# 11 A WYSIWYG Interface for User-Friendly Access to Geospatial Data Collections

Helen Jenny[1], Andreas Neumann[2], Bernhard Jenny[1], Lorenz Hurni[1]

[1]Institute of Cartography, ETH Zurich, Switzerland
[2]Office of Survey, City of Uster, Switzerland

## Abstract

Map collections and dataset providers increasingly offer online access to their geospatial data repositories. Users can visually browse and sometimes select and download datasets to their desktop. The experience of those using such applications may vary greatly from novice to GIS expert. Two types of user interfaces for geospatial data collections are currently prevalent, the wizard-based and the search-based interface. Both types do not serve experts and novice users equally well: the former imposing a rigid chronological order of user actions, the latter requiring the user to handle complex search mechanisms. The inadequacies of these types of interfaces led to the development of a new interface for geospatial data collections, the WYSIWYG interface. The WYSIWYG interface encourages the user to explore available datasets and system capabilities. The sequence of actions for map selection is flexible and can be influenced by the user. Instead of showing reference maps, scale-dependent representations of the downloadable datasets are displayed giving an immediate impression of dataset characteristics. User-friendly layout and function design contribute to making the WYSIWYG interface a suitable front-end for geospatial data collections satisfying the needs of expert users und novices alike.

## 11.1 Introduction: Common Types of Geospatial Data Collection Interfaces

When comparing online access to geospatial libraries, two major types of graphical user interfaces (GUIs) are often encountered: the wizard-based and the search-based interface. This section takes a closer look at the characteristics of theses two types and, for each type, presents interface examples of established geospatial map collections. Observations based on the authors' experience are then made on the suitability of the wizard-based and the search-based interface, which will clarify the need for a new type of GUI for geospatial data collections. The focus lies on web GUIs allowing the user to select from a number of geo-referenced geospatial datasets, including raster and vector data, which can be downloaded directly to the user's desktop.

### 11.1.1 The Wizard-based User Interface

The wizard-based GUI is task-oriented. The user follows a step-by-step process. For selecting and downloading data from a geospatial library, a wizard-based user interface could include the following steps: first select a map product and format, then perform a location search, choose the correct location from a hit list, display the dataset or its outline on a reference map, select tiles or layers for download, choose a file format and access the provided link to the downloadable file.

The decisions the user needs to take can be imagined as a hierarchical tree. Beginning at the root, at each node the user selects from a number of options that let him follow a branch of the tree. At the bottom of the tree, each leaf represents a selection for download. The tree metaphor shows very well the advantages and disadvantages of a geospatial library with a wizard-based GUI. The wizard provides a novice user with the necessary guidance and chronologically leads to an output with correct dataset combinations. Empty search results or cartographically unfortunate dataset combinations are avoided.

A disadvantage of this approach is that the user traverses only one path of the tree. The user ignores the existence of the other branches and therefore is not aware of the systems capabilities and content. For a geospatial map collection with a wizard-based interface, this means that the user may see a text-based list of the available datasets for download but does not

have a real understanding of the geospatial data's characteristics, possible appearance or application. Also the user may not be aware of certain functionalities that are only activated upon the selection of a specific dataset. According to Lauesen and Harning (2001, p. 68), main problem of the wizard-based user interface design "is that the user never gets an overview of
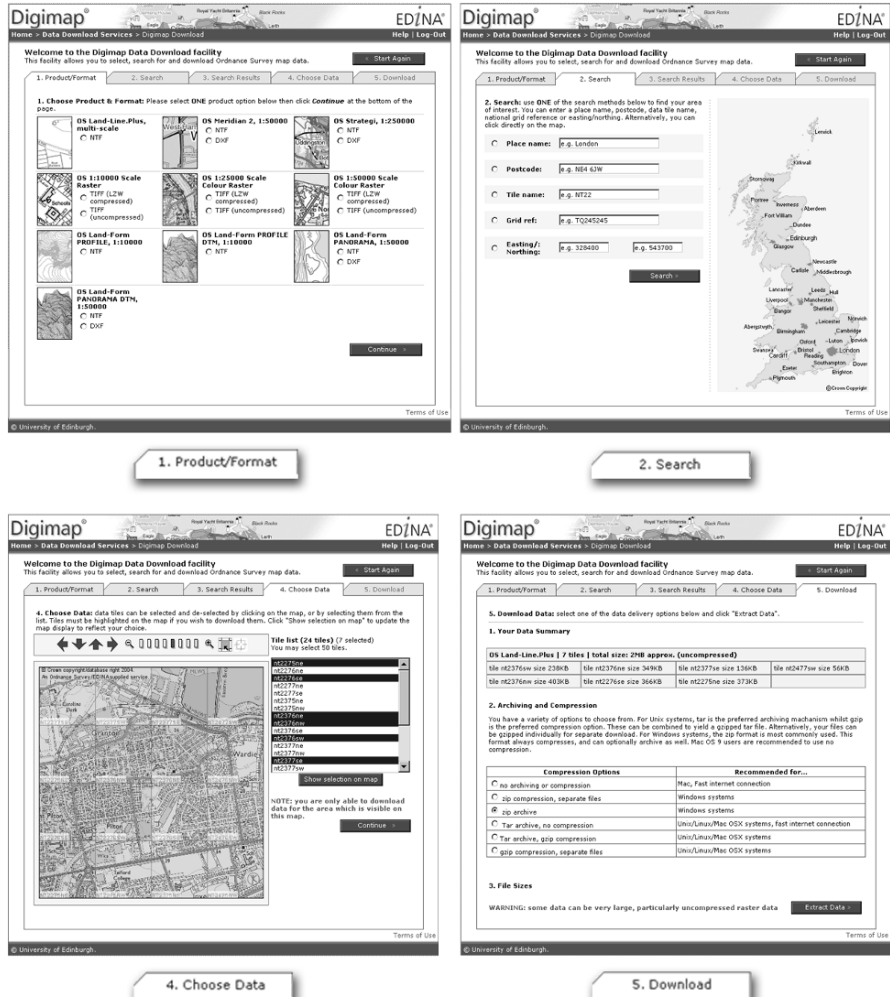


**Fig. 11.1.** Screenshots of Edina Ordnance Survey Collection Data Download Service: dataset selection (top left), location search (top right), tile selection (bottom left) and download parameter selection (bottom right) (EDINA n.d.).

the data available. (…) Furthermore, real-life tasks are usually much more varied and complex than the analyst assumes. Consequently, the system supports only the most straightforward tasks and not the variants." While guiding the novice user, the wizard-like GUI does not promote understanding of the system and can be very limiting to the experienced user.

An established example of a geospatial library with a wizard-based GUI is the British EDINA Digimap Collection (EDINA 2009). Its Ordnance Survey Collection Service provides "the ability to create and customize maps online, down to individual feature selection, specifying scale and area, and generating plots up to A0 in size" (Sutton, Medyckyj-Scott and Urwin 2007, p. 269). Also part of Digimap is the Ordnance Survey Collection Download Service that offers a task-oriented step-by-step GUI to help novice users with downloading datasets to their desktop (Fig. 1). The progress bar at the top of the interface, with the names of the different process steps to be taken in predefined order, is a GUI element that is often present in wizard-based user interfaces.

### 11.1.2  The Search-based User Interface

Another type of geospatial data collection interface is the search-based interface. It usually starts with a location name search or a thematic keyword search. Visual selection of a geographic area of interest on a reference map is also often available. The search results are typically presented to the user as a text-based hit list. The user then selects one or more datasets from the hit list to be displayed in the map window. This display is possible in the form of a dataset extent frame on a reference map, the dataset itself (e.g. a satellite image) or a symbolization of point, line or polygon data. This interface type usually offers a multitude of text-based search options. The chronology of predefined steps is not as rigid as in the wizard-based GUI. A combination of different datasets can be displayed in the map window allowing expert users to more exactly check and compare data availability for a location. One reason to choose a search-based geospatial data collection interface lies in the nature of the available datasets. Locally very dispersed datasets are difficult to adequately display on a single map. A search mechanism helps to narrow down the number of eligible datasets and the search results can in turn be individually displayed.

While this type of interface offers more flexibility to the expert user, it can be confusing to the novice user. As for the wizard-based interface, it takes several steps before the user sees downloadable data in the display
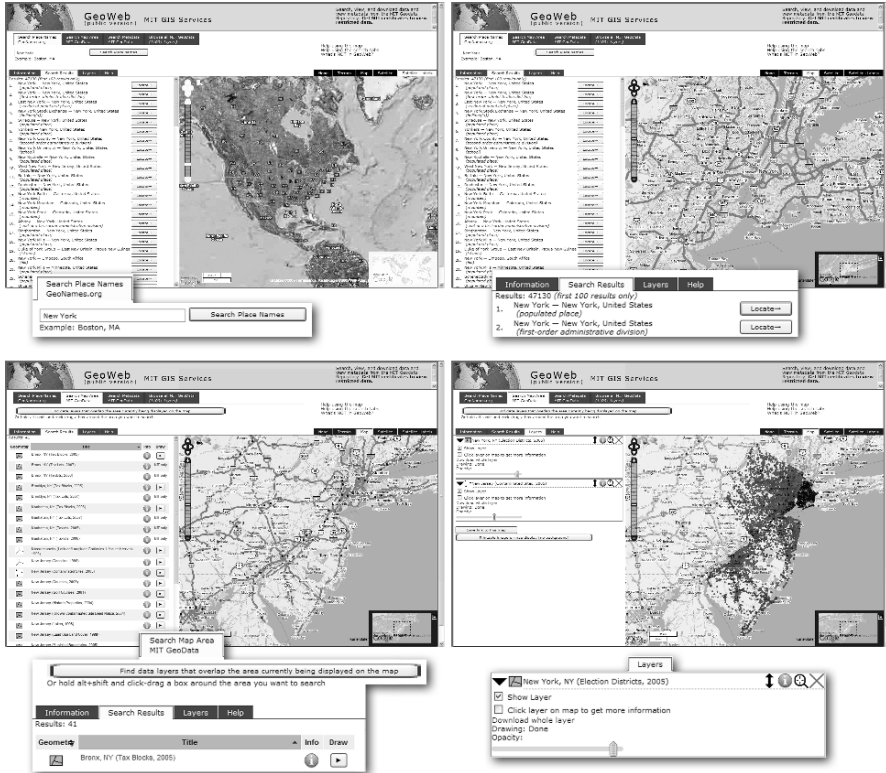
**Fig. 11.2.** Screenshots of MIT GeoWeb (MIT GIS Services n.d.): search results for "New York" (top left), map window zoomed to first result on list (top right), list of available datasets for the selected area (bottom left), symbolization of two downloadable datasets (bottom right).

window. A wrong keyword may lead to an empty hit list, and reference maps may be mistaken for downloadable datasets. A novice user may not be familiar with the (abbreviated) dataset names in the hit list or may not have an accurate understanding of the dataset types. The user may also get the impression that it is not possible to gain access to the required datasets because he/she cannot think up the correct keyword for the text-based search. Often the symbolization of several selected datasets on the same reference map is not cartographically optimized, e.g. the same color is used for two different datasets or thematic layers.

Established examples of geospatial libraries with search-based GUI are the Harvard Geospatial Library (Harvard University Library n.d.) and the
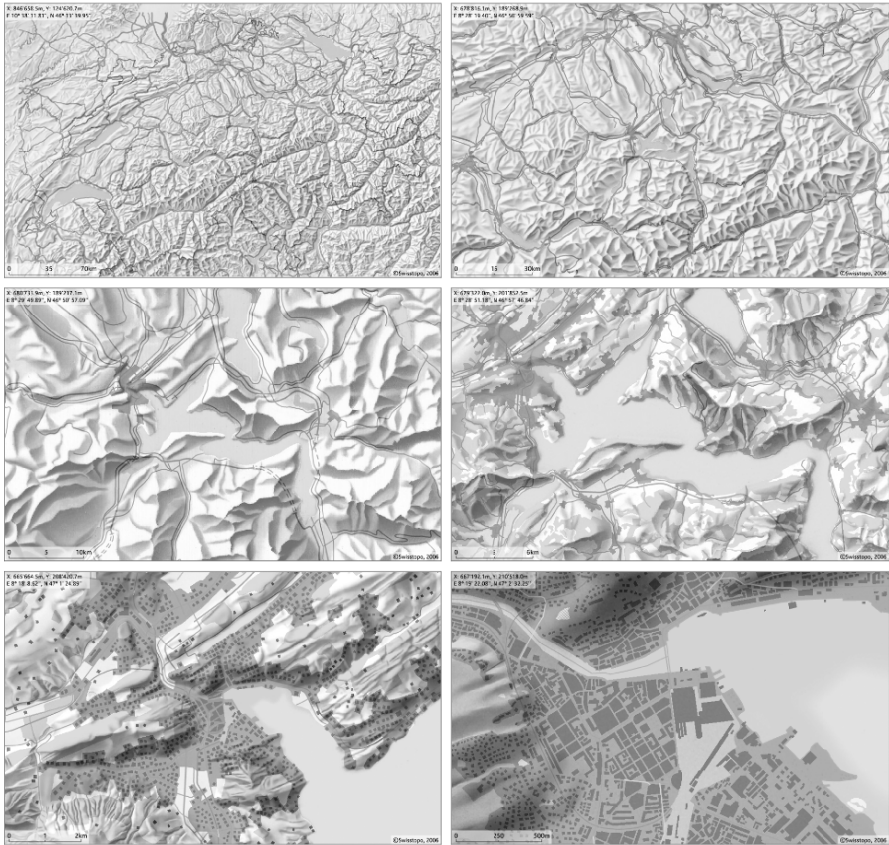
**Fig 11.3.** Swisstopo vector data at different display scales shown in the WYSI-WYG map window of the ETH Base Map Collection; display from small scale to large scale from top left to bottom right.

GeoWeb application of the MIT GIS Services (MIT GIS Services n.d.). MIT GeoWeb (Fig. 2) focuses on a variety of search options and allows the user to create arbitrary data layer combinations and retrieve additional attribute information. Based on a list of text based search results, the user selects what data should be displayed on the background reference map. The downloadable output can be a raster or vector dataset in a number of formats or a geodatabase link for use with a GIS.

## 11.2  The WYSIWYG User Interface

The wizard-based and the search-based interfaces presented in the previous sections both do not serve the experienced and the novice user equally well. In both interfaces the user needs to take several pre-selection steps before seeing downloadable data. The novice user may have difficulties selecting a dataset without receiving a visual impression of its appearance and characteristics. The user may even confuse reference maps and downloadable datasets. In both interfaces, it is difficult to gain an overview of the available datasets and functionalities.

The WYSIWYG interface is a new type of interface for geospatial libraries that meets the requirements of users of varying experience levels with geospatial data. This is achieved by the following principles:

- Reference maps and text-based searches are used as little as possible. Instead, the user is always exposed to downloadable data in the map window. Hence comes the name What-You-See-Is-What-You-Get (WYSIWYG) interface. The symbolization of datasets is cartographically correct and adapted to different display scales.
- The user is encouraged to explore all available datasets. The interface is flexible and does not impose a strict chronology of actions: it is up to the user to either first navigate to a different dataset type or a different location. A variety of paths can be taken to arrive at the data of interest.
- GUI windows and sub-windows are clearly arranged according to specific design guidelines and user-friendly measures are taken to optimize application use.

An example of a geospatial library with WYSIWYG interface is the ETH Zurich Base Map Collection, which has been developed by the Institute of Cartography. In the following sub-sections, the above named principles will be further explained and a possible implementation of these principles will be demonstrated by showing details from the ETH Zurich Base Map Collection.

### 11.2.1  The WYSIWYG Map Window: Presenting Downloadable Data at Different Display Scales

After the user logs into the geospatial library application, a default downloadable dataset is immediately displayed in the map window of the WYSIWYG interface. The user can either continue with this default data-
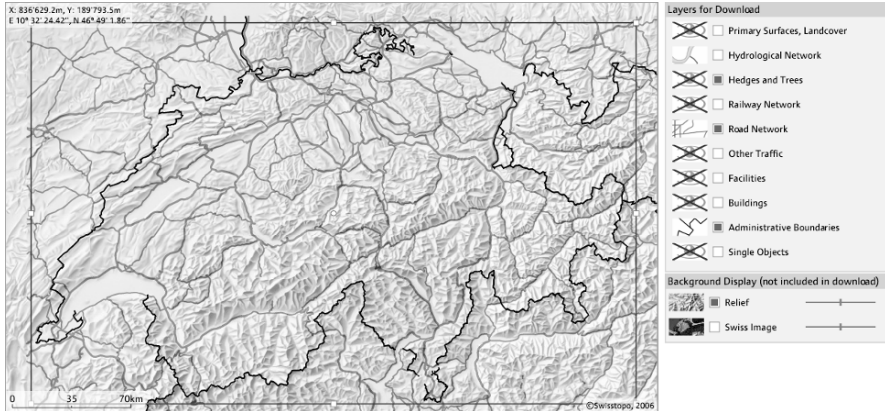
**Fig. 11.4.** Display of vector data in the WYSIWYG map window of the ETH Base Map Collection (left) and the corresponding sub-window to select layers for download (right). The hedges and trees layer, road network and administrative boundaries are selected for download. Layers marked with a crossed-out eye are not visible at the current display scale.

set or switch to other downloadable datasets. What the user sees in the map window should resemble as closely as possible the content of the file that, as a final step, will be downloaded to the user's desktop.

In the map window of the search-based and the wizard-based interface type, a reference map (e.g. satellite image, street map, topographic map) is usually shown. Downloadable datasets are displayed in a much later step, directly as symbolized vector data or image clip or indirectly as dataset boundary box. The WYSIWYG map window, which immediately displays
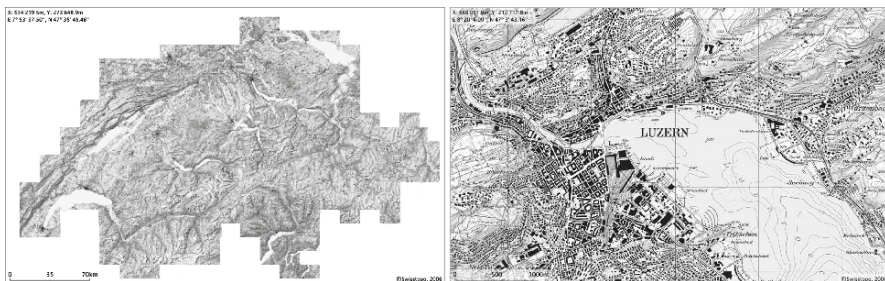


**Fig. 11.5.** The 1:25 000 swisstopo raster map at different display scales in the WYSIWYG map window of the ETH Base Map Collection. For small scale display (left) a down-sampled image of the original (right) is used.

downloadable datasets and avoids using reference maps, bears a number of advantages:

- Some of the characteristics of the datasets are conveyed visually to the user without needing further textual explanations, e.g. the user automatically differentiates between satellite image or topographic map, point or line information, river or highway.
- The user does not need to deal with the content of the reference map, nor does he/she risk confusing it with downloadable data. Unfortunate combinations of reference map and downloadable dataset (e.g. a downloadable relief map combined with a satellite image reference map) are also avoided.
- The user sees exactly where downloadable data is available because it is always directly symbolized in the map window.
- Navigating to a location in the WYSIWYG map window, especially by zooming in several steps to a location, is at the same time an act of exploring the downloadable dataset.

When the user zooms in and out on the WYSIWYG map window, a screen display of the downloadable datasets corresponding as closely as possible to the content of the download file needs to be created. A major challenge is therefore, to find an appropriate representation of the downloadable data at different display scales. The following sub-sections show how this challenge was met when designing the WYSIWYG GUI for the ETH Zurich Base Map Collection. Different solutions were chosen for displaying raster and vector datasets.

### 11.2.1.1  Displaying Vector Data at Varying Scales

The ETH Zurich Base Map Collection contains currently three topographic vector datasets (an overview map and two digital landscape models) covering the area of Switzerland, which are provided by the Swiss national mapping agency (swisstopo 2008). The datasets were generalized for the scales of 1:1 Million, 1:200 000 and 1:25 000. To mark the entire 1:25 000 vector dataset of Switzerland for download in the WYSIWYG map window, the user would need to view the dataset at full extent. The challenge was that the 1:25 000 dataset, being very detailed, could not be used for an overview map showing the whole country. At the same time, as stated in the previous sub-section, the screen display at full extent needed to look as similar as possible to the downloadable 1:25 000 vector dataset.

For the topographic vector datasets in ETH Zurich Base Map Collection, the problem was solved in the following way: three main display scale intervals were defined. At small scales the 1:1 Million dataset was used, for medium scales the 1:200 000 was applied and at large scales the 1:25 000 dataset itself was shown in the map window. To give the user the impression of adaptively zooming within the same dataset, care was taken to symbolize themes in the same manner in all three datasets. E.g. the same line symbols were used for rivers, administrative boundaries and highways. Within each display scale interval, geometry density needed again to be reduced towards the small-scale end of the interval. Subscale intervals were defined based on thematic attributes of the vector dataset. E.g. at a 1:400 000 display scale, only highways, two lane roads and major railways of the 1:200 000 transportation layer are shown. Narrower roads and shorter railroads from the 1:200 000 dataset are gradually added when the user zooms further in on the WYSIWYG map window until the display switches to the 1:25 000 dataset at the appropriate zoom level. Fig. 3 shows the content of the WYSIWYG map window at different scales when the user selects the 1:25 000 topographic vector dataset.

A negative side-effect of defining attribute-based intervals for display can be that fragmented or isolated geometry elements appear in the WYSIWYG map window; e.g. when two highways are connected by a narrow road and the latter is not displayed at the current display scale. But since this problem appears rarely and only concerns the display and not the downloadable datasets themselves, it was judged to be acceptable.

By using three different datasets for screen representation with harmonized symbolization, the user receives the impression of viewing the same dataset at different generalization levels. At all zoom scales the displayed map is similar in appearance to the downloadable dataset. To optimize the dataset symbolization for screen display, general web map design guidelines (Jenny, Jenny and Räber 2008) were followed wherever possible; e.g. anti-aliasing was applied to vector data and the size of line and point symbols was adapted for screen display.

It needs to be noted that vector datasets can often only be downloaded without a symbolization file. If one interprets the term WYSIWYG narrowly, for vector data the user does not get what is displayed. In a broader interpretation, which is favored in this article, by looking at symbolized vector data in the WYSIWYG map window, the user still learns about many of the characteristics of the dataset that will be included in the down-

load file. Due to this broad interpretation, in the context of this article the WYSIWYG principle is considered to also apply to vector datasets.

Another challenge concerning the display of vector datasets at different scale is encountered when the user needs to include a layer in the download even if it is not shown in the WYSIWYG map window. This is for example the case, when the user wants to download a layer containing hedges and trees for the area of entire Switzerland. Hedges and trees are only shown starting at a display scale of 1:10 000 and larger and certainly cannot be shown on a country scale representation. For this purpose special GUI elements were created: a sub-window shows the names of the layers of the downloadable dataset with a check box (Fig. 4). If the check box is turned on, the layer will be included in the download even if it cannot be seen at the current display scale. A crossed out eye next to the check box indicates that the user needs to zoom in further to see the layer. When the layer can be shown, a legend icon replaces the crossed out eye. Layers not selected for download are also not displayed on the map.

### 11.2.1.2  *Displaying Raster Data at Varying Scales*

For the display of raster datasets in the ETH Base Map Collection, a different approach was chosen. Swisstopo produces topographic raster maps at different scales (between 1:1 Million and 1:25 000), but the maps do not always share the same symbolization. It was therefore not possible, in analogy to the vector data representation, to use a small-scale map for a full country view of a large-scale dataset selected for download. Instead, for each dataset a pyramid of down-sampled images (with the dataset in original resolution at the base) was created. Depending on display scale, a lower or higher resolved image is shown. While this method is not equival-
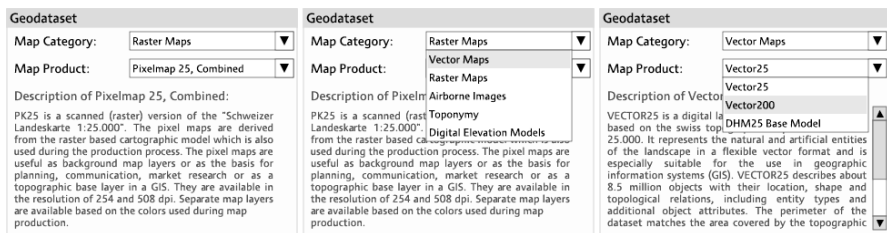


**Fig. 11.6.** Drop down menus for dataset selection: for the selected dataset a description is provided (left); selection of dataset category (middle); dataset selection (right).

ent to a cartographic generalization, it does not falsify the appearance of the dataset (Fig. 5).

It was also assumed that users would have fewer problems handling raster datasets since layer selection is not necessary. The majority of users are probably familiar with the appearance of digital topographic raster maps, given that they look identical to their paper equivalent.

## 11.2.2  Interface Flexibility: Allowing the user to Choose the Order of Actions

The WYSIWYG interface for geospatial libraries does not only consist in the WYSIWYG map window. It also offers a number of features that support flexible usage. A pre-defined sequence of actions to arrive at a display of downloadable data is not imposed, as it is often the case in wizard-based and search-based interfaces. A flexible WYSIWYG GUI allows the user to follow a variety of paths to arrive at the same result. As a consequence the user gains a better overview of the available datasets and their characteristics and becomes acquainted with the system's capabilities. In the WYSIWYG interface of the ETH Base Map Collection such flexibility was implemented in the following ways:

- Geospatial dataset and location selection can be executed in arbitrary order. This facilitates browsing available datasets and learning about geospatial data.
- A number of complementary location search tools were implemented supporting users of varying experience levels and interests.
- Because download parameter tuning is a demanding task, it can be approached in two ways: novice users are guided by default values, whereas experienced users may customize download parameters to better fit their needs.

After login into the ETH Base Map Collection, the user has the choice to display a different dataset in the map window or to navigate to a location. Selecting a new dataset is executed by manipulating two drop down menus (Fig. 6).

The first drop down menu shows categories of dataset types e.g. vector data, airborne images, and digital elevation models. The second drop down menu shows available datasets for the selected category. The user can quickly browse through all available datasets. Selecting a name will dis-

play the data immediately in the WYSIWYG map window. Browsing through available geospatial datasets with the WYSIWYG user interface is a learning experience. By looking at the display of different downloadable datasets of the same category, the novice user will discover common characteristics. If not familiar with dataset names and abbreviations, the user will soon be able to form an approximate mental classification of geospatial datasets. Since not all dataset characteristics can be intuitively deduced from their visual representation, a short description of the dataset and its typical use cases are provided (Fig. 6 left).

Users who are already acquainted with the ETH Base Map Collection may prefer to navigate directly to a location. Several ways to display an area of interest are offered, serving different experience levels and needs of the users (Fig. 7).

Users can directly navigate in the map window or on a small overview map using standard map navigation tools. The zoom function can be operated gradually by moving a slider, in predefined steps by clicking a plus or a minus button, or directly on the map by drawing a rectangle. Users who are not familiar with interactive tools or are looking for a particular location may prefer the text-based gazetteer search. It is a live search that
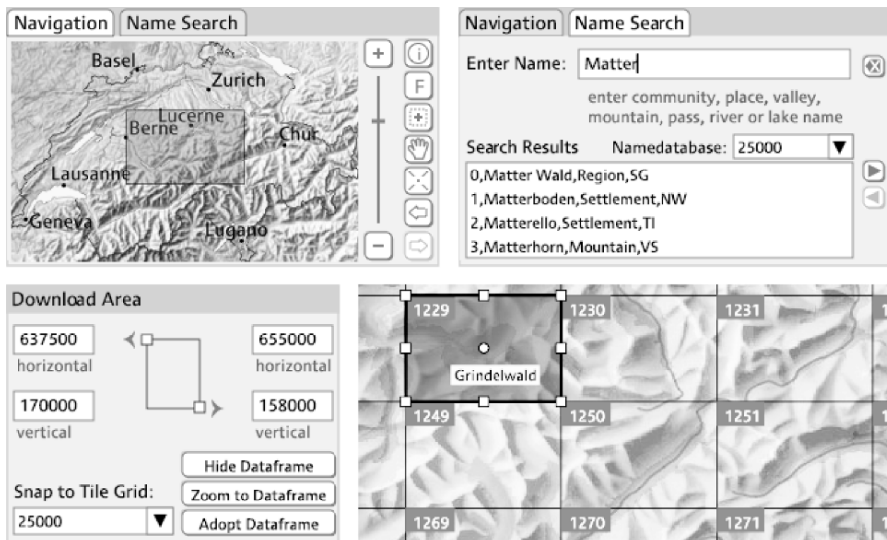


**Fig. 11.7.** Different location search options of the ETH Base Map Collection (from left to right and top to bottom): map navigation tool and overview map; gazetteer; coordinate search; tile grid overlay.

shows the corresponding matches for every character that the user enters. According to Lauesen (2005, p. 281), this makes the search more intuitive because the user receives immediate feedback. Clicking on a place name displays the selected location in the WYSIWYG map window. It is also possible to provide exact geographical coordinates to speed up the selection process. For users who want to download a certain map sheet, tile grids can be overlaid on the map display. Clicking the map sheet number will select the map sheet's coordinates. By pressing the shift key several map sheets can be selected. When the user switches to a different geospatial dataset, the display stays at the selected location. This provides the user with the flexibility to determine the order of the selection steps optimally supporting his/her interests.

Sometimes it is necessary to provide different options for experts and novice users, especially where specific background knowledge is required. In the ETH Map Collection interface this is the case for download parameter tuning. In the Download Folder tab (Fig. 9), where a user's dataset selections are listed, default values for download format, projection and vector data attribute selection are provided. The default values were defined to meet typical user needs. For example, if the user accepts the default values, vector datasets for download will be delivered in ESRI shape format, in Swiss projection without additional attributes. Experienced users have the option to select a different projection, file format or add attributes to each layer.

### 11.2.3  User-friendly Interface Implementation

The functionality of the WYSIWYG user interface was designed as user-friendly as possible. User-friendliness also needs to be taken into account when designing the interface's layout. When designing the WYSIWYG interface for the ETH Base Map Collection, selected steps for systematic interface design suggested by Lauesen (2003) and Lauesen and Harning (2001) using virtual windows were followed. Among other guidelines, Lauesen and Harning (2001) suggest:

- to use as few windows as possible,
- to reuse windows,
- to display the same data in one window only.

The interface of the ETH Base Map Collection is a tabbed document interface with only three main tabs: a tab for dataset browsing and selection, a

download folder to save selections and a help page. The tab for dataset browsing is clearly structured into three sections (Fig. 8): (1) the WYSI-WYG map window; (2) a vertical section to the right of the map window letting the user choose the datasets and layers; (3) a horizontal section below the map window where the user can navigate to or search for a location. Window reuse was realized in the bottom tabs (navigation and name search) sharing one sub-window as shown in the first two images of Fig. 7. To select part of a dataset for download the user places a red-rectangle on the WYSIWYG map window that is also used for dataset browsing.

The interface designer can help to avoid disappointment on the user's side by respecting the following general guidelines for user interface implementation:

- to give warning messages and block unsupported actions early,
- to allow state or result saving,
- to call on the user's patience and time conscientiously.
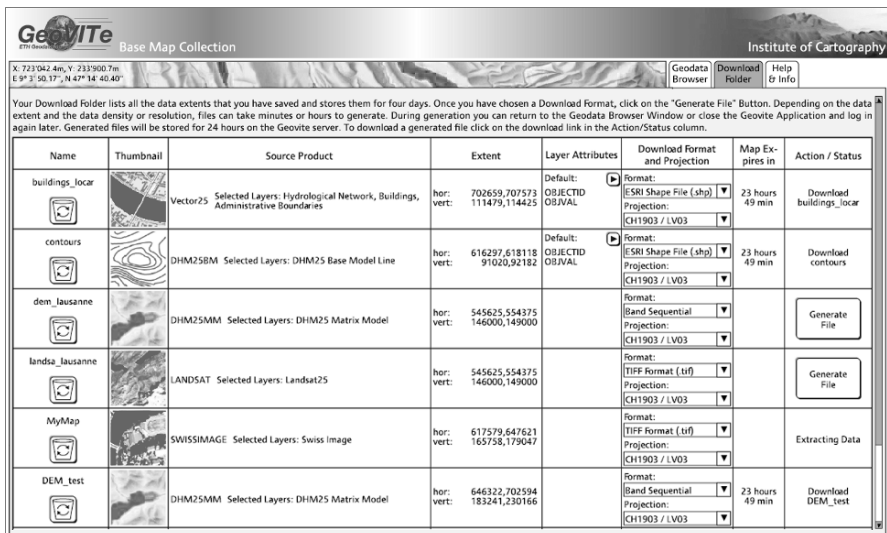
When working with a geospatial map collection, warning messages are typically needed when the user has insufficient download permissions or exceeds the allowed file size for download. In the ETH Base Map Collec-
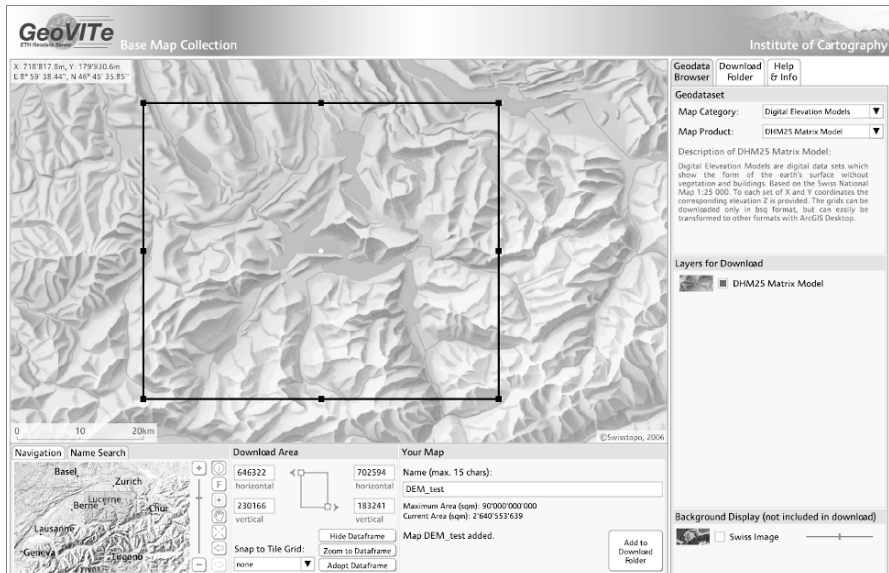


**Fig. 11.8.** Dataset selection interface in The ETH Base Map Collection: map window (middle), content selection (right) and location selection (bottom) sections. The rectangle on the map window defines the extent of the download area.

tion interface care was taken to warn the user as early as possible. For example, to avoid overly large files, which would block the server process and could not be reasonably handled by the user, for every dataset a maximum area for download was defined. The size of the selection rectangle is displayed in red if the selection exceeds the allowed size. To profit from the maximally allowed area for download, the user can easily adjust the rectangle until its size is displayed in black. Attempts to add oversized selections to the download folder are blocked, and an alert message is shown.

Many geospatial dataset collection interfaces also do not offer the option to interrupt the data selection process and to save the current map display including current settings. Often it is also necessary to keep the application open in the web browser and to wait until the file extraction process has finished. With the ETH Base Map Collection interface, the user can persistently save up to ten map definitions containing information on selected datasets, layers and area. File extraction can be executed simultaneously to dataset browsing and does not stop when the application is closed. A status field informs the user on file extraction progress (Fig. 9).



**Fig. 11.9.** Download Folder of the ETH Base Map Collection showing a user's maps for download. Download parameters can be selected by the user before starting file extraction. Default values are provided, but can be replaced by customized options. The status column informs on file extraction progress.

### 11.2.4 Technical Implementation

The section gives a brief overview of the three-tire architecture used for this client-server system. The interface of the ETH Base Map Collection was implemented in Scalable Vector Graphics (SVG), XML and JavaScript. Reusable widgets (e.g. tab groups, selection lists) were defined that are resized when the user changes the browser dimensions. When the user logs into the client application, information on available layers and attributes for each dataset and a list of projections and formats is requested from the server. This information dynamically initializes the GUI according to available data.

On the server side, the ETH Base map collection relies on a geodatabase (relational geo-spatial database and ESRI ArcSDE) and a map server (ESRI ArcIMS), the Apache web server and Apache Tomcat. Requests from the client are processed by a Java Servlet, which makes a decoupling of client and server possible. Depending on the parameters sent by the client, the servlet forwards the client's request to ArcIMS, ArcSDE or to the database system. To communicate with ArcIMS the servlet translates requests into ArcXML and uses the Java Database Connectivity (JDBC) to send SQL-statements to the database. The servlet returns a text string or http link to the client referring to the dynamically created result and if necessary creates a zip archive containing the selected data.

## 11.3 Conclusion

The WYSIWYG interface is a new type of interface to geospatial dataset collections. Compared to other interfaces it offers the advantage to cater equally well to experts and novice users alike. The most important characteristic of this new type of interface is the WYSIWYG map window. It displays scale-adapted representations similar in appearance to the downloadable datasets allowing for visual browsing. A strict order of actions is not imposed by the interface. Instead, the user can choose between many paths to arrive at a dataset selection for download giving precedence to the order or tool that best suits his/her interests and experience level. A user-friendly window design and implementation add to making the WYSIWYG interface a well-suited solution for a user group with varying experience levels. The ETH Zurich Map Collection, which successfully uses a WYSIWYG interface implementation, will in the future be extended to also include his-

torical maps of Switzerland. These maps are not always available for all parts of Switzerland and also include datasets from varying years. It will be intriguing to integrate access functions for such datasets into the WYSI-WYG interface.

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