnects the connection to the server. You can always reconnect with the server via **Multi User Mode**, unless the server is already shut down. This is also possible if you created the server yourself, as the server is independent of the GAFmap® client.

9.2.4 Multi User Settings

In GAFmap Express: 3D Viewer Toolbar > Multi-User > Multi User Settings

In the **Multi User Settings**, you can customize your username and avatar:

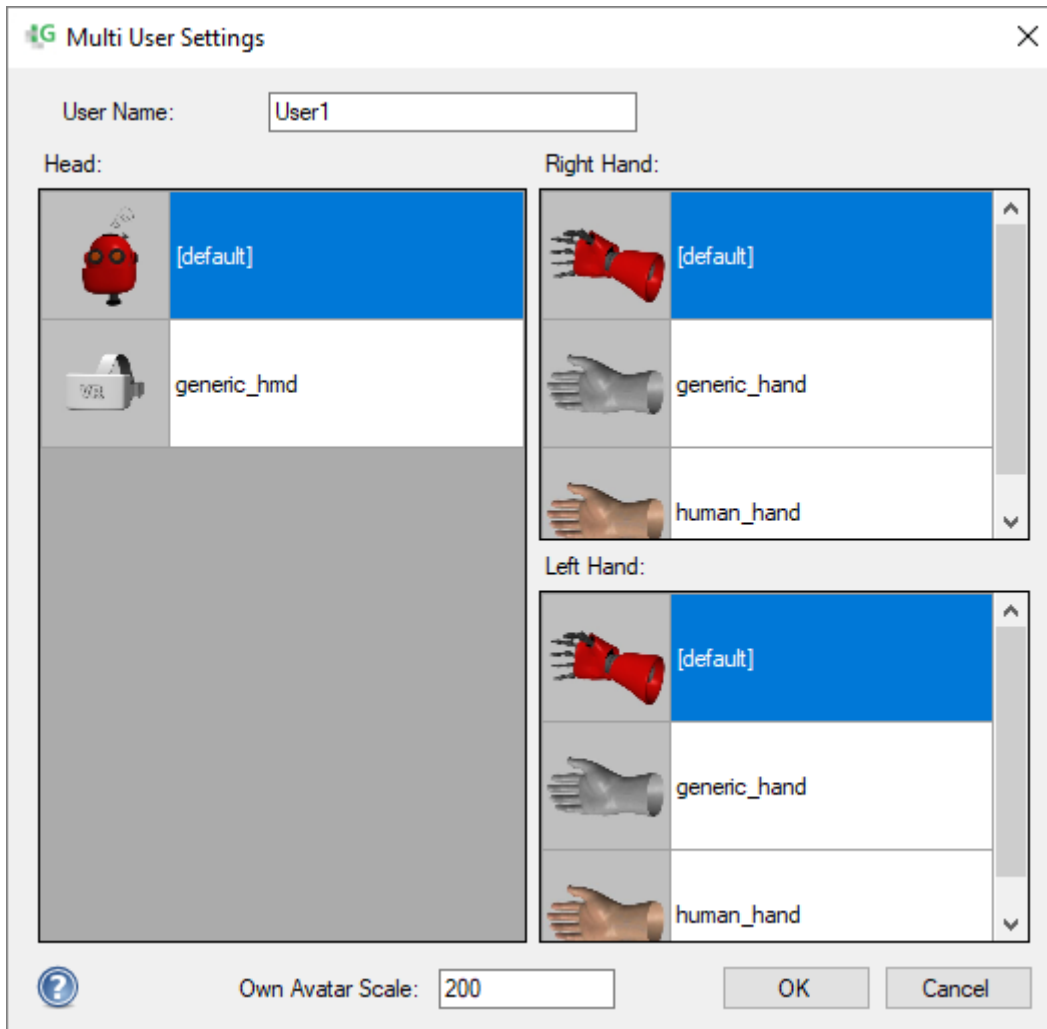


Figure 202: Dialog **Multi User Settings**.

- **User Name:** specifies your username, which is displayed for the other participants.
- **Head:** specifies the head used for your avatar.
- **Right Hand** (*only if VR is enabled*): specifies the right hand used for your avatar.
- **Left Hand** (*only if VR is enabled*): specifies the left hand used for your avatar.
- **Own Avatar Scale** (*only if VR is disabled*): specifies the scale of the avatar in the 3D viewer or the virtual world. A value of 1 (1: 1) corresponds to a natural scale. For a correct display it is useful to adjust the scale according to the data's resolution and size of the scene. Larger values let the data appear smaller in the 3D viewer or the virtual

world. If you use the multi user mode in combination with virtual reality, the **Avatar Scale** depends on the currently used **Virtual World Scale** (see chapter 5.1.7).

Ok confirms the settings. **Cancel** closes the dialog without further action.