



Introduction to ArcGIS

WATENV - WS 2011/12

Environmental Data Analysis (GIS Part)

Basics for Laboratory Exercises with ArcGIS

Contents

- 1. Overview of ArcGIS 10..... 1
 - 1.1 What is ArcGIS? 1
 - 1.2 ArcGIS Desktop Products..... 1
 - 1.3 ArcGIS Desktop Application..... 1
 - 1.4 ArcGIS Help and Literature 2
- 2. Introduction to ArcCatalog..... 3
 - 2.1 Starting ArcCatalog..... 3
 - 2.2 ArcCatalog User Interface 3
 - 2.3 Catalog Tree..... 4
 - 2.3.1 Folder Connections..... 4
 - 2.3.2 Representation of Different Data Files..... 4
 - 2.4 Map Window 5
 - 2.4.1 Contents Tab 6
 - 2.4.2 Preview Tab 6
 - 2.4.3 Description Tab..... 7
- 3. Data Management with ArcCatalog 9
 - 3.1 Copying, Renaming and Deleting of Data..... 9
 - 3.2 Data Properties..... 9
 - 3.3 Creation of new ArcGIS data files..... 10
 - 3.3.1 New Shapefile..... 11
 - 3.3.2 New File Geodatabase..... 12

3.3.3	New Feature Dataset.....	13
3.3.4	New Feature Class.....	14
3.3.5	New Table.....	16
3.4	Importing and exporting geodata in a Geodatabase.....	18
3.5	Converting co-ordinates in a text file or a table into a Shapefile.....	19
3.6	Data management from ArcMap.....	21
4.	Introduction to ArcMap.....	22
4.1	Starting ArcMap.....	22
4.2	ArcMap User Interface.....	22
4.3	Personal adaptation of ArcMap.....	23
4.4	ArcMap Document.....	24
4.4.1	Opening a new or an existing ArcMap Document.....	24
4.4.2	Saving ArcMap Documents.....	25
4.4.3	Repairing Broken Data Links.....	25
4.4.4	Data Source with Relative Path name.....	26
4.5	Basic ArcMap Elements.....	27
5.	Adding and Viewing Data in ArcMap.....	28
5.1	Adding and Removing Data.....	28
5.2	Navigating in the Display Window.....	29
5.3	Navigation with the keyboard.....	Fehler! Textmarke nicht definiert.
5.4	Navigation with the mouse wheel.....	Fehler! Textmarke nicht definiert.
5.5	Temporary change in the Navigation mode.....	30
5.6	Setting the Map Scale.....	31
5.7	Bookmarks.....	31
5.8	Overview, Magnifier and Viewer Windows.....	31
6.	Layers and Data Frames in ArcMap Document.....	33
6.1	Layer visibility using checkbox.....	33
6.2	Layer drawing order principle.....	33

6.3	Changing symbols.....	33
6.4	Layer properties	34
6.4.1	Changing Layer name	35
6.4.2	Layer's Data Source	35
6.4.3	Layer transparency	35
6.4.4	Customizing layer symbology.....	35
6.4.5	Labelling of features	38
6.5	Saving and importing of layer properties.....	40
6.6	Working with Data Frames.....	40
6.7	Data Frame Properties	41
6.7.1	Name and Reference scale	41
6.7.2	Coordinate System	41
7.	Tools in ArcMap.....	43
7.1	Selecting Features and Removing Feature Selection	43
7.2	Identifying objects	44
7.3	Searching for Objects	44
7.4	Measuring Objects.....	45
8.	Thematic Data and Attribute Tables	46
8.1	Attribute Table User Interface	46
8.2	Moving and Sorting Fields	47
8.3	Table options	47
8.4	Connection between Features and Attributes	48
9.	Selecting Objects	49
9.1	Selections methods	49
9.1.1	Interactive selection	49
9.1.2	Selection by means of a graphic element	49
9.1.3	Selection By Attributes	50
9.1.4	Selection By Location	50

9.2	Clear selection	52
9.3	Selection options	52
9.4	Saving the selected features as a New Dataset.....	52
10.	Spatial Analysis of Vector Data.....	53
10.1	Using the ArcToolbox	53
10.2	Example: Creating Buffers	53
11.	Map Design and Layout.....	55
11.1	Choosing a Map Size.....	55
11.2	Changing Page Size & Orientation in ArcMap	55
11.3	Layout view.....	55
11.4	Layout toolbar	56
11.5	Elements of a map composition.....	56
11.5.1	Title.....	57
11.5.2	Legends.....	57
11.5.3	Scale.....	58
11.5.4	Credit Note and Date.....	58
11.5.5	Directional Indicator	59
11.5.6	Borders and Neatlines	59
11.5.7	Graticules and Grids	59
11.6	Planar Organization of Visual Elements	60
Appendix A:	Georeferencing Raster Images in ArcMap	61
Appendix B:	Digitization.....	63

1. Overview of ArcGIS 10

1.1 What is ArcGIS?

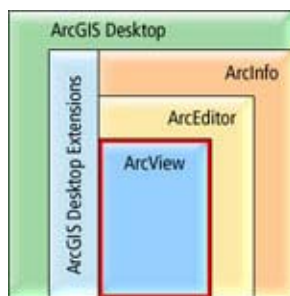


Desktop is a GIS product created by ESRI (Environmental Systems Research Institute)

It contains integrated GIS products and development tools

It is a software package for spatial data capture, management, storage, processing, analysis, simulation, output and presentation.

1.2 ArcGIS Desktop Products



- ArcGIS Desktop software is an integrated suite of advanced GIS applications: *ArcCatalog*, *ArcMap* and *ArcToolbox*
- It is a family of three products (editions)—*ArcInfo*, *ArcEditor*, and *ArcView*—that share the same core applications, user interface, and development environment.
- All the three products contain *ArcCatalog*, *ArcMap* and *ArcToolbox* applications
- Each product provides additional GIS functionality as you move from *ArcView* to *ArcEditor* to *ArcInfo*, depending on the license level.

1.3 ArcGIS Desktop Application

ArcCatalog – Data management application

- Defining and changing properties for geometric and attribute data
- Creating, copying and deleting datasets
- Metadata creation and editing

ArcMap – Data capture, analysis and map display application

- ArcMap is the central application in ArcGIS Desktop. It is the GIS application used for all map-based tasks including:
 - Editing of geometric and attribute data
 - Carrying out of analyses and queries
 - Table operations
 - Creation and visualization of maps
 - Printing and exporting layouts

ArcToolbox – Geo-processing tool

- ArcToolbox helps users to perform geo-processing operations such as:
 - data conversion
 - overlay processing
 - buffering,
 - proximity analysis
 - map transformation.
- Each tool has a menu-driven interface with wizards or dialogs.
- ArcToolbox can be launched from either ArcMap or ArcCatalog applications

ArcScene – Visualization of 3D data

- ArcScene is a 3D visualization application that allows to view GIS data in 3D:
 - Manipulate and visualize data in virtual 3D
 - Allows some geo-processing tools and functions.

Extensions – for additional capability

- ArcGIS 3D Analyst
- ArcGIS Network Analyst
- ArcGIS Spatial Analyst

1.4 ArcGIS Help and Literature

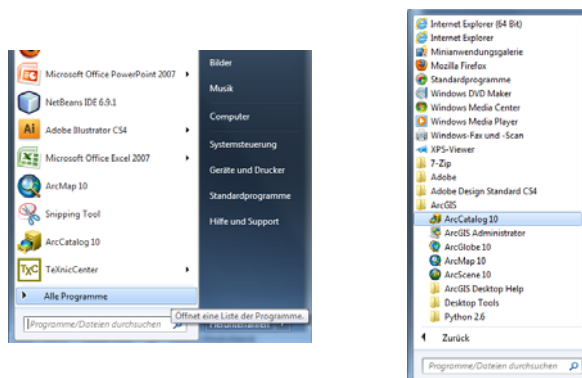
- ArcGIS Desktop help (in ArcMap or ArcCatalog)
- Online help/ Demos
 - <http://www.esri.com/software/arcgis/arcgis10/index.html>
 - <http://support.esri.com/>
- Online Course
 - <http://training.esri.com/>
- Books
 - Ormsby, T. – Getting to Know ArcGIS Desktop
 - ESRI – What is ArcGIS?
 - ESRI - Using ArcCatalog
 - ESRI Using ArcMap
 - Zeiler M. – Modelling Our World: the ESRI Guide to Geodatabase Design
- General on-line GIS Tutorials


2. Introduction to ArcCatalog

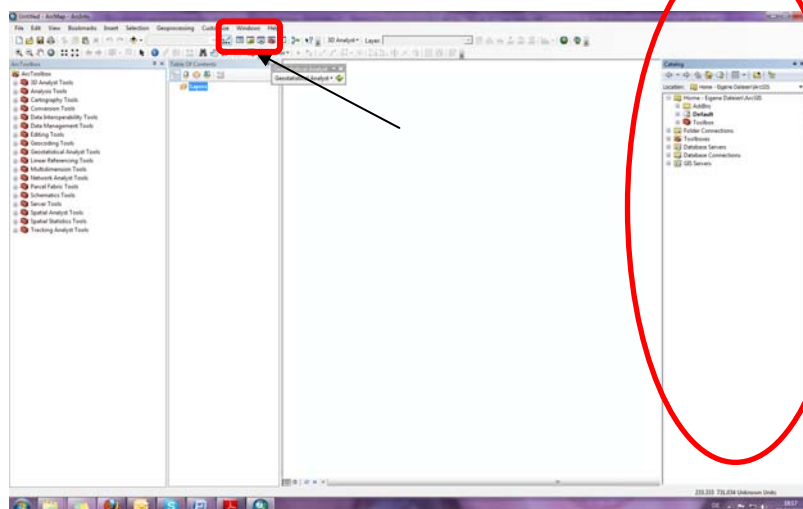
ArcCatalog helps users to browse, search, explore, view, and manage data and maps. It also helps GIS database administrators maintain spatial and tabular GIS data for use by others in their organization.

2.1 Starting ArcCatalog

- ArcCatalog can be launched by clicking Start>All Programs>ArcGIS> ArcCatalog10.



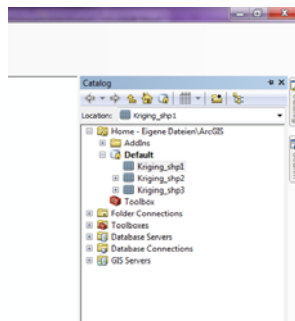
- ArcCatalog can also be started by clicking on the icon  on the Standard tool bar in ArcMap.



2.2 ArcCatalog User Interface

The main features of the ArcCatalog User Interface include the toolbars, the Catalog tree and Data/Display Window (depicted earlier on the right side of the window).


On the left of the ArcCatalog window, you see the *Catalog tree*; it gives you a bird's-eye view of how your data is organized. On the right are tabs that let you explore the contents of the selected item in the Catalog tree.

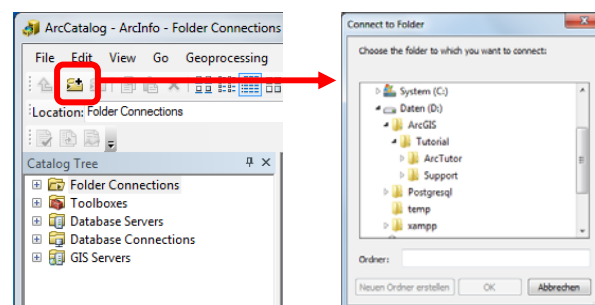


2.3 Catalog Tree

In the table of contents window, all network and folder connections are listed, can access the ArcGIS directly.

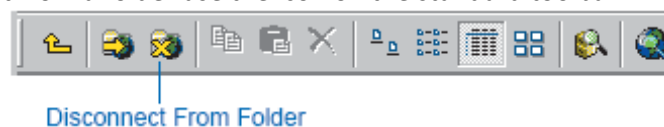
2.3.1 Folder Connections

- The first time you start ArcCatalog, it contains *folder connections* that let you access your computer's hard disks. The Catalog also contains folders that let you create and store connections to databases and Internet servers.
- Folder connection is made using the icon  on the standard toolbar.



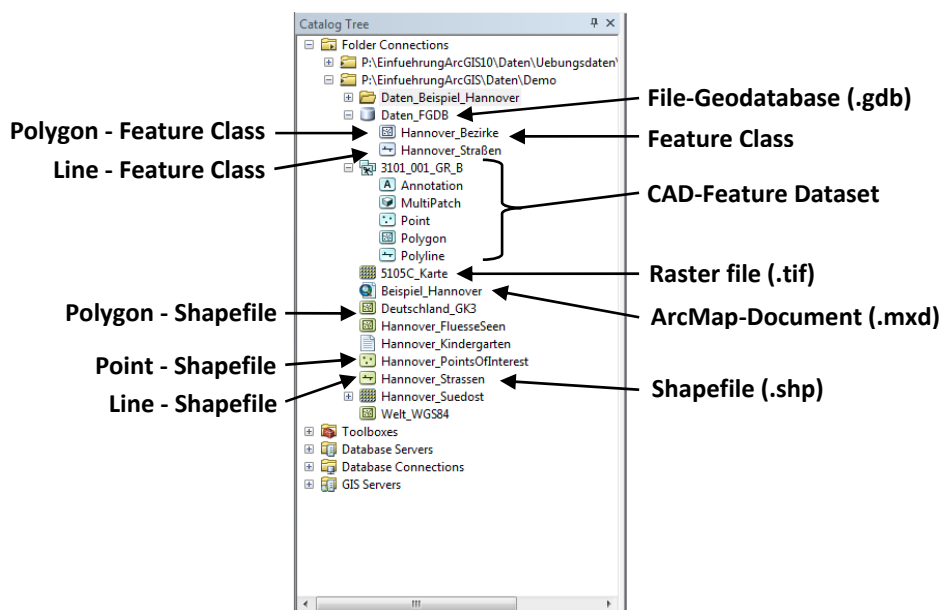
Alternatively, there exists the possibility to produce folder a connection under file – Connect. If, nevertheless, too many connections exist, one easily loses the overview. To remove a Be-standing connection, this is marked with a mouse click and the badge is operated.

- To disconnect from a folder use the icon on the standard toolbar.



2.3.2 Representation of Different Data Files

ArcMap and ArcCatalog let you work with an extensive array of data sources, such as computer-aided design (CAD) files, numerous image and table formats, and many other data types.



Geodatabase: is the common data storage and management framework for ArcGIS. It combines "geo" (spatial data) with "database" (data repository) to create a central data repository for spatial data storage and management.

Feature Dataset: A feature dataset is a collection of related feature classes that share a common coordinate system. The primary purpose of a feature dataset is for organizing related feature classes into a common dataset for building a topology, a network dataset, a terrain dataset, or a geometric network.

Feature Class: It is composed of geographic features with the same type of geometry (point, line, or polygon) and the same set of attributes. They can be contained in a Geodatabase or within a Geodatabase feature dataset.

Shapefile: is a simple, non-topological format for storing the geometric location and attribute information of geographic features. Features in a *shapefile* can be represented by points, lines, or polygons (areas). The Shapefile is composed of 3 files: *.shp* (geometric data), *.dbf* (attribute data) and *.shx* (index file that allows direct access to the main file).

Raster: ArcGIS supports many image formats like TIFF and JPG

CAD: ArcGIS supports CAD-formats such as DXF, DWG and DGN

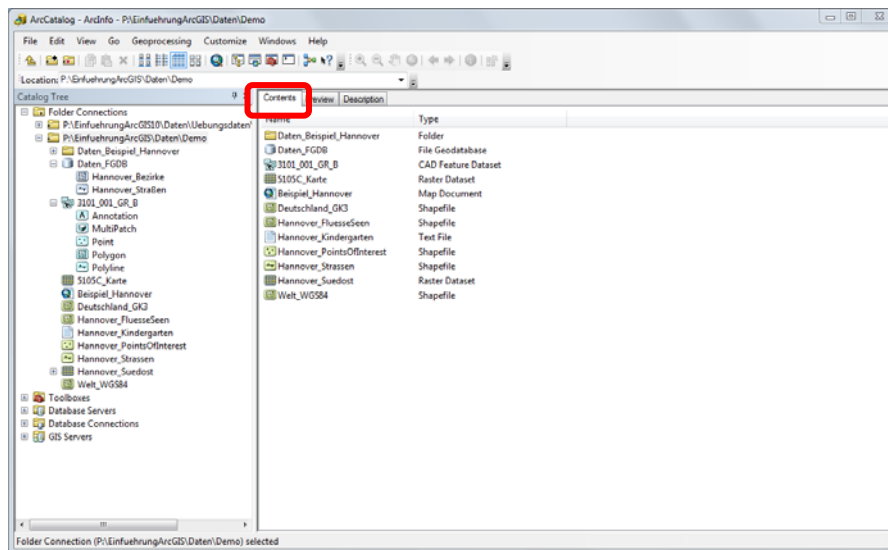
MXD: i.e., ArcMap document is the project file for ArcMap

2.4 Map Window

Each of the three tabs in the Data Window provides a different way to explore the contents of the selected item in the Catalog tree. Within each tab, there are different views that let you change the appearance of the selected item's contents. The tabs are Contents, Preview and Description.

2.4.1 Contents Tab

The Contents tab lists the items contained by the selected item in the Catalog tree, for example, the items in a folder.

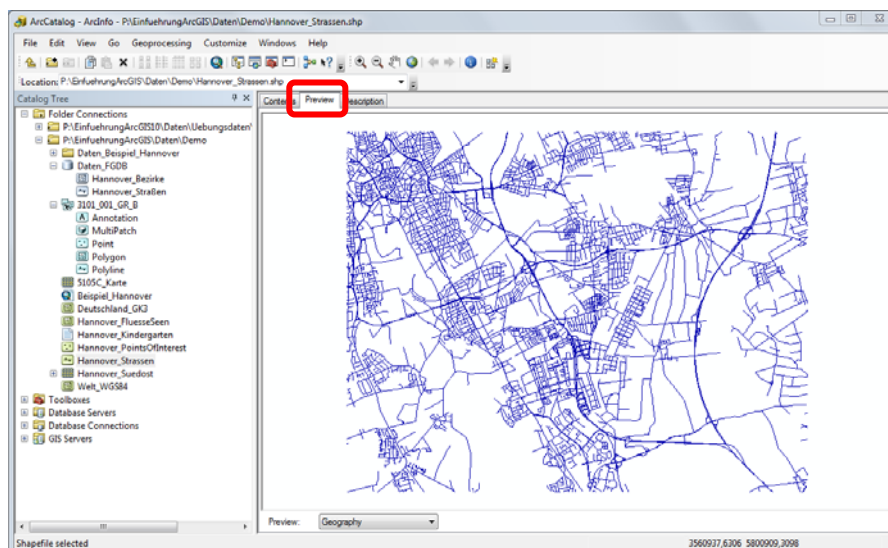


Note:

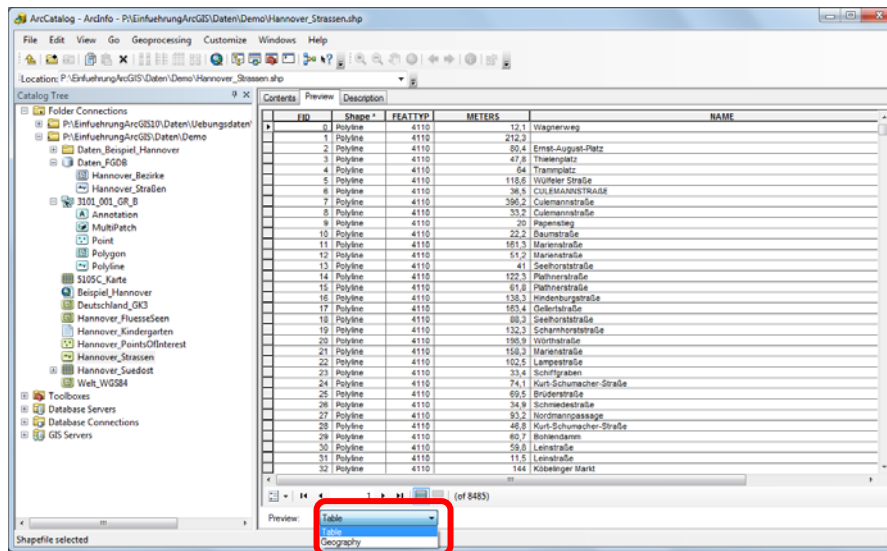
The files listed in the Catalog tree are sometimes not updated. To update, click the appropriate directory, select the Right-click and in the context menu click *Refresh*.

2.4.2 Preview Tab

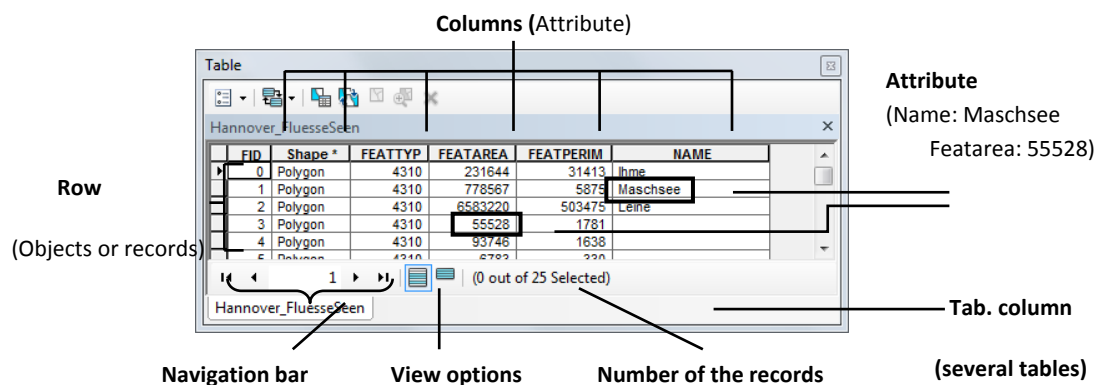
The Preview tab lets you explore the selected item's data in either Geography or Table view.



For items containing both geographic data and tabular attributes, you can toggle between the Geography and Table views using the dropdown list at the bottom of the Preview tab.

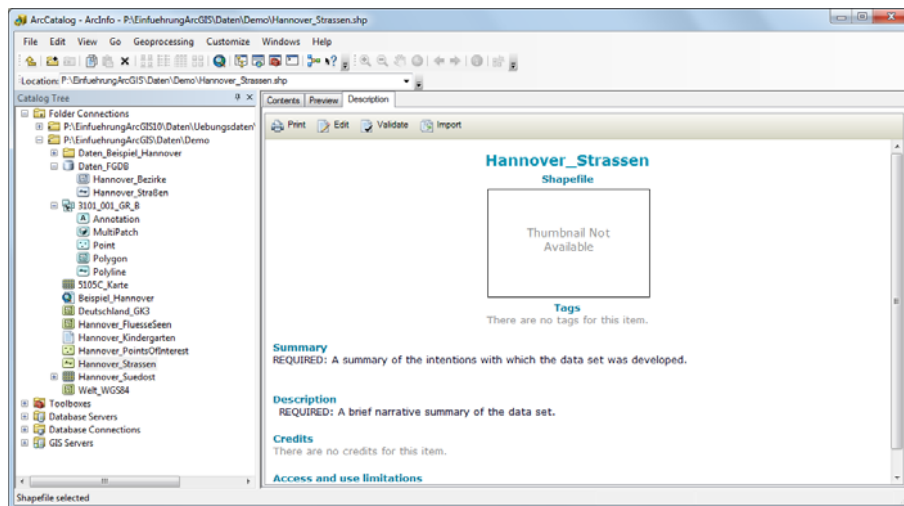


Every line in the table corresponds to an object, every column to an attribute of this object. The columns with the feature or Object-ID and Shape are automatically generated.



2.4.3 Description Tab

In the Description tab, the Metadata (data about the data) are indicated. Metadata provide information about the existence of datasets, contents and quality. These include, for example, the summary, description, credits, and access and FEATPER user limitations. Through the Edit item, a user has the possibility to work on Metadata independently and to add detailed information about the data.



3. Data Management with ArcCatalog

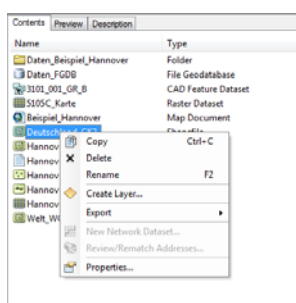
Unlike in Windows Explorer, in ArcCatalog, the data can be displayed (previewed). Spatial data management should always be carried out using ArcCatalog (and not in Windows Explorer. This can be made clear by comparing files in the same subdirectory in both ArcCatalog and Windows Explorer.

For example, a shapefile consists not only of a *.shp*-file but also various other files of the same prefix (name) but different extensions, for example, *.dbf*, *.shx*, *.sbn*, *.prj*. If you rename a shapefile in Windows explorer, you would have to do the same for each of the related files (same prefix, different extensions). In ArcCatalog, you only do it once.

TIP: If you would like to send your GIS project, remember to send not only the **.mxd* file or only the **.shp* file. It is advisable to store all files that belong to the project in the same folder and this can then be transferred as a zip file.

3.1 Copying, Renaming and Deleting of Data

Similar to Windows Explorer, you can copy, rename and delete files in ArcCatalog. To do this, use the Context menu, by Right-clicking the particular file. By Drag & Drop, you can also shift files in other folders and lists.

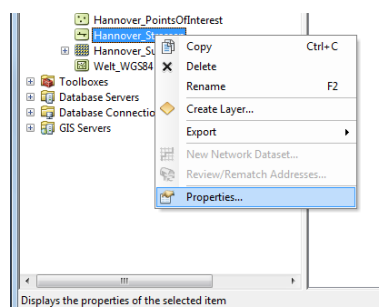


Note:

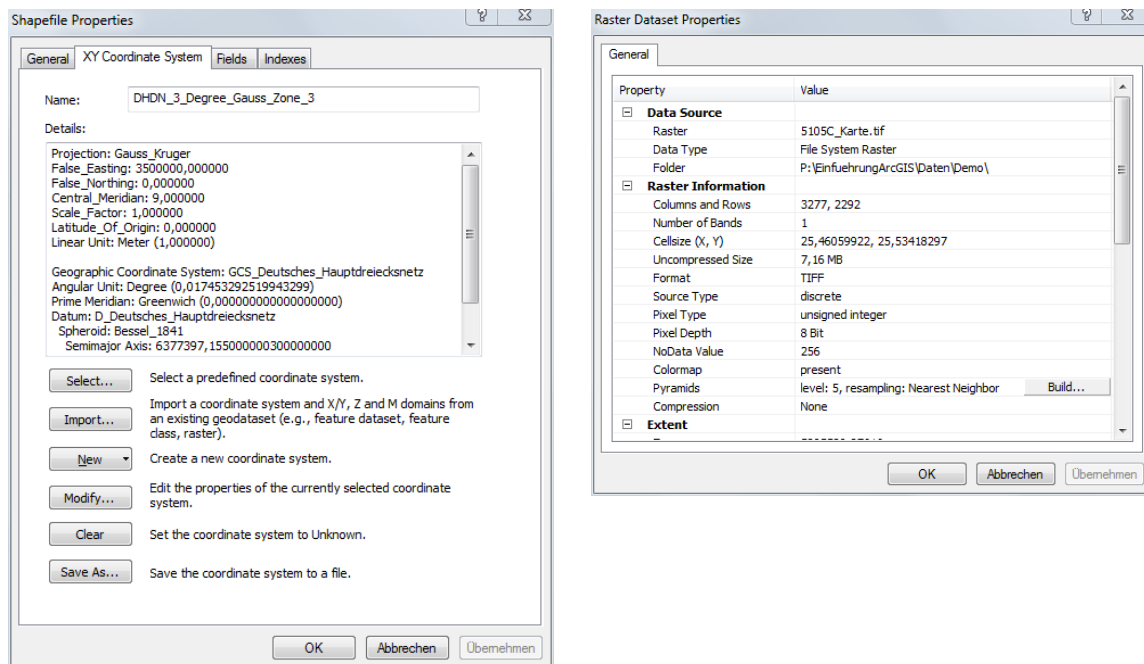
- In ArcCatalog, some folders may appear to be empty; in which case the actual contents can be checked in Windows Explorer.
- Files deleted in ArcCatalog cannot be restored; neither can they be found in Windows Recycle bin

3.2 Data Properties

To view the properties of a file, select a shapefile, a feature class or a raster file and then in the context menu (Right-click) click properties.

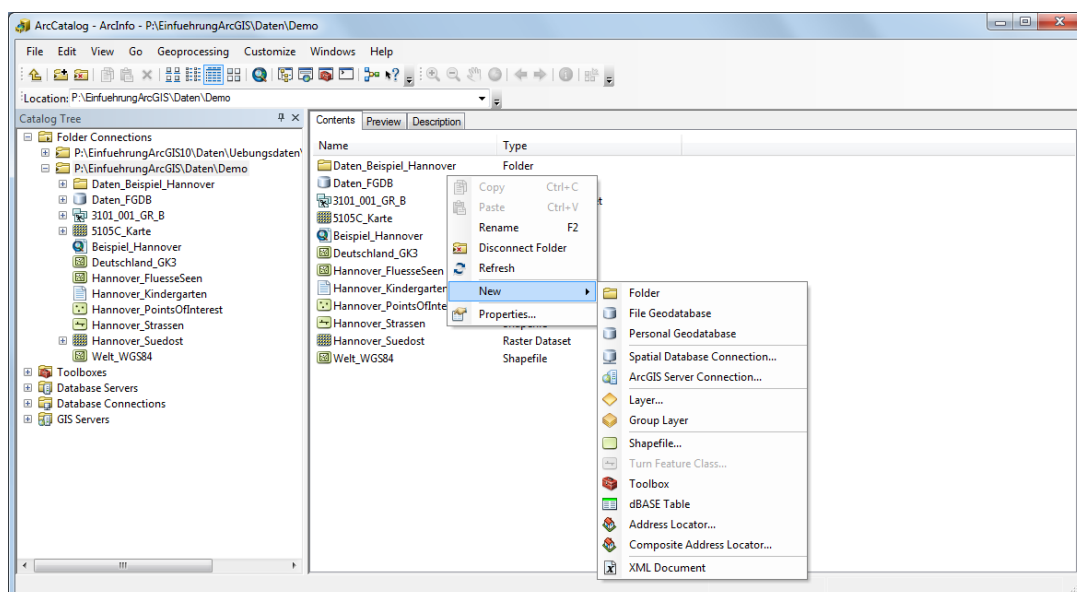


Depending on the data type, a window with different information tabs is opened. The tabs in the properties window include for example, file name, geometry type, fields, pixel size and extension.



3.3 Creation of new ArcGIS data files

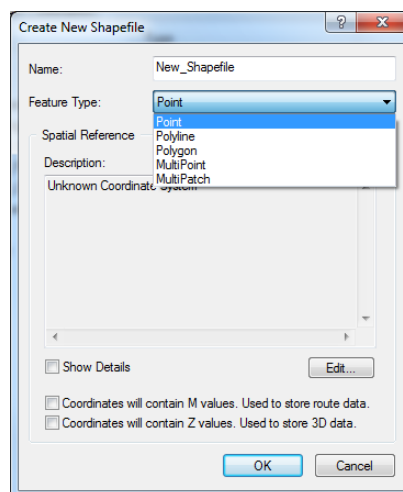
New data files can only be created in ArcCatalog. There are different ways to create new data files: You can open the context menu of the dataset in table of contents; Through the File menu (File > New) or with the right mouse click in the Data window. After which you can create either a new Shapefile or a new Geodatabase.



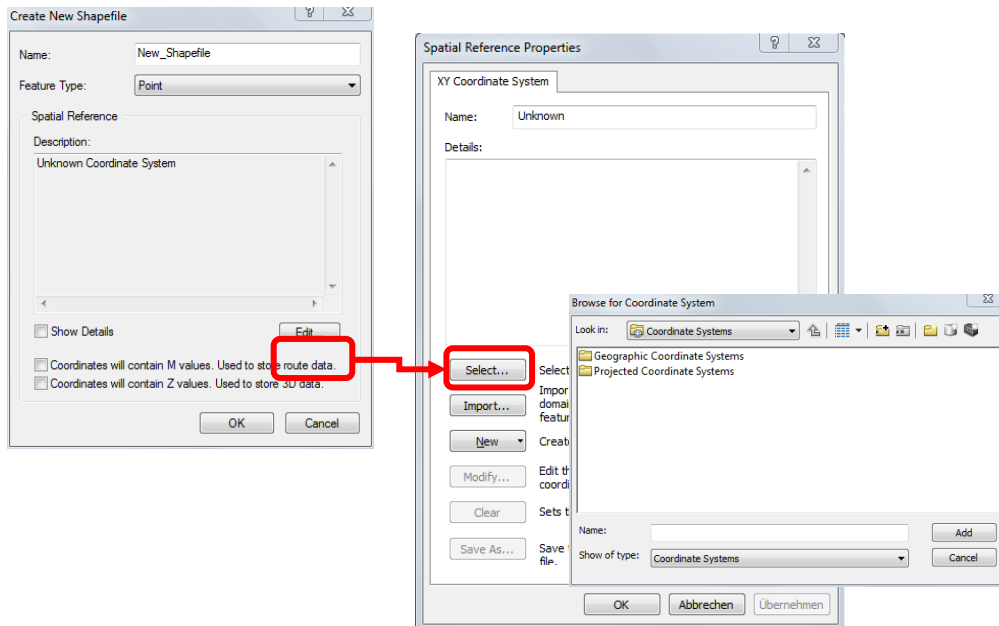
3.3.1 New Shapefile

The data format Shapefile is an established exchange format for geodata, which is used not only in ArcGIS. It is often called Shapefile or just Shape. A Shapefile is a collection of geographic objects with the same geometrical type (point, line or polygon), the same attributes (thematic data) and the same spatial extent. A Shapefile consists of at least *three* files: a file with the ending *.shp (geometry information), a *.dbf file (material data in the form of a dBASE table) and a *.shx file, which ties together the geometry data and the material data.

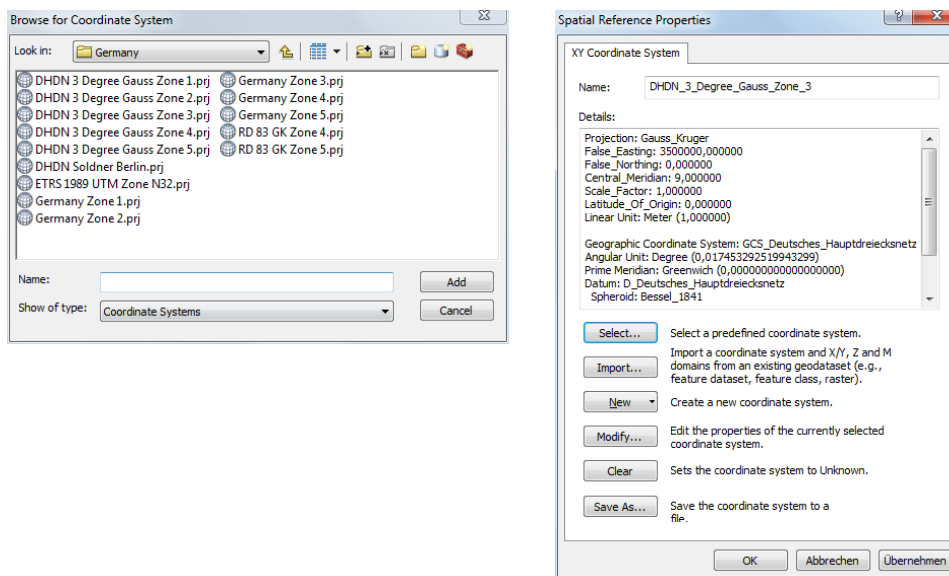
If you choose to create a new Shapefile, a *Create New Shapefile* window opens. In the window, you have to fill in the name of the new shapefile, a unique name without a blank in between is recommended. You also have to specify the feature type (point, line or polygon) the Shapefile will contain. Note that these properties cannot be changed once specified.



As the next step, a co-ordinate system must be assigned to the Shapefile. To define the coordinate system, click the *Edit Tab*. To use a predefined co-ordinate system, click on the *Select* button and the Spatial reference Properties window will open Browse for Coordinate system.



In the Browse for Coordinate system Window, choose for the spatial data in Hannover:
Projected Coordinate systems\National Grids\DHDN 3 Degree gauss Zone 3.prj

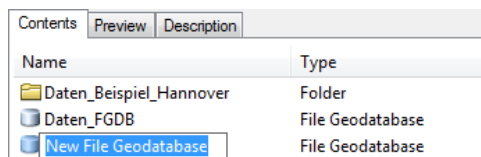


In the Spatial Reference Properties Dialog window, in the Detail frame, the parameters for the coordinate system are filled in. Confirm with OK and finally with another OK, a new but empty Shapefile is created.

3.3.2 New File Geodatabase

A Geodatabase organises geographic information in an object hierarchy. A geometry level is called feature Class. In it feature (objects) with the same geometry type and the same attributes are included. Several features Classes with same spatial extent can be grouped to a feature Dataset.

In ArcCatalog, you can create a new Geodatabase (New – File Geodatabase) file with *.gdb extension.



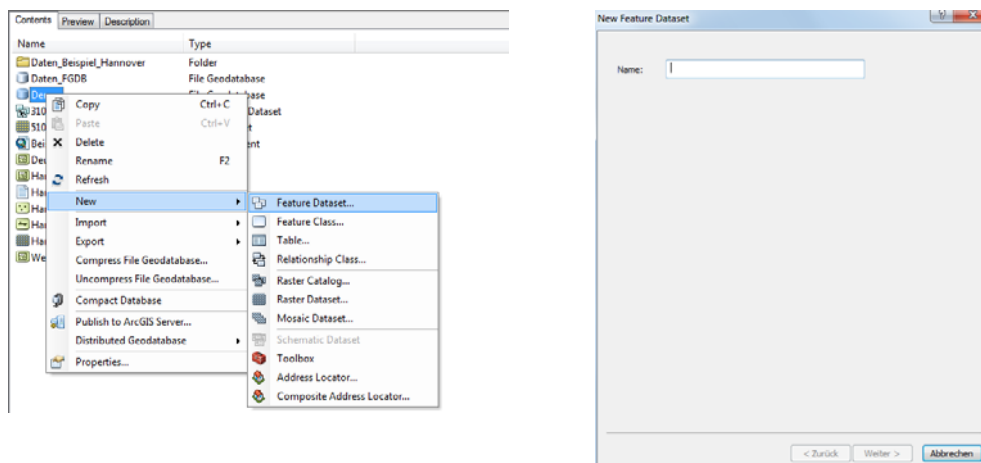
You can then specify a name for the new file Geodatabase. Note that the Geodatabase is empty.

You can import more files into the Geodatabase, for example, a Feature Class, more Feature Classes, one or more tables, one or more raster datasets. Through the context menu, you have to import, on the one hand, the possibility already available data in the file Geodatabase or to add new data. The various Geodatabase elements (described in section 4.4) that can be imported or exported are explained in the following sections. These include Feature Datasets and Feature Classes and Tables. You can also add new Feature datasets, a Feature Class or a table through the context menu.

3.3.3 New Feature Dataset

A feature Dataset is a collection of feature Classes in the same spatial extent and referenced to the same authoritative coordinate system (e.g., DHDN 3). A feature Dataset can contain furthermore networks (Geometric networks), relations (Relationship Class) or topology rules (Topology).

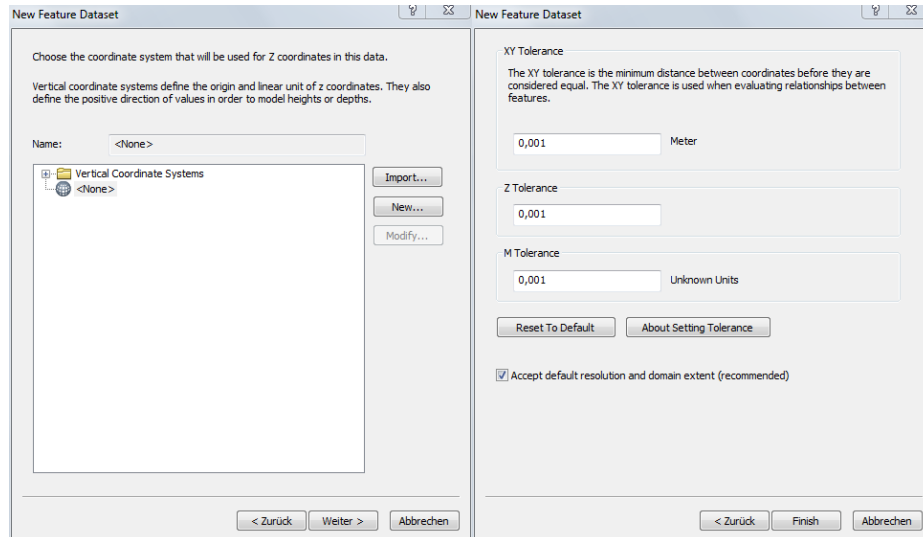
You create a new feature Dataset from the context menu of the Geodatabase. In the context menu select New Feature Dataset and input a name.



Afterwards you must fix the spatial reference for the feature Dataset. Besides, a co-ordinate system either from the given list predefined coordinate systems or the co-ordinate system of another file imports (import), a new one defines (New) or a customizing an existing one (Modify). For the geodata in and around Hannover which in the Gauss coordinate system lies in zone 3. You choose the projection file:

Projected Coordinate of system | Nationwide Grids | Germany | DHDN 3 Degree Gauss zone 3

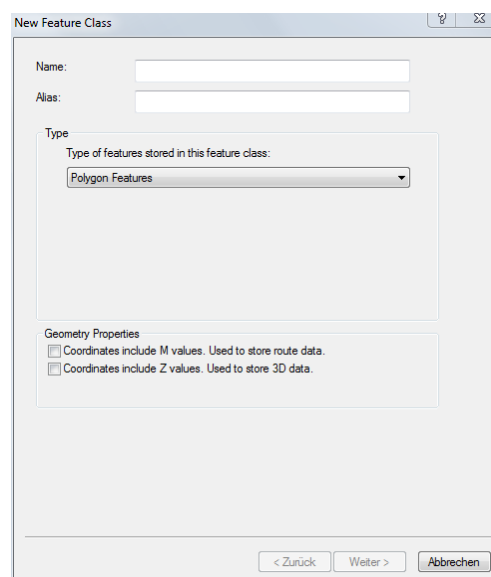
In the third step, a co-ordinate system of the height Z can be selected. Nevertheless, this is not necessary for most uses. Furthermore, the tolerances for X, Y, Z and m can be specified. However, the preset defaults can be accepted.



3.3.4 New Feature Class

A feature Class is a collection of geographic objects with the same geometrical type (Sharp, line or polygon), the same attributes and the same spatial extent. A feature Class can be contained either in a feature Dataset or directly (individually) in a Geodatabase.

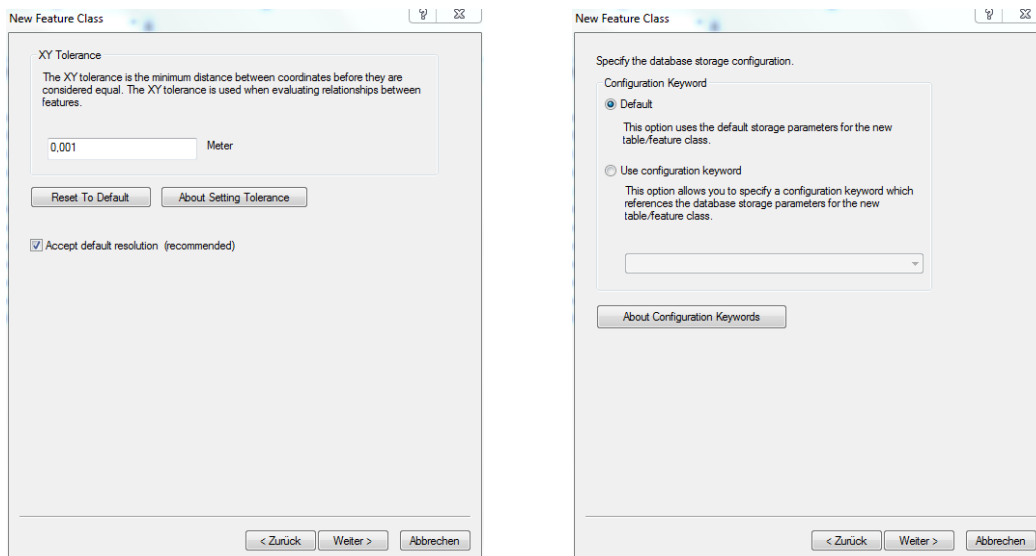
If you choose New – Feature Class, a Dialog window opens, which is similar to that for creating a Shapefile. In the New Feature Dialog window, you must specify the name of the feature class. The convention is that the name should not begin with a number, and no space is allowed between the characters in the name. Below the name, is the field for the Alias name, which can be specified. Finally, you have to select the Type of geometry of the feature from the list.



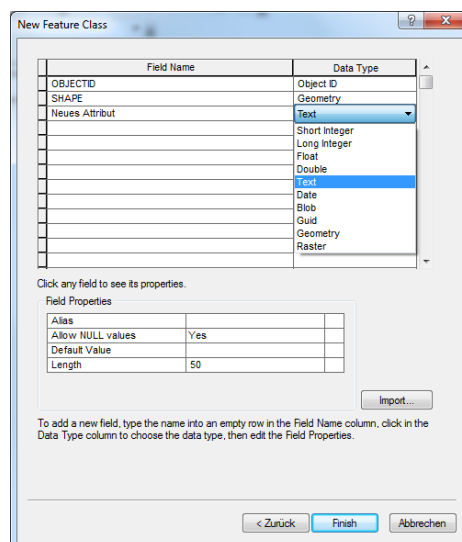
In the second step, you must specify the coordinate system for the feature class. The approach is by analogy with in segment 3.3.1. Again, for spatial data in Hannover:

Projected Coordinate systems\National Grids\DHDN 3 Degree Gauss Zone 3.prj

In the next step, the default X, Y tolerance of 0.001 m can be accepted.



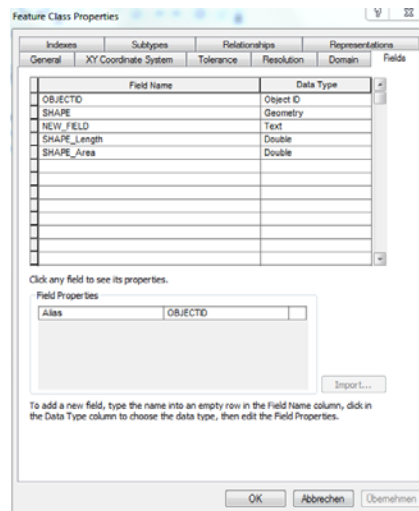
In the fifth step an overview of the attributes of the dataset or attribute table are displayed. The attributes OBJECTID (unique Object-ID) and SHAPE (geometry) are put on always automatically. At this point, you can add new attributes. Click on the line below the entry SHAPE and type the new attribute name. Besides, you must specify the data type of the attribute from the given list. The most common data types are integers, floating decimal point figures or text.



You can also add new attribute fields even after the creation the feature Class in the Properties or directly in ArcMap in the attribute table. Once all the specifications are filled in, the new feature Class is created by clicking *Finish* button.

If you choose properties from the context menu of the Feature Class, you will be able to have an overview of the Fields in the Attribute Table.

You will notice that two additional field SHAPE_Length and SHAPE_Area: are automatically added for a Polygon Feature Class. The length and area for individual features are automatically filled when the features are altered.

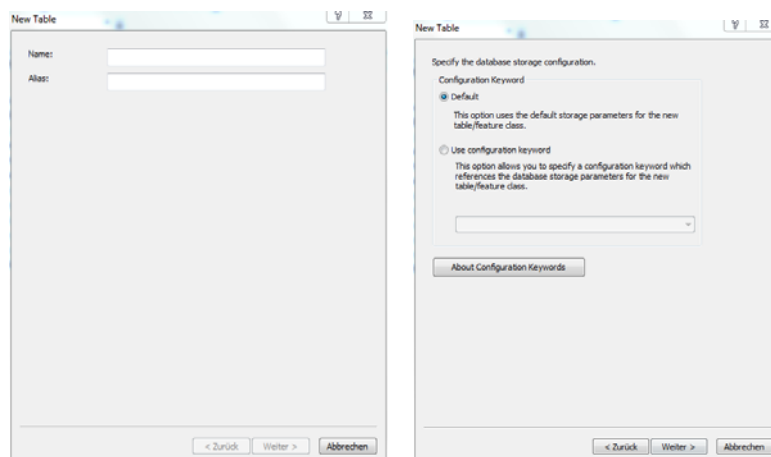


3.3.5 New Table

Though a normal table (without **binding connection** to geo-objects, i.e. without column SHAPE) can be provided within a Geodatabase, **it** however **cannot be contained** within a feature Dataset. Also beyond a Geodatabase, tables can be generated, however, one calls this dBASE tables (section 3.3.5.2).

3.3.5.1 New table within a Geodatabase

Through the *New Table* in the context menu of the Geodatabase, a dialogue window opens. A name for the *New Table* must be defined and an alias name can optionally be specified. The default configuration can be accepted.



In the next step, an overview of the attributes is presented. Because this kind of table contains no geometry as opposed to the feature Class, only the attribute OBJECTID is automatically generated. To add new fields, click on the line below the entry OBJECTID, type the field name and select a suitable data type from the given list. Under the Field Properties, an alias name can be defined, Null values and a Default value, which are automatically assigned to all objects during the process.

Field Name	Data Type
OBJECTID	Object ID
Name	Text
Vorname	Text
Geburtsdatum	Date
Anschrift	Text

Field Properties

Alias	Vorname
Allow NULL values	Yes
Default Value	
Length	50

You can add new fields. This can also be done through the Table Properties or directly in ArcMap. After all settings are carried out, click on finish button to confirm the creation of the new table.

3.3.5.2 New dBASE table outside a Geodatabase

A dBASE table can be created outside a Geodatabase. To generate a new dBASE table, choose from the context menu of the folder a *New dBASE Table*. ArcCatalog will create an empty file with the ending *.dbf. Please, provide a suitable name.

Name	Type
New_dBASE_Table	dBASE Table

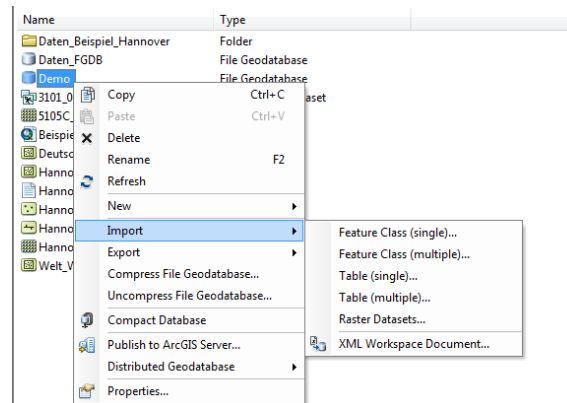
You can view the available attributes of the table from Properties window accessed via the context menu of the newly created dBase Table. The field OID (Object ID) is automatically generated in the system. Click on the line below the entry OID to add a new attribute and you provide name and select a suitable data type from the list.

Field Name	Data Type
OID	Object ID
Field1	Long Integer

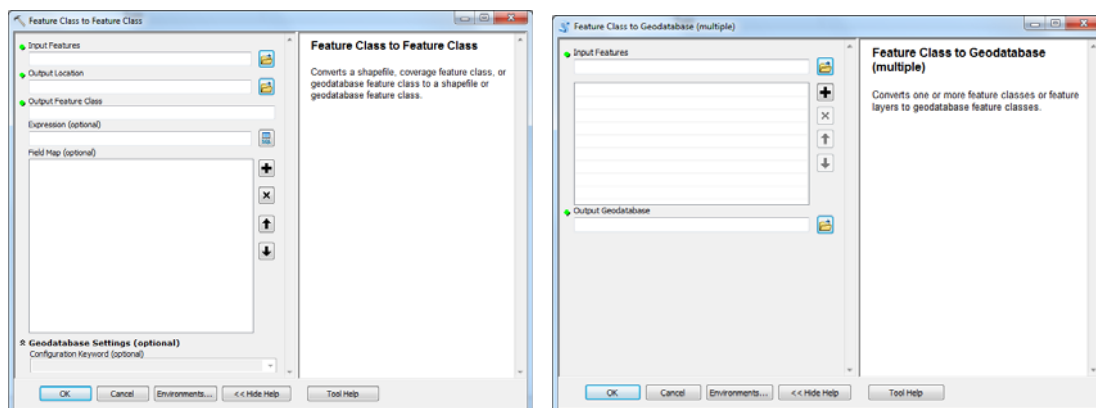
You can also add new attributes directly in ArcMap. The entry of the actual attribute values is possible only in the ArcMap and is obtained when the thematic data is captured.

3.4 Importing and exporting geodata in a Geodatabase

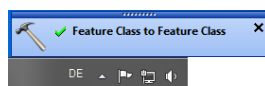
From the context menu of a file Geodatabase you have the possibility to import data, as for example a feature Class, several feature Classes, one or several tables or as grid records into your file Geodatabase.



Feature can be imported from either a Shapefile or other feature classes in another Geodatabase. Depending on what you import, a similar dialogue window opens in the following. On this occasion, all fields with which at the beginning a green symbol of a circle stands must be filled. Select input features to be imported from the Shapefile or the feature class and specify the output location and the name of the output feature.

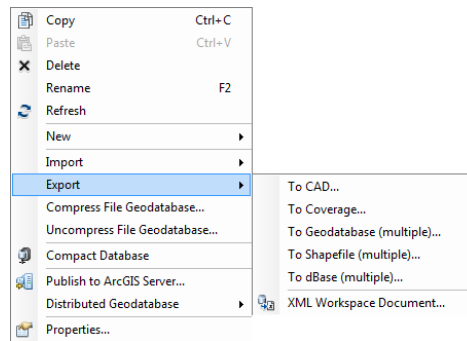


After you have specified all the necessary information, click the OK to begin import. Importing is successful if the following information appears at the right corner of your screen:



The procedure for importing one or several tables and importing of grid data is accomplished in a similar way.

With the export procedure, you have the possibility to export, e.g., data from a Geodatabase into another Geodatabase. However, it is also possible to convert feature classes into a Shapefile.

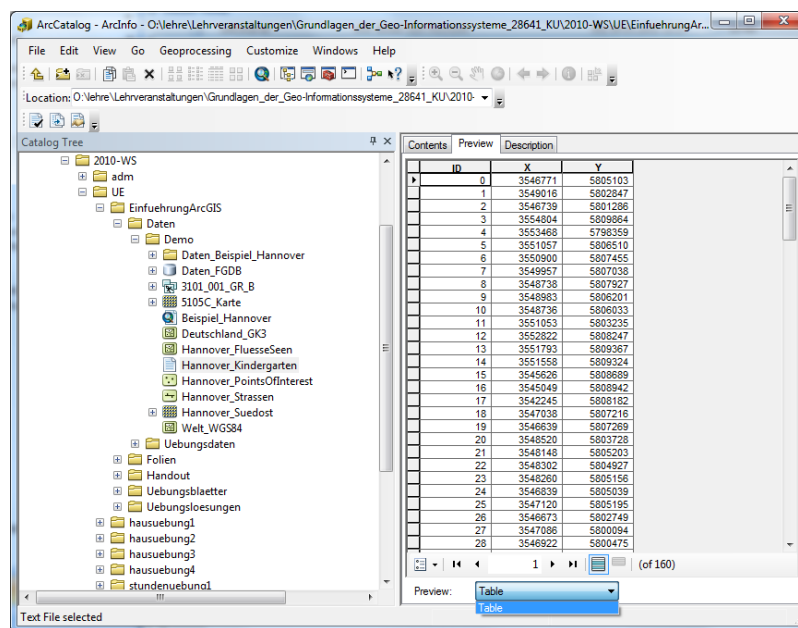


The import and export functions one can be understood as a copy function of geodata between two Geodatabases.

3.5 Converting co-ordinates in a text file or a table into a Shapefile

It is possible In ArcCatalog to convert a text file or a table (dbf table, Excel table) with X Y co-ordinates (or X-, Y-and Z co-ordinates) into a Point-Shapefile or directly into a feature Class in a Geodatabase.

Beside the geodata, ArcCatalog can also be used to view text files and tables. Nevertheless, in contrast to geodata, only the attributes are indicated with these thematic data in the Preview Tab and no geometry is available.



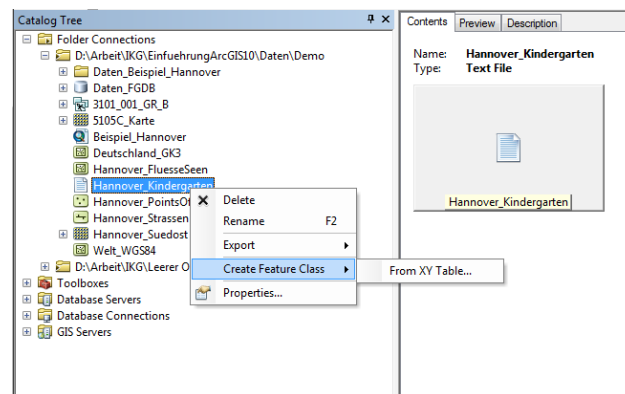
To be able to convert a text file into a Shapefile or a feature Class, the file must have the following structure:

In the first row, the names of the different columns (fields) must be listed.

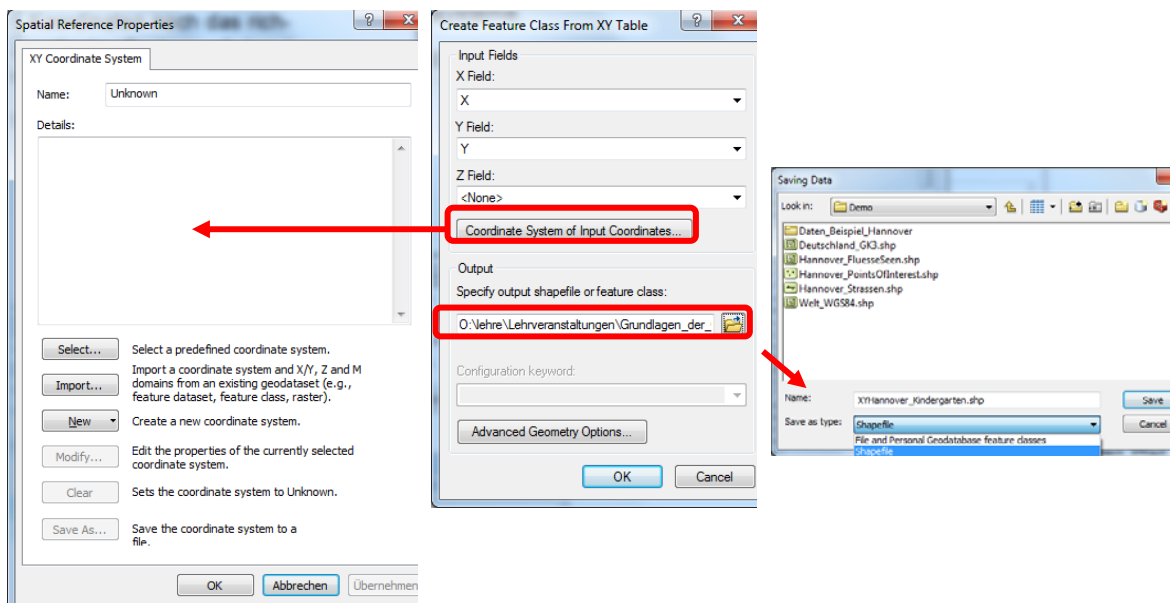
The single columns must be separated either by a tabulator or by a comma. It is important that in the first line the same hyphen be used like in the following example.

ID	X	Y
0	3546771	5805103
1	3549016	5802847
2	3546739	5801286
3	3554804	5809864
4	3553468	5798359
5	3551057	5806510
6	3550900	5807455
7	3549957	5807038
8	3548738	5807927
9	3548983	5806201
10	3548736	5806033
11	3551053	5803235

To convert the text file into a Shapefile you choose from the context menu of the text file the entry Create feature Class – From XY Table.




In the area of *Input* fields, you select from the list in each case the fields in which the X or Y coordinates are stored away. Afterwards, you have to specify the correct co-ordinate system for the feature class or shapefile. The Coordinate System of input Coordinates can be accessed from a list of the co-ordinate systems.

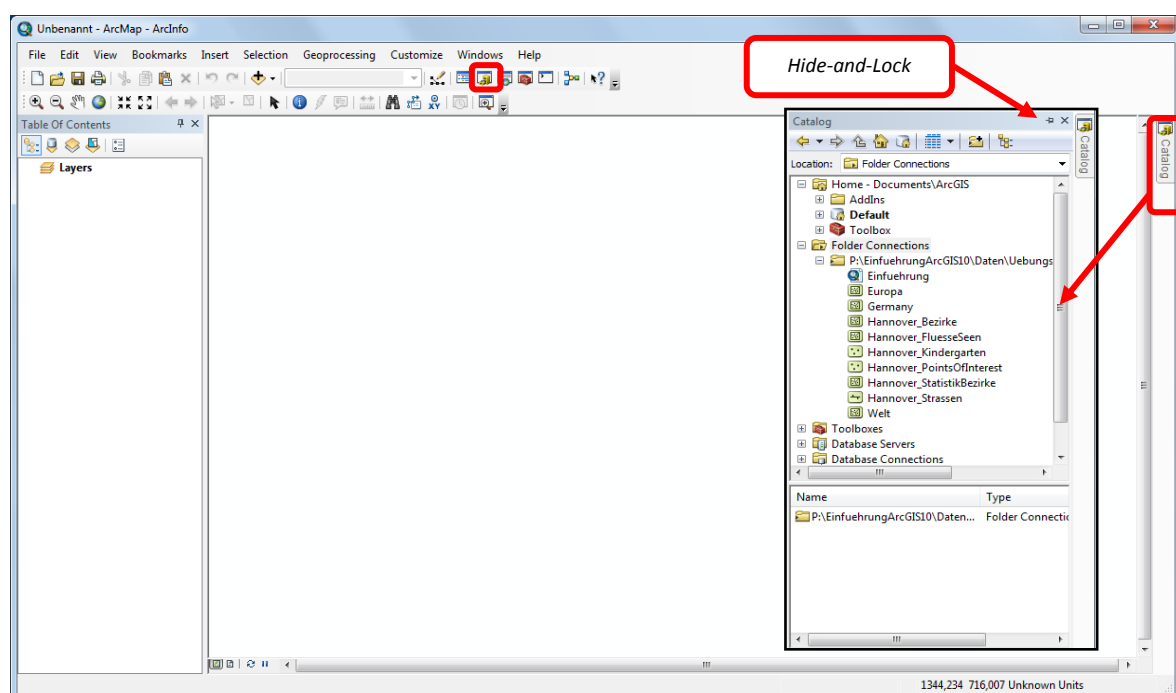


In the Output field, you specify a name for the file and select the path and the file type (Shapefile or feature Class). It can be that the new provided file is not immediately visible in the given folder. In this case from the context menu of the folder select Refresh or simply press F5.

3.6 Data management from ArcMap

Since the introduction of ArcGIS 10, advanced users have the possibility to carry out data management with ArcCatalog directly in ArcMap. Normally a small tab is docked in the right edge of the ArcMap window. Sometimes it is hidden; in which case, it can be activated with a click on . While crossing the field with the cursor the Catalog-Window opens. As long as the cursor is within this window, it remains open, but as soon as one moves outside the window automatically shuts. If one likes to have the Catalog-Window constantly, it is possible with the so-called Hide and Lock function. This function is hidden behind a small pin-like symbol beside the cross, which closes the Catalog-Window again.

The most important functions of ArcCatalog are slightly workable with it. This function is suitable for the data management functions, which must be carried out particularly fast.




4. Introduction to ArcMap

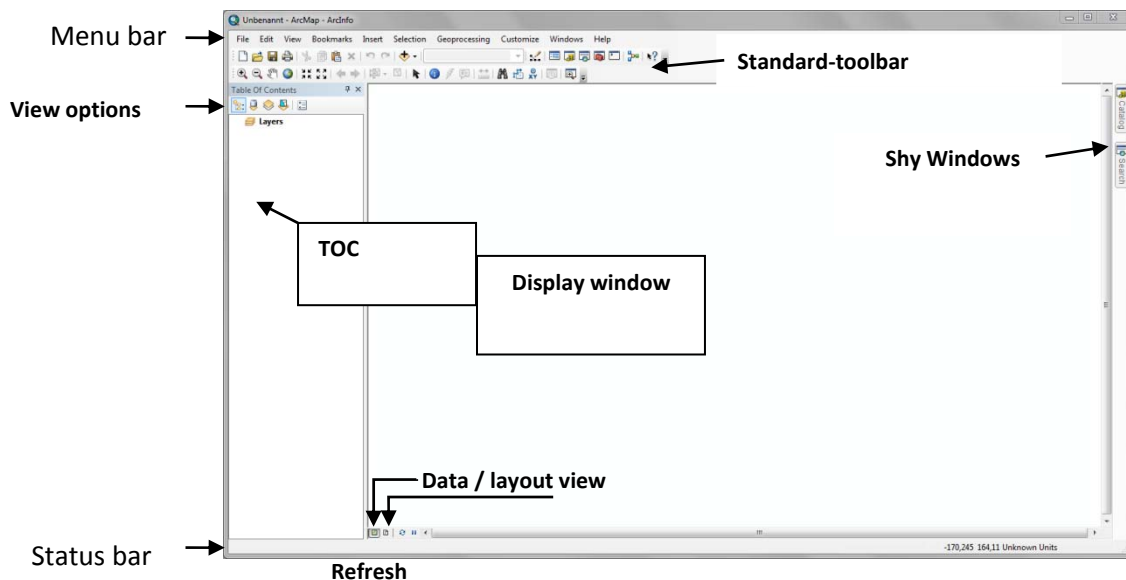
ArcMap is the central application in ArcGIS Desktop. It is the GIS application used for all map-based tasks including data capture, editing, analysis and cartography.

4.1 Starting ArcMap

The possible ways of starting ArcMap are-

- Click the Start button on the Windows taskbar > Point to Programs > Point to ArcGIS > Click ArcMap.
- Starting ArcMap from ArcCatalog using the launch ArcMap button  in the standard toolbar.
- By opening an ArcMap Document (.mxd file) in Windows Explorer or in ArcCatalog.

4.2 ArcMap User Interface



Title bar: displays the name of the ArcMap document.

Toolbars: contains many toolbars viz.

Main Menu: default tool bar with pull-down menu that contains file, Edit, View, Insert, Selection, Tools, Windows and Help. Click on these menus to select various options within each menu.

Draw: allows drawing and editing graphics/text on the map and layout.

Layout: allows display, zoom and scale layouts.

Standard: allows creating a new document, opening an existing document, saving and printing a document, editing functions, adding/editing map and data, opening ArcCatalog and ArcToolbox, opening Model Builder, and activating help.

Tools: allows working with data view frame or work space viz. displaying, zooming, selecting, identifying, finding and measuring features and elements.

Several other toolbars can be made active by right-clicking on the Main Menu toolbar or by clicking on the pull down Main Menu/View/Toolbar.

Status Bar: displays coordinates/units of the cursor in the Data View or Layout View.

Display mode: to toggle between layer, source and selection displays

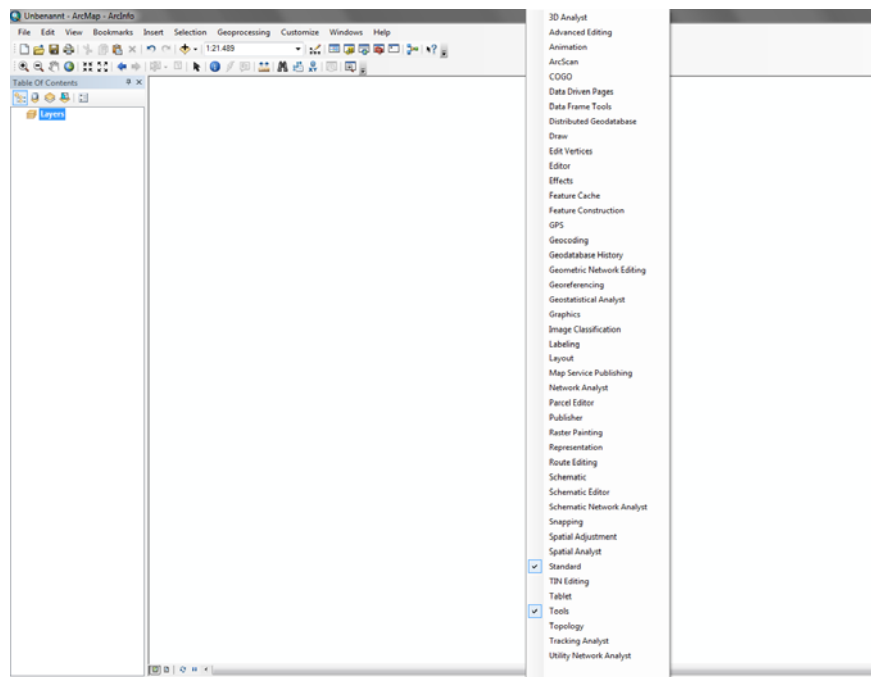
Data view is an all-purpose view for exploring, displaying, and querying the data on your map. This view hides all the map elements on the layout, such as titles, north arrows, and scale bars, and lets you focus on the data in a single data frame, for instance, editing or analysis.

Layout view: is where you prepare your map layout. In the layout view you will see a virtual page on which you can place and arrange map elements, and you can do almost everything you can in data view, plus design your map.

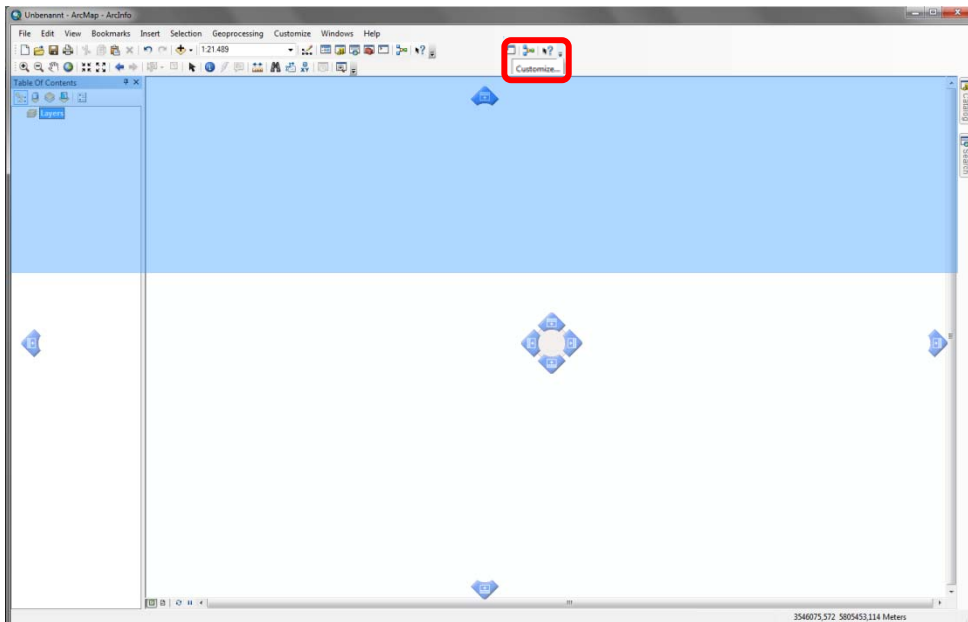
Shy Windows: all windows are dockable to the Sidebar (e.g., Catalog-, Search-, ArcToolbox-or Table of Contents-Window) and can be "hidden" in such a way that they become visible only while crossing with the mouse

4.3 Personal adaptation of ArcMap

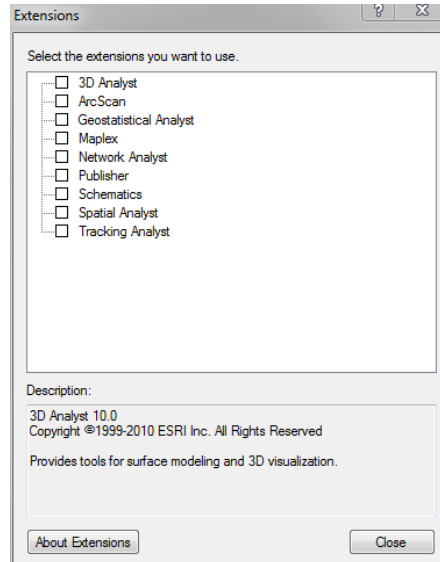
To customize the ArcMap interface according to the personal needs, there are numerous possibilities in the ArcGIS 10. Additional toolbars can be loaded to given standard-toolbars there. This happens with a right mouse click in the toolbar area or on any the menu item and then choose customize - tool bars. Now the required toolbars can be selected from the indicated tools. The selected toolbars automatically opens. The toolbar can be pushed to or docked at any place in the ArcMap window.



If one likes to position, for example, the table of contents or the "Catalog-Window" at another place other than the default position, this can be done by using the Drag & Drop function. The blue arrows allow automatic docking of the window on the respective side.



Further customizations are possible through the Customize option. They can call the function either by the click on the arrow at the right end of every toolbar or from the menu item list *Customize - Customize mode*. Under the same menu items together with the Extensions can also be turned off, i.e. if one would like to use one of the ArcGIS Extensions (e.g., the 3D-analyst), these are activated first in the under the menu *Extensions*. Afterwards the toolbar will appear deactivated.



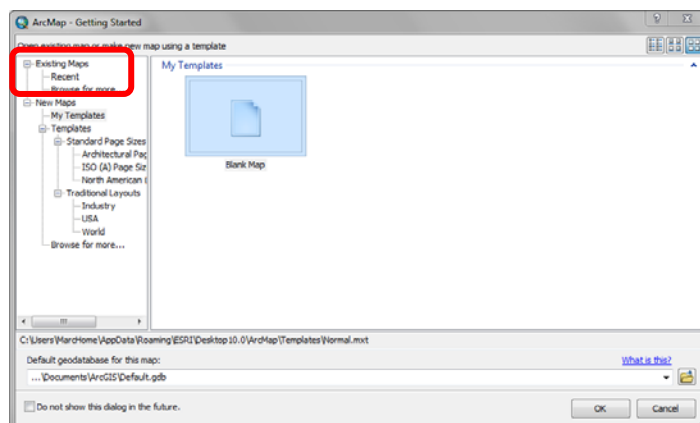
4.4 ArcMap Document

When working in ArcMap, you work with a Map Document (ArcMap Document), which is a (.mxd) file containing a map, its layers, display information and other elements used in ArcMap.

4.4.1 Opening a new or an existing ArcMap Document

After starting ArcMap from the Start button either on the Windows taskbar or from ArcCatalog, a Start-Dialog opens up. You can either open a new ArcMap Document (a new empty map) or open an

existing ArcMap Document. When ArcGIS 10 is launched, a new empty map automatically opens. Should one wish to open an already existing project, this can be searched under the list of Existing Maps.



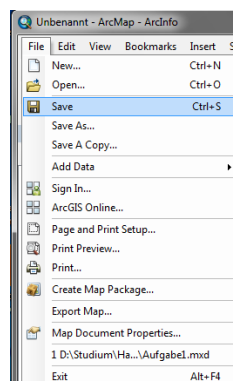
It is also possible to use preset Templates, like, for example, of a topographic overview of the USA or the world.

Alternatively, you can open an existing ArcMap Document (mxd-file) in Windows Explorer by double clicking on the file.

Name	Änderungsdatum	Typ	Größe
5105C_Karte.tif.xml	13.11.2008 09:02	XML-Dokument	11 KB
Beispiel_Hannover.mxd	23.10.2008 22:49	ESRI ArcMap Doc...	238 KB
Deutschland_GK3.dbf	01.11.2007 16:51	DBF-Datei	1 KB

4.4.2 Saving ArcMap Documents

Save the map by clicking on the File tab on the Main Menu toolbar. The Save dialogue box will pop up. Name the document, navigate to the location and click Save. The map will be saved as ArcMap Document (.mxd), which will contain all the working layers and referenced data.



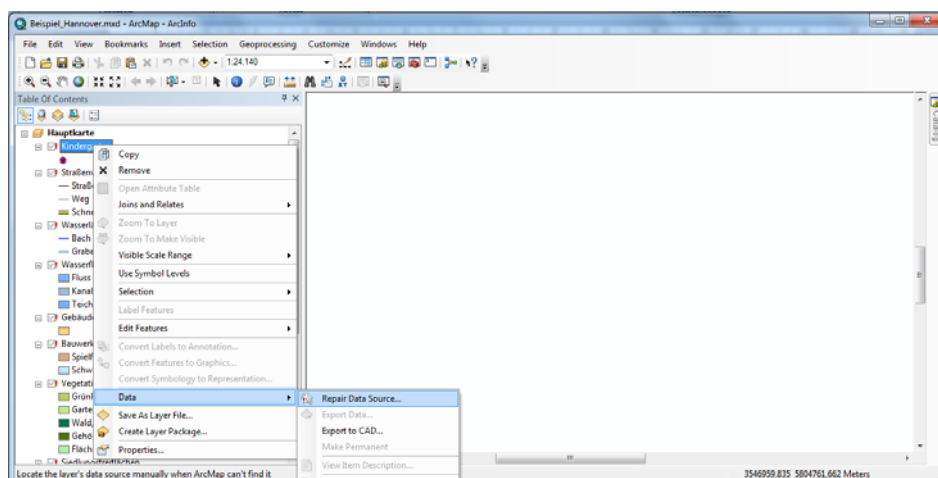
Note:

No data is stored in an ArcMap Document, but reference to the data sources. The Document contains settings such as Layer zoom settings, and reference to data sources.

4.4.3 Repairing Broken Data Links

When you first open a map, ArcMap searches for the data referenced by the layers on the map. If it cannot find the data, for example, if the data has been moved the layer will not display. You can immediately tell which layers on your map have broken links because you will see a red exclamation mark next to their name in the table of contents. If you know the new location of the data, you can repair the link.

Locate the layer with the broken link in the table of contents. It will have a red exclamation mark next to it. Then Right-click the layer, point to Data, and click Set Data Source and navigate to the location of the data source and then click *Data – Repair Data Source*.

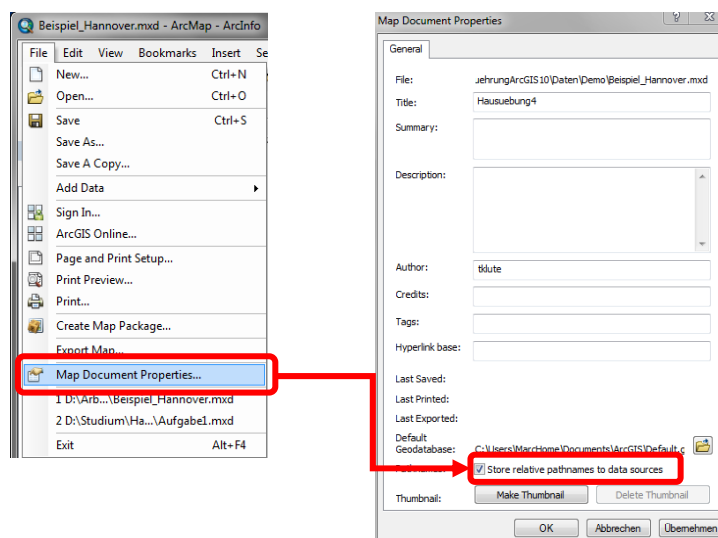


4.4.4 Data Source with Relative Path name

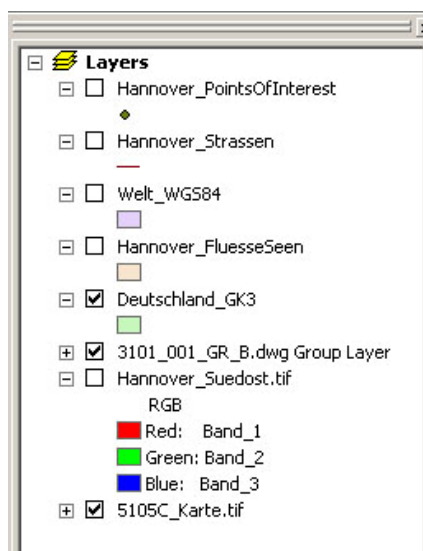
If you plan to distribute your maps to others, they will need access to the data referenced on it. If you have access to the data, for example, data stored on a server, the ArcMap document simply updates the references to the data if necessary. Otherwise, you do not have access to the data; you will probably have to distribute the data with your map (ArcMap document).

To make it easier to distribute data with your map, ArcMap allows you to store relative pathnames to data sources referenced on a map. This allows you, for example, to distribute your map and data in the same directory. The references stored in the map would be correct regardless of where they were placed on disk.

Click the File menu and click Map Properties. Then click Data Source Options > Click Store relative pathnames.



4.5 Basic ArcMap Elements



Contents: displays and manages (group, ungroup, activate, access layer properties, etc.) all the layers (and its source) and symbology of the layers.

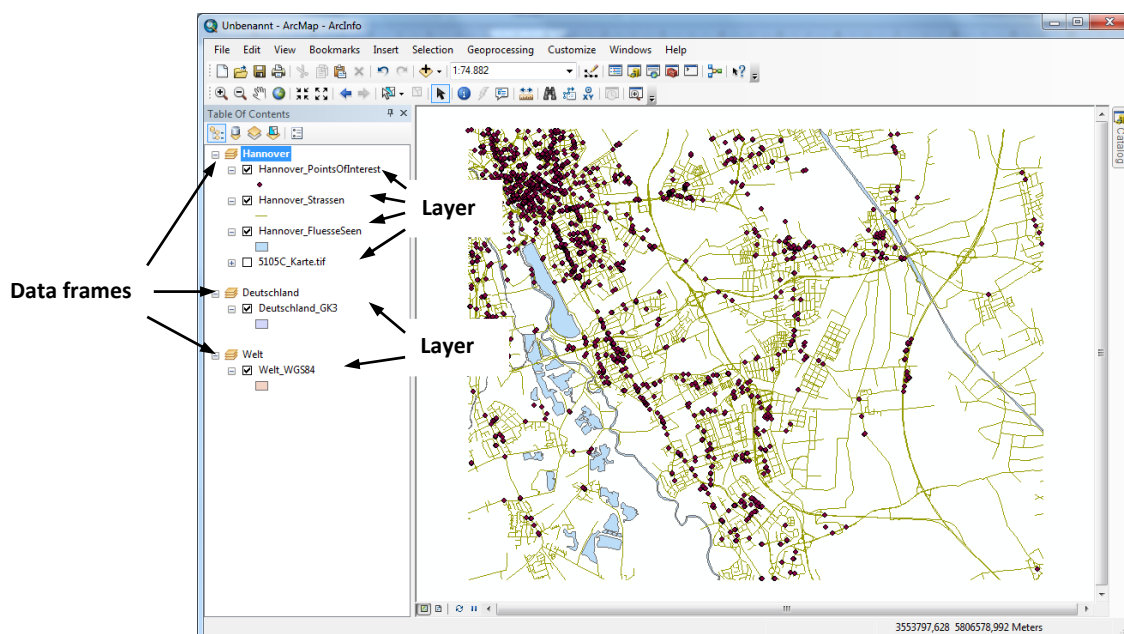
Data Frame: workspace that allows displaying and working with maps. Data Frame displays maps as layers that are checked in the Table of Contents. Each displayed layer does not store the actual geographic data but it references data stored in shapefiles, Geodatabase, etc.

Layers: A layer contains information about how to display the dataset, but not the dataset itself. Each data frame contains one or more layers. Any datasets you add to the map are represented as layers in the Table of Contents. Checking the box next to each layer will display the map elements. The order of the layers will display map elements in that order.

Feature Class: is composed of geographic features with the same type of geometry (point, line, or polygon) and the same set of attributes

Shapefile: is a feature class in a Geodatabase. It contains features and is represented as a layer

Feature: a feature is single geometric object. Each layer includes features and thus objects that represent real world features.

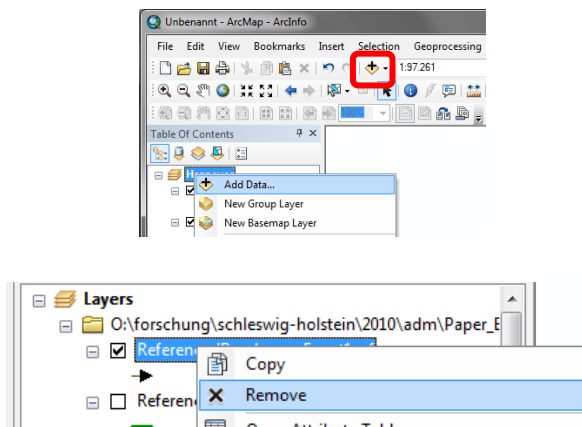


5. Adding and Viewing Data in ArcMap

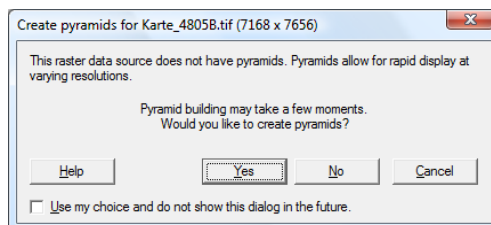
5.1 Adding and Removing Data

To add layers for display click on Add Data icon  located on the Standard Toolbar. Alternatively, through the content menu (right click) of the data frame.

- Then navigate to the data folder where the data is stored.
- Once the data is loaded, it is then displayed as a layer in the data window.



If a raster file (image) is loaded, the following window appears that requires you to indicate if you would like to create pyramids:



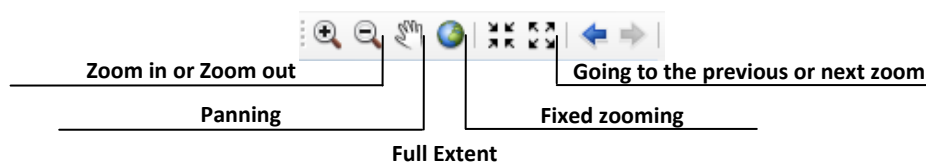
You will always be prompted to build pyramid layers every time you add a raster image to the Data Frame in ArcMap that does not already have pyramid layers. If you zoom in more on an image, the more finely the resolution of the image becomes. The "pyramids" are used to render an image in ArcMap quickly at various scales, for example; a low-resolution image is rendered at very small resolution faster. During the creation of image pyramids, resampling (new calculation of the grid data) is carried out. Besides, a resolution reduction is carried out. An additional file with all necessary pyramid information is generated which is stored in the same place like the image and has the extension (*.rrd). Nevertheless, the old image file does not changed by the when pyramids are created.

To remove data from the ArcMap document, click with the right mouse key on the Layer to be removed and select *Remove* from the context menu.

5.2 Navigating in the Display Window

As you work with a map, you can easily change how you view the data it contains. When you're just browsing a map, you might want to pan and zoom around the data to investigate different areas and features.

Most of the tools for navigating your data are found on the Tools toolbar.

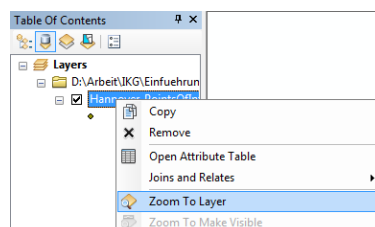




To zoom in or out, click the *Zoom In* or *Zoom Out* button on the Tools toolbar. Then move the mouse pointer over the map display and click once to zoom around a point. Alternatively, click and drag a rectangle defining the area on which you want to zoom in or out.

Zooming In or Zooming out can be fixed at a particular factor, for example, 75% or 125% of the actual zoom scale. The fixed zooming buttons on the toolbar achieve this

To pan, click the *Pan* Button on the Tools toolbar. Move the mouse pointer over the map display and click and drag the pointer. You can also pan the map in data view by dragging the scroll bars.

With the Full extent zoom, all the layers will be displayed; to zoom to a particular layer, right click on the layer to select *Zoom to Layer* from the context menu.



If the data view has been changed by zooming in or out or by panning, you can go back or forward to the next extent by clicking the *Go Back to Previous Extent*  or *Go To Next Extent*  buttons on the Tools toolbar.

Note:

If your map has more than one data frame, panning and zooming will occur in the active data frame. In layout view, clicking a data frame will activate it.

5.3 Navigation with the keyboard

Key combination	Function
Arrow keys ←↑↓→	Pan the map in the any of the four directions (Note: If however any graphic is selected, then only that graphic is panned)
+ / -	zoom in or out. The same function like Fixed Zoom In and Fixed Zoom out of the toolbar.

[Insertion]	<i>Full Extent</i>
[Home] and [End]	Panning to the left and the right respectively.
[Page ↑] and [Page ↓]	Panning up and down respectively
[Ctrl] and [Tab] simultaneously	Change from one data frame to the next
[Esc]	Put keyboard focus back on the map from the Table of Contents window
[Shift] and [F1] simultaneously	Context sensitive help
[F2]	Rename selected item
[F3]	Set focus on the legend
[F4]	opening a choice list
[F5]	Refresh (update) map
[i]-Taste	Changing between zoom in, zoom out or Panning is active
[F9]-Taste	Interrupting a process
[F12]	Opening the properties window of an element

5.4 Navigation with the mouse wheel

Key combination	Function
Roll the mouse wheel backward and forward. Hold down Ctrl for a finer zoom	Zoom in and out.
Click mouse wheel. Ctrl + click to center and zoom in.	Center maps
Hold down Q and move mouse, or hold down mouse wheel until cursor changes, then drag mouse.	Roam

5.5 Temporary change in the Navigation mode

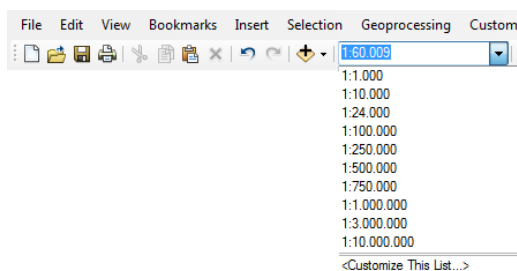
Key combination	Function
Hold down [Z]	Temporarily change to Zoom In tool.
Hold down [X]	Temporarily change to Zoom Out tool.
Hold down [C]	Temporarily change to Pan tool.
Hold down [B]	Temporarily change to Continuous Zoom/Pan tool.

All these short cuts and more can be found in the following link:

<http://www.esri.com/library/brochures/pdfs/arcgis-desktop-tips.pdf>

5.6 Setting the Map Scale

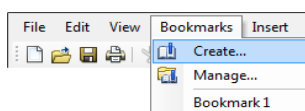
You can specify the scale of your map by either typing in a value or choosing one from a list. When you specify a scale, the map is zoomed to that scale.



If the text field for the scale is deactivated, you cannot enter the scale value. Activate the text field through the context menu of the data frame under properties, in data frame tab tick the Automatic checkbox.

5.7 Bookmarks

A *spatial bookmark* identifies a particular geographic location that you want to save and refer to later. For example, you might create a spatial bookmark that identifies a study area. That way, as you pan and zoom around your map, you can easily return to the study area by accessing the bookmark. You can also use spatial bookmarks to highlight areas on your map you want others to see.

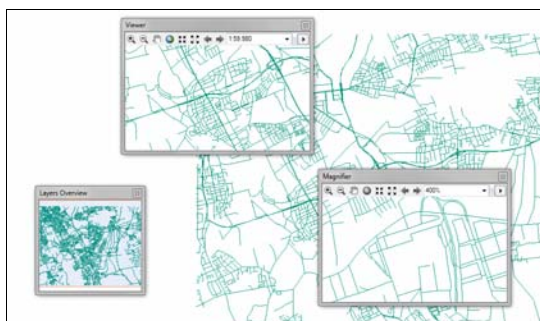


Pan and zoom to the area where you want to create a bookmark. In the main menu, *Bookmarks > Create*.

To use the Bookmark, click the Bookmark menu, point and click the name of the bookmark you want to use. The bookmarked display appears.

5.8 Overview, Magnifier and Viewer Windows

When you do not want to adjust your map display, yet you want to see things a bit differently - see more detail or get an overview of an area - open another window. ArcMap provides two additional ways to explore the spatial data on your map through an overview and a magnifier window.



The overview window shows you the full extent of the data. A box in the overview window represents the currently displayed area on the map. You can move this box to pan the map and shrink or enlarge it to zoom in or out.

The magnifier window works like a magnifying glass: as you pass the window over the data, you see a magnified view of the location under the window. Moving the window does not affect the current map display.

A viewer window behaves like an independent view onto the map, and you can use any of the ArcMap interactive tools inside the window.

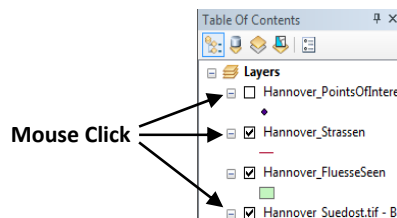
Note:

Click the arrow button to switch to a viewer window, flash or pan to the location, or set additional properties. Both windows operate only in data view, and are accessible through the Window menu.

6. Layers and Data Frames in ArcMap Document

6.1 Layer visibility using checkbox

- By default, each layer in the Table of Contents is symbolized by a single symbol for all features, with the symbol displayed following the layer and with the layer displayed in the ArcMap Display Window (indicated by a checkbox preceding the layer name in the Table of Contents)



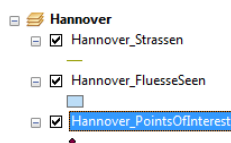
- To switch a layer so that it is not displayed in the ArcMap Display Window, you would click on the checkbox so that the box is empty (not checked). The Map Display will redraw without the layer
- The second box to the left of the layer display checkbox controls whether the symbol for the layer is displayed in the Table of Contents. By default, all symbols are displayed indicated by a minus sign. This is similar to (+/-) in windows explorer, controlling whether the contents of the tree are expanded and displayed in the tree view.

6.2 Layer drawing order principle

The order of layers in the table of contents determines how layers are drawn on a map. Within a data frame, the layers listed at the top will draw over those listed below them, and so on down the list. You can easily move layers around to adjust their drawing order or organize them in separate data frames. Normally, point, line, polygon and raster layers are organized in that order.

In the table of contents, click and drag the layer up or down. A black line indicates where the layer will be placed. Release the mouse pointer to drop the layer in its new position.

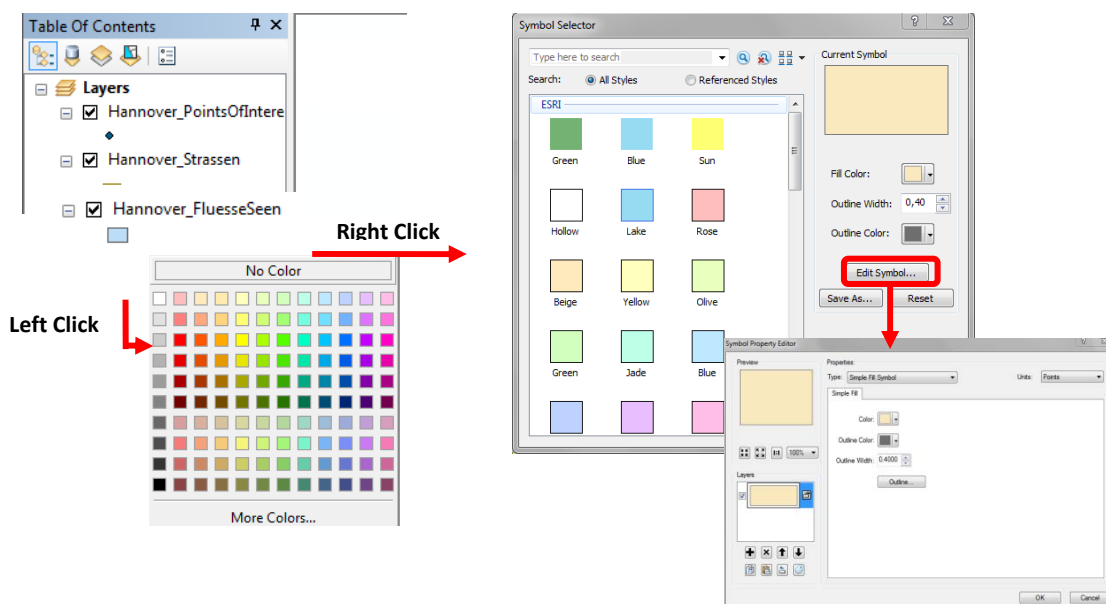
Tip: If one of your layers fails to display, check that it is not beneath another solid filled polygon layer.



6.3 Changing symbols

When you add a layer to your ArcMap Document, the layer is automatically symbolized. The symbol and colour of the layer can be changed and customized.

From the Table of Contents in ArcMap, right clicking the mouse over the symbol and then selecting the colour from the colour palette can change the colour of the layer. Left clicking the mouse will allow you to select a new symbol for the layer from symbol selector window.

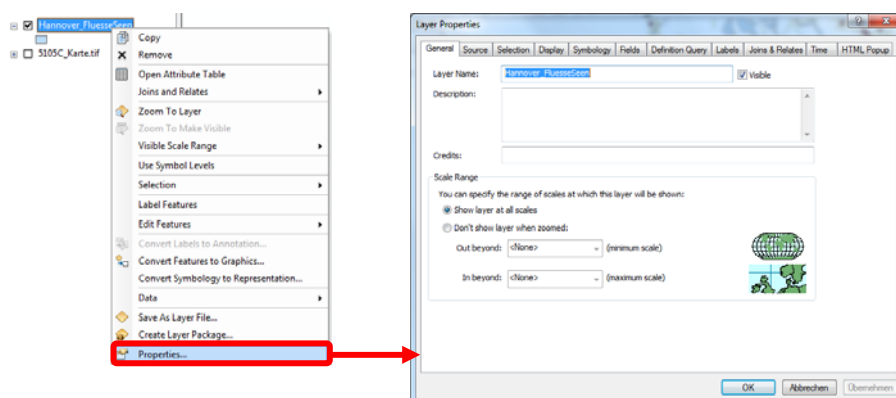


You also have the possibility to change some properties of the symbols individually, e.g., the width and colour of a borderline. This is achieved with a click on the Edit symbol.

6.4 Layer properties

You control all aspects of a layer through the layer's properties. From here, you can define how to draw the layer, what data source the layer is based on, whether to label the layer, and what attribute fields the layer contains.

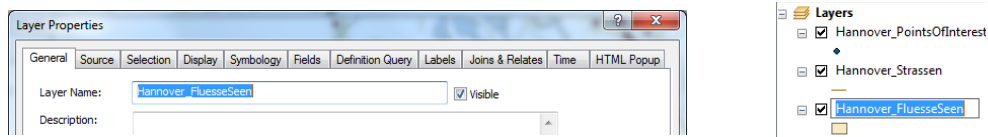
To set and display layer properties, Right-click the layer in the Table of Contents and click Properties. Then click the tab containing the properties you want to adjust.



The Layer Properties dialog box will be different for different types of geographic data. For example, defining the symbology of a vector data source will be different from a raster dataset. If you have write permission for the data, you can change the layer's properties such as its symbology. Generally, the Properties window contains the following tabs: (*General, Source, Selection, Display, Symbology, Fields, Definition Query, Labels, Joins & Relates, Time* and HTML Popup).

6.4.1 Changing Layer name

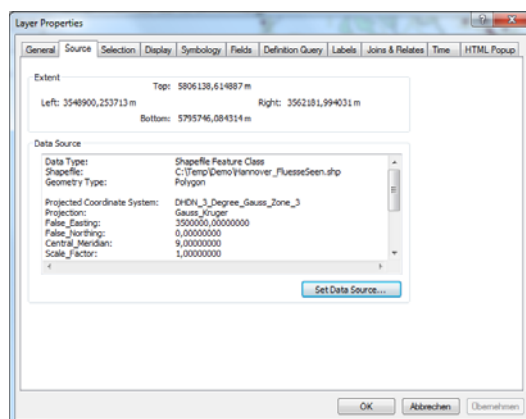
- The name of the layer can be renamed in the General Tab in the Layer properties window



- Another way to change the layer name is to click on the layer to make it active, and then click again to change the name.

6.4.2 Layer's Data Source

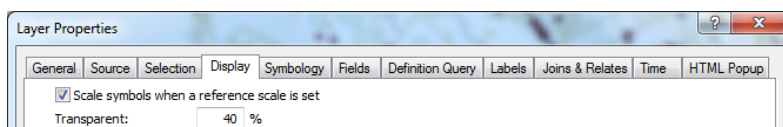
When the layer's name is changed, the name of the dataset is not changed. To find out the source directory of the dataset, select the Source Tab from the Layer properties window.



In the example above, the layer "Hannover-Strassen" is referenced as "Hannover_Strassen.shp" in the location "C:\Data\" and is of type line; projection is Gauß-Krüger coordinate System.

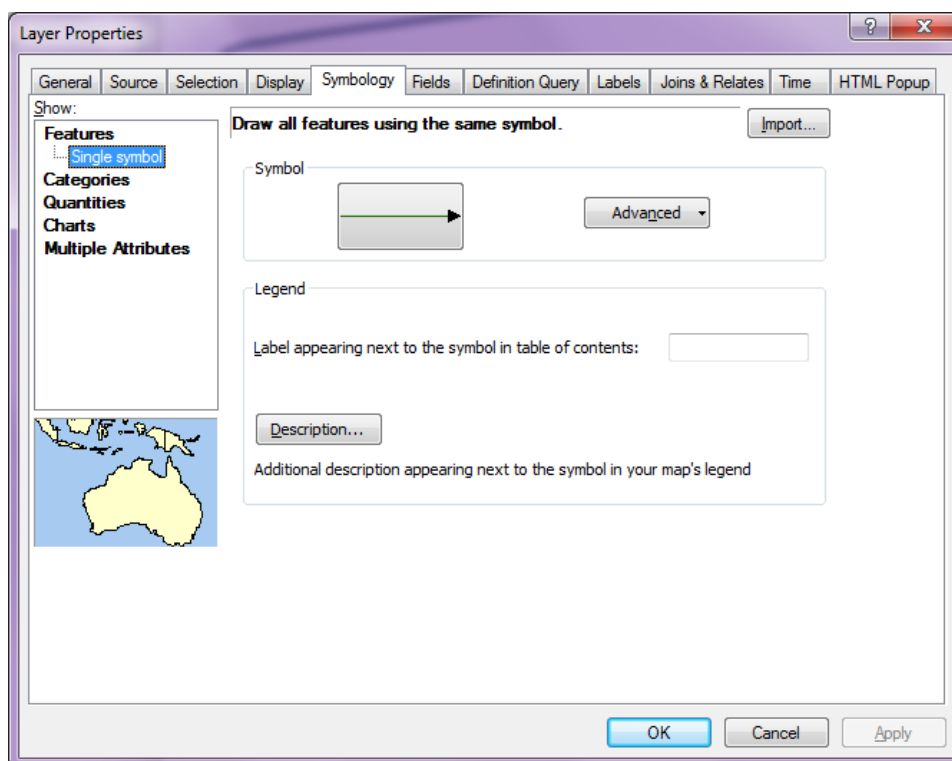
6.4.3 Layer transparency

Changing layer's transparency allows you to see map features that lie underneath the layer. From the Display Tab of the Layer Properties window you can change the transparency between 0% - 100%. When transparency is 0%, it simply means that the layer is not transparent.



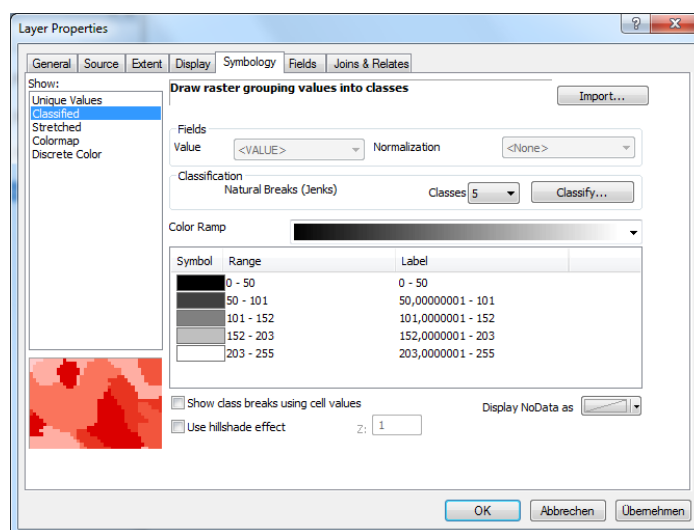
6.4.4 Customizing layer symbology

When you create a new layer, ArcMap by default draws it with a single symbol. You can change this quickly by *click the symbol in the table of contents to display the Symbol Selector* or by clicking the Symbology tab in the Properties window. Clicking Features, ArcMap automatically selects "single symbol" because it is the only option. Click the symbol button, opens the Symbol selector dialog where you can select your symbol.



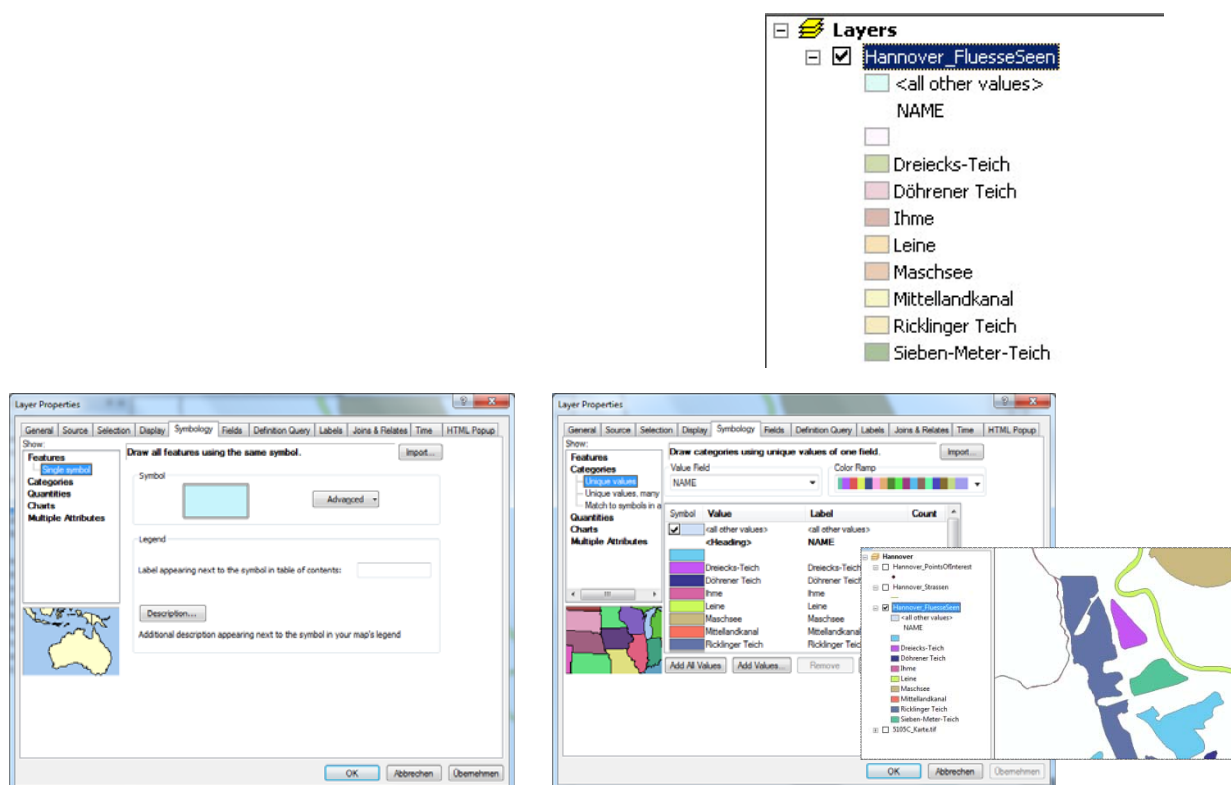
In the left area of the properties window, you find different representation methods. These differ according to data type. The following possibilities are available for the visualisation of a raster (number of the representation types are available depending on the type of the raster file):

- Single Symbol: This is the simplest method of symbolizing your data. It is used when there is no need to distinguish between categories within an attribute field.
- *Unique Values*: This method of symbolizing is appropriate when you would like to group features based on an attribute in your table.
- *RGB Composite*: Displays a raster dataset as a *RGB* composite.
- *Classified*: Draws raster grouping values into classes
- *Stretched*: Stretches values along a colour ramp (e.g., an aerial Photograph in grey -scale).
- *Colormap*: Renders data with a fixed set of colours



The following possibilities are available for the representation of vector data:

- *Features*: All features are drawn using the same symbol
- *Categories*: This method of symbolizing is appropriate when you would like to group features based on an attribute in your table.
- *Quantities*: If you have quantities in your attribute table and would like to display these quantities in relationship to specific features, you can use graduated colors, graduated symbols, proportional symbols, or dot density.
- *Charts*: Different attributes can be displayed in a chart
- *Multiple Attributes*: Features can be rendered based on more than one attribute.



Representing Quantities

When you want your map to communicate how much of something there is, you need to draw features using a quantitative measure. This measure might be a count; a ratio such as a percentage; or a rank such as high, medium, and low.

You can represent quantities on a map by varying the colour or symbol size you use to draw features. For example, you might use increasingly darker shades of blue to represent increasingly higher rainfall amounts or larger circles to represent cities with larger populations.

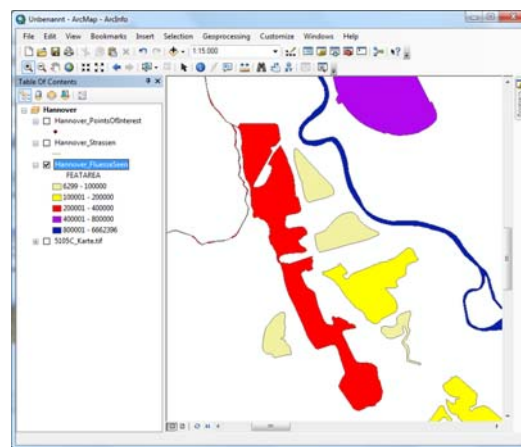
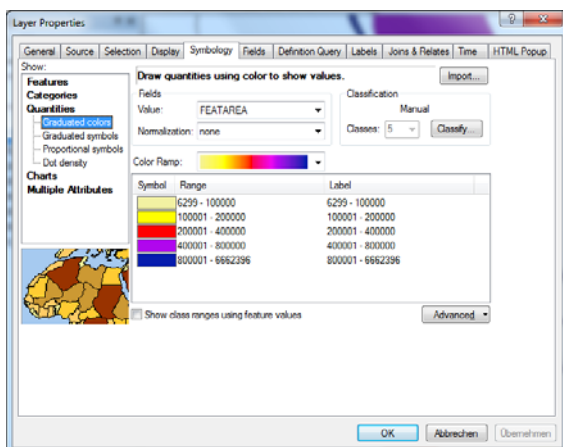
Generally, you will need to classify your data when you display it. Classifying data groups features with similar values into discrete classes and displays them with the same symbol. You can either manually define classes or apply one of the standard classification schemes to do so automatically, just specify the number of classes you want to show.

The preset representation for vector data is *features*: the same symbol for all features in a Layer. The methods for symbolising features in ArcMap have already been introduced in section 6.3. Another

possibility to customize symbols is described here below. Another representation method for vector data is the representation based on attributes. To show features with identical attributes with the same symbol,

- Choose *Categories* then *Unique Values*.
- Under Value Field, you determine which attribute of the layer to be used for symbolization.
- Click on “Add all Values”, so that the categories from all values can be generated. In this manner, the features, which contain the same value in the suitable field, are summarised into a common category and are shown accordingly with the same Symbology. Beside the given colour pattern, the symbolic colours of the single categories can be also changed by hand by the click on a single symbol. The column Value corresponds to the attribute values of the record. In the column label, you can change the description for the attribute names by hand.

The *quantitative* representation method is introduced here only briefly. You use a quantitative representation if you want to show how much of something is where. The values refer to numerical values and can be shown with different colours or different symbolic dimensions. Besides, you can create classes manually or use the given classification procedures. Try out yourselves a few settings.



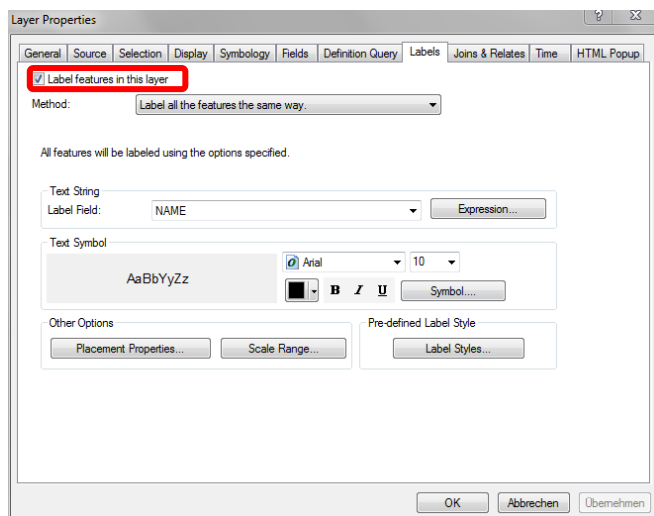
6.4.5 Labelling of features

Labelling is the process of placing a descriptive text string next to one or more features on your map. Labels help a map reader to interpret a map.

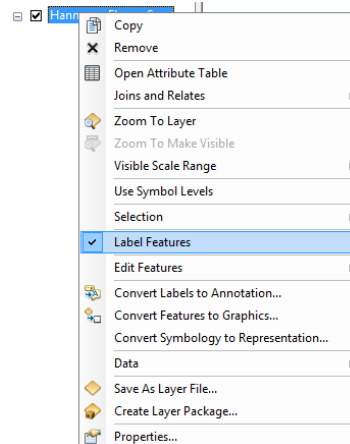
When you want to label all the features in a layer, or in several layers, turn dynamic labelling on in ArcMap. With dynamic labelling, ArcMap automatically places a label next to each feature as long as there is space to display it without overlapping other labels.

- (i) In the table of contents, right click the layer you want to label and click Properties. Click the Labels tab. Check Label Features. Click the Label Field dropdown arrow and click the field you want to use as a label. Click OK.
- (ii) In the table of contents, right click the layer and check Label Features to turn dynamic labels on. Uncheck Label Features to turn them off.

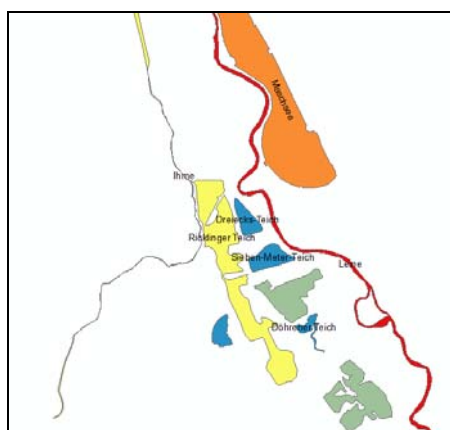
(i)



(ii)

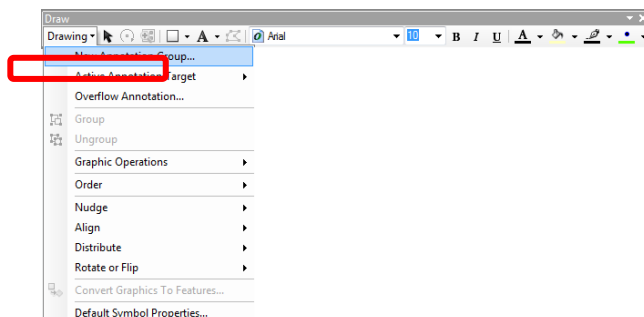


The result of automatic labelling means that the labels are resized accordingly, when the map display is zoomed in or out.



Feature-linked annotation describes a special type of label that is directly linked to the feature it annotates. In a given ArcMap document, annotations are represented as graphic text fields.

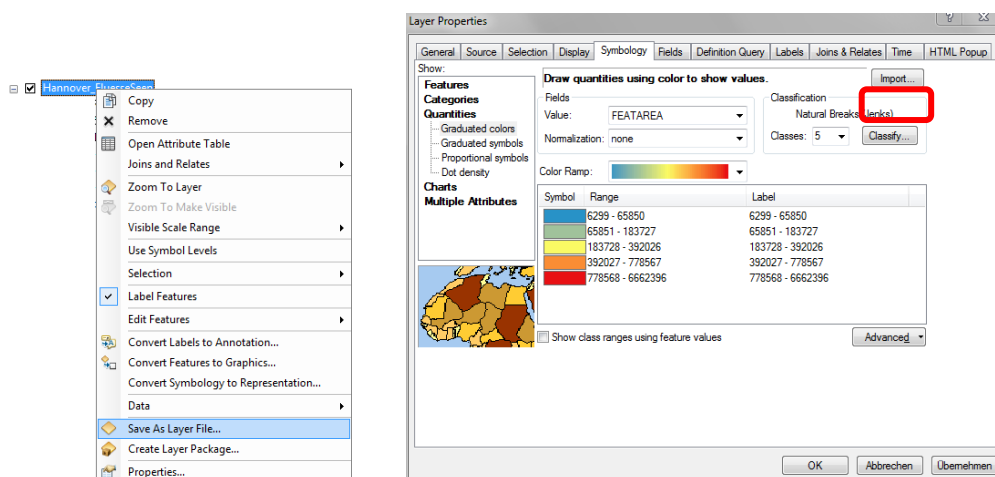
Features can be annotated individually by add an annotation feature class to your map that is linked to the layer you want to create feature-linked annotation for. On the Draw toolbar, click Drawing, point to Active Annotation Target, and click the name of the annotation feature class. Click the Label button. Point to the feature you want to label.



It also possible to convert the labels into annotations. This is simply achieved with a right mouse click, and from the context menu select *Convert to labels To Annotation*.

6.5 Saving and importing of layer properties

As soon as you have changed customized layer properties you can save the GIS project and the changes made are automatically saved in the *.mxd file. When the ArcMap document is opened next, the objects of the layers are displayed with same colour, which you had assigned to before. It is very complicated to carry out all changes once more if you would like to use the same layer properties in another GIS project. In this respect, ArcGIS offers the possibility to save the properties in a so-called *.lyr file. This is achieved through the context menu of the layer by selecting *Save as Layer File* and then specify the folder location.



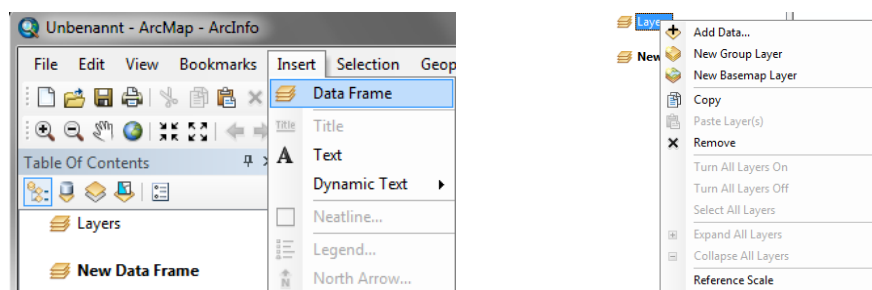
Now the stored layer properties (*.lyr) can simply be used in another GIS project. To use the saved layer properties, under the layer properties window and the Symbology Tab click on import and select the layer properties *.lyr file. Now the symbolic qualities are automatically applied.

6.6 Working with Data Frames

A data frame is the most fundamental element in a Map Document and in the ArcMap User Interface. It groups together layers in a particular geographic extent. An ArcMap Document can contain more than one Data frames.

When you create a map, it contains a default data frame listed in the Table of Contents as Layers that is usually empty. You can organize the layers within the data frame

A new data frame can be added through *Insert > Data frame* in the main menu.



In an ArcMap Document, only one data frame can be active and is usually bold in the Table of Contents. You can activate a different data frame using the context menu or by using [Ctrl] +[Tab].

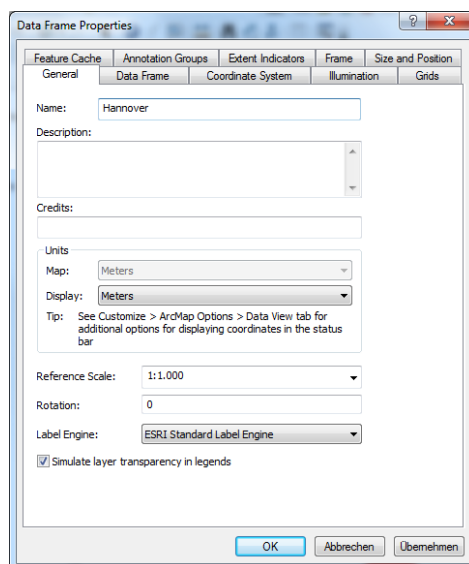
6.7 Data Frame Properties

Data frame properties like coordinate system, scale, name, position und size can be accessed and changed (if required) in the data frame properties window through the context menu or by double clicking the data frame

6.7.1 Name and Reference scale

Just as the name of the layers can be changed, the name of the data frame can also be renamed. Either through the data frame properties window or directly in the Table of Contents by clicking the active data frame.

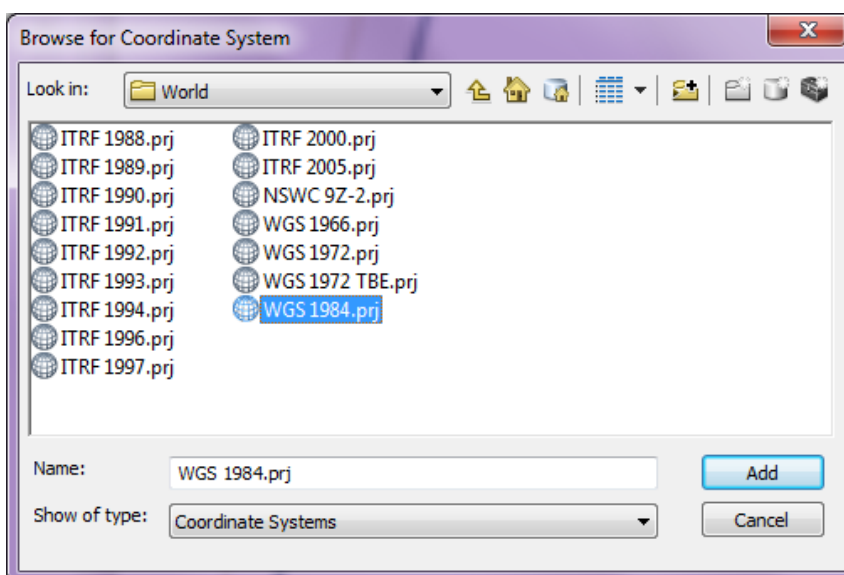
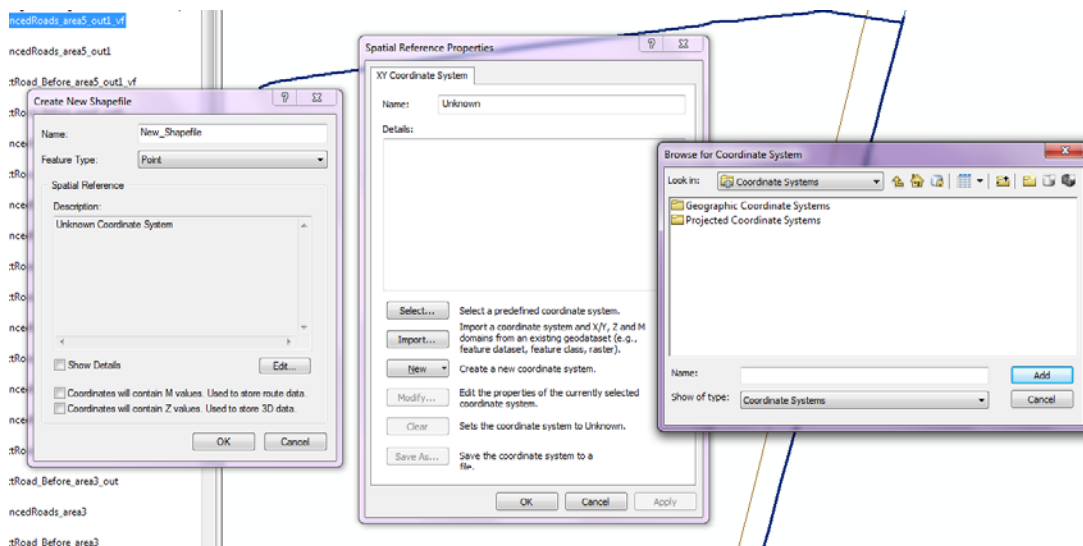
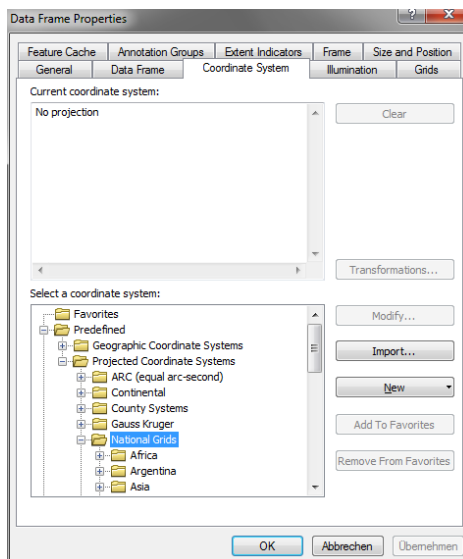
In the General Tab of the data frame properties window, the map units, which depend on the coordinate system, can be selected



The reference scale for all symbols and text in the map of the data frame can also be changed. For a given reference, scale the size of the symbols and texts is fixed. Therefore, the symbols and texts are scaled accordingly when zooming in or out.

6.7.2 Coordinate System

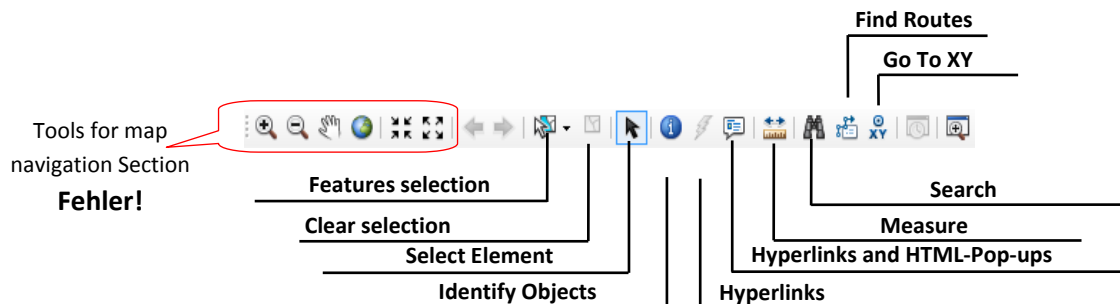
In a new data frame, there is no coordinate system. When the first layer is added to the data frame, the coordinates system is automatically added from the dataset. The coordinate system of the data frame can also be specified explicitly.



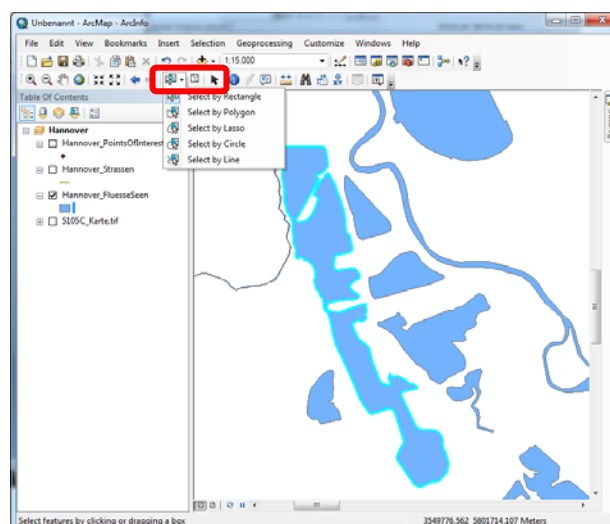
7. Tools in ArcMap

7.1 Selecting Features and Removing Feature Selection

ArcMap has four possible ways to select features: Interactive selection, selection by means of a graphic object, selection based on attributes and selection based on location.



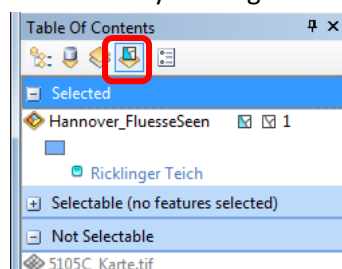
Interactive selection is achieved using feature Selection icon in the tools toolbar and in the data display window, the selected objects are marked. With the interactive selection tool, you can select a single feature, by right clicking on the feature. To select more features, hold the [Shift] key and then select the features interactively one after the other.




With the arrow on the right side of the *Select feature* icon, objects can be also selected possibly within a polygon or circle, or along a line drawn around the features.

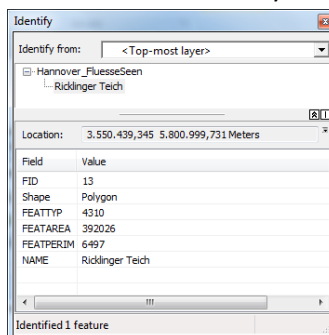
With *Clear Selected features* icon, all selected features are deselected once again.

With *Elements select*, you can select text fields, graphics elements and other objects in the map. These tools are interesting, e.g., in the layout view for the map production. In the table of contents, the number of the selected Features is indicated by clicking on *List by Selection*.

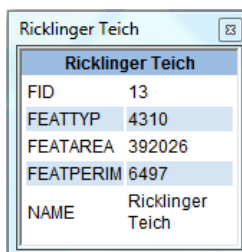


7.2 Identifying objects

With the active *identify*  tool you can obtain attribute information about individual features, by clicking on the feature the attributes are shown in the identify window.

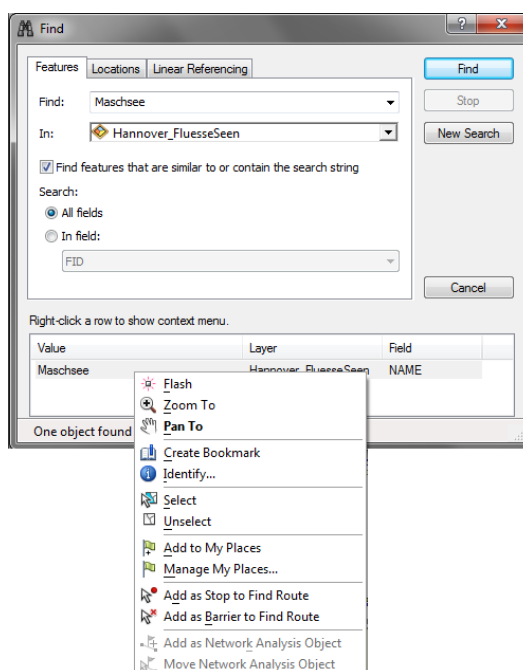


If one activates the HTML-Popup tools and selects with it the same object, a window similar to the one below pops up.



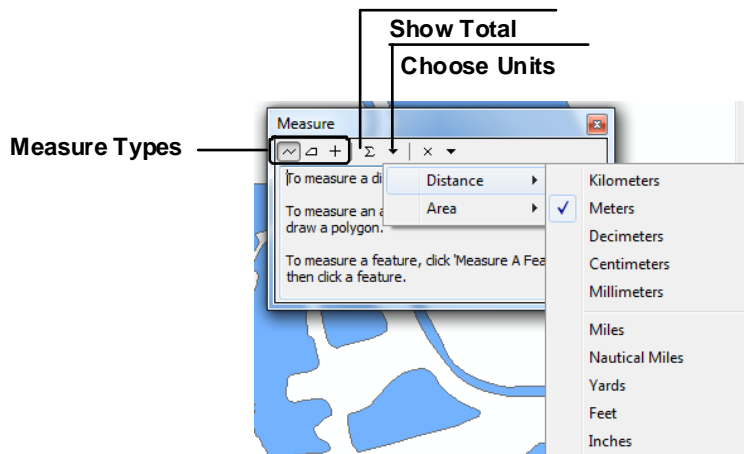
7.3 Searching for Objects

Using the Search tool, you can search for features with particular attribute information. Similarly, when you know the attribute information but not the position information, you can use different search options through the Dialog window. Through the context menu of the searched feature, perform different actions on the feature in data display window, for example, to flash or zoom to the feature.



7.4 Measuring Objects

The Measure tool can be used to measure distance between two points and the area for individual features. By simply clicking on a polygon features, you can obtain its area and perimeter. The units of the measurements can be selected.

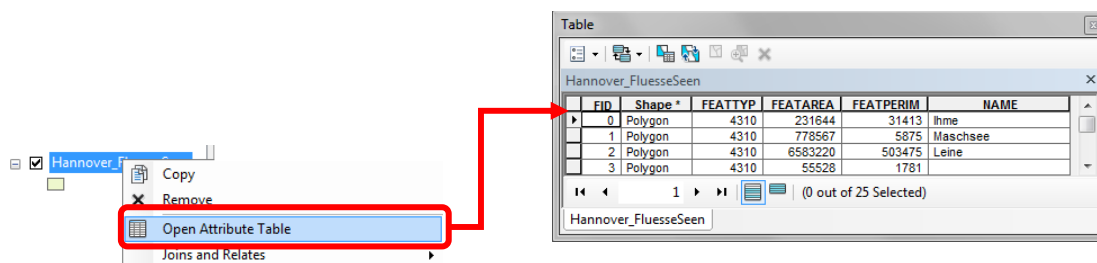


It can be selected from the following measuring types:

- *Measure Line*: Lines measure. The lengths of the single segments as well as the total length of all segments are displayed.
- *Measure an Area*: Surfaces measure. The lengths of the single segments as well as the surface and the extent are displayed.
- *Measure a feature*: Either point co-ordinates, line length or surface of the object are indicated by clicking on an object.

8. Thematic Data and Attribute Tables

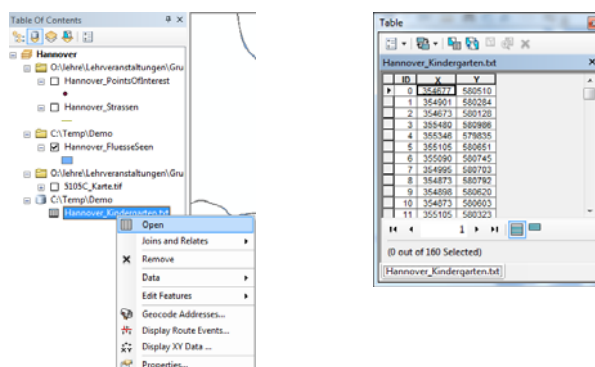
In a Geographic Information System, the objects and their thematic information are connected. Therefore, every layer with thematic data i.e., attributes is connected. The thematic data for a layer are represented in a table. The attribute table is opened through the context menu of the layer (Attribute Table open)



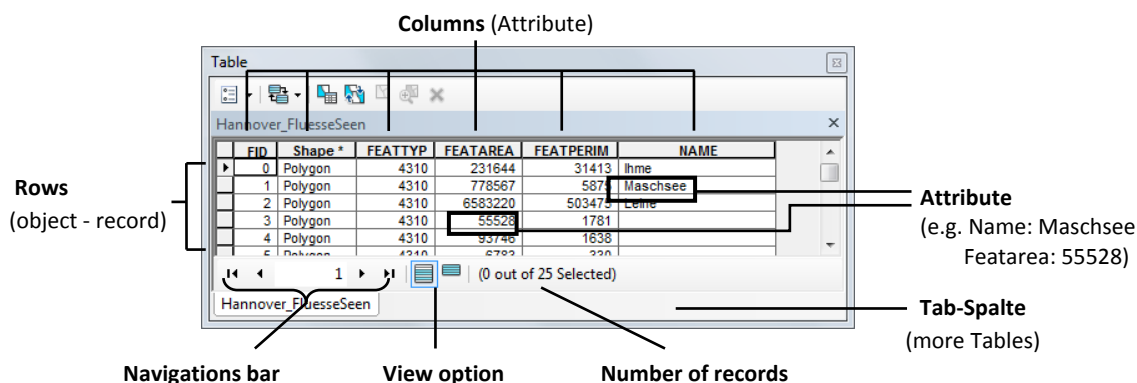
There is also the possibility to dock the attribute table (section 4.3) at a certain place in the ArcMap window.

Besides the attribute table, you can also have other data that does not depend on thematic data. In this case, there are no geographic objects.

If you add a table to your ArcMap document, this is not organised based on the drawing order (see section 4.2) with the other layers. This is because an independent table does not contain objects that can be displayed. The objects can be opened through the context menu of the Table with a double click.



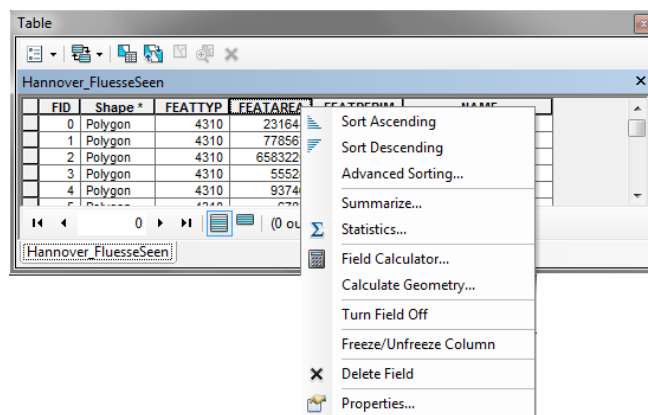
8.1 Attribute Table User Interface



Every line in the table corresponds to an object, every column to an attribute of this object. The columns with the feature or Object-ID and Shape are automatically generated.

8.2 Moving and Sorting Fields

You can access table operations through the context menu of the field. The operations include sorting, summary, statistics. In addition, the fields can be fixed or deleted.

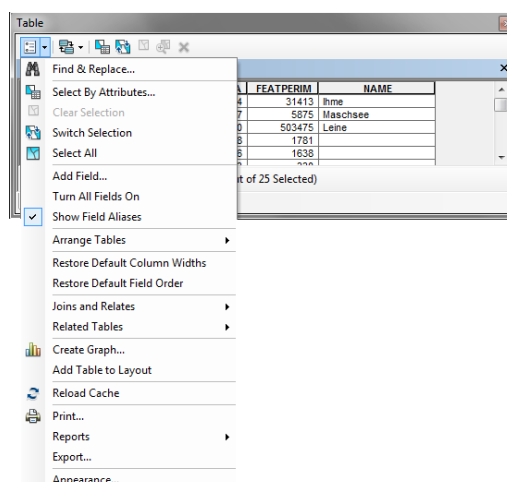


A column can be marked by click on the column name (it is coloured). The following options can be called by a right click with the mouse on the grey edge of the marked column:

- Sort Ascending or Sort Descending
- Summarize
- Statistics
- Field Calculator
- Calculate Geometry (e.g., perimeter, area, centroids, length) – calculation options are derived from the layer/feature geometry type
- Attribute fields fade out (Do gymnastics Field out of vision)
- Turn Field Off
- Freeze/Unfreeze Column
- Delete Field
- Properties

8.3 Table options

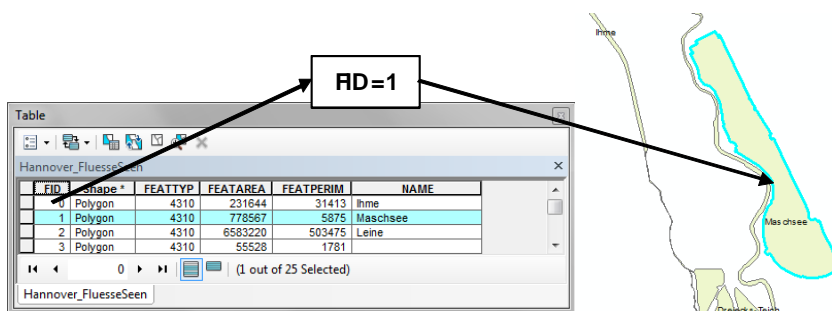
With the button Table Options, other functions are given to the work with attributes or records.



- *Find & Replace* – find or replace particular attribute values
- *Select By attribute* – select attributes by composing a query
- *Clear Selection* – unselect all currently selected records
- *Switch Selection* – Toggle selected and unselected records
- *Select all* –select all records
- *Add Field* –add a new attribute field to the table
- Turn All Fields On – Turn on all attribute fields so that they may be available in the Table window
- *Arrange Tables* –organise several tables in the Table window
- *Restore Default Column Widths/Field order* –restored the Default width or the original for all attribute fields.
- *Joins and Relates* – connections and links between tables
- *Related Tables* – listing of the tables which are connected as "Related Tables"
- *Create graph* – create graph from table
- *Add table to layout* – places the table in a map layout
- *Reload Cache* – Reloads the cached records from the source table
- *Print*– Print the table
- Report s– Create reports with a wizard
- *Export* – Exported the table or a selection of the table elements as a .dbf file
- Appearance – change the appearance of the table (e.g., font and size, colour of the selected elements)

8.4 Connection between Features and Attributes

Every object has a unique feature Identifier (FID), through which it is organized in space and in the dataset. The FID connects ensures a one-to-one connection between the features and the attributes.



Selected objects are marked in the attribute table in blue.

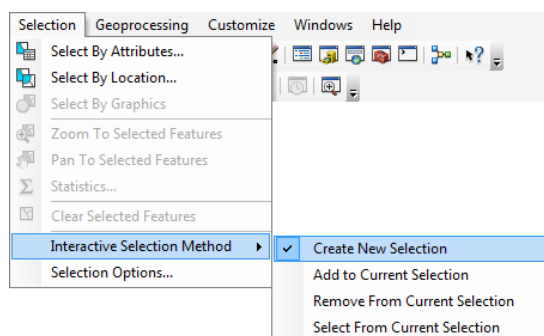
9. Selecting Objects

9.1 Selections methods

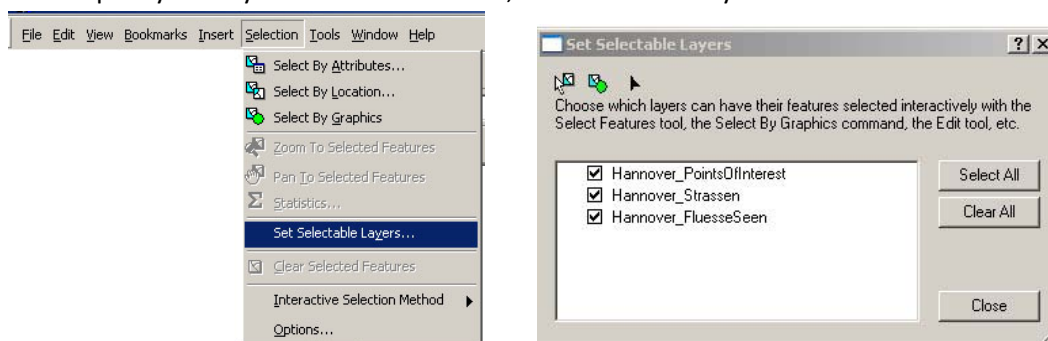
In section 7.3, one methods of searching objects based on feature attribute was introduced. In ArcMap, there are four methods of selecting objects: Interactive selection, selection by means of a graphic object, selection based on attributes and selection based on location.

9.1.1 Interactive selection

Interactive selection was introduced in section 7.1. In the Selection menu, you can also access more options of interactive selection, for example, creating a new selection, adding to the current selection etc.

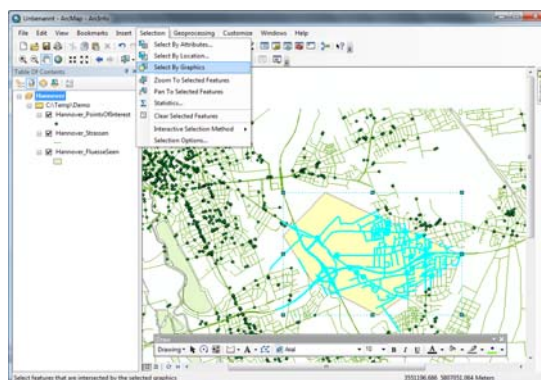


You can also specify the layers to select from i.e., Set Selectable Layer.



9.1.2 Selection by means of a graphic element

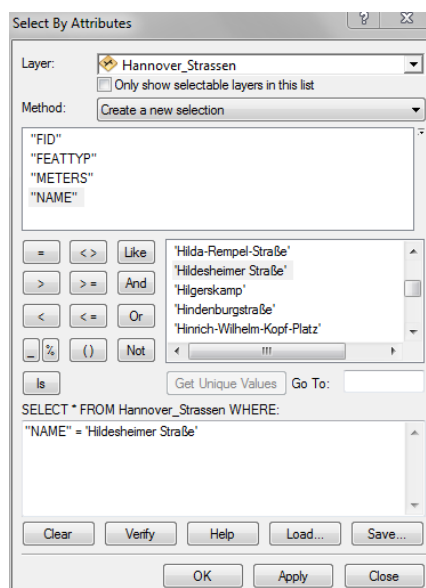
Selection by means of graphic elements is achieved using a graphic drawn with the help of *Drawing* Toolbar. For example, you can draw a polygon around some features, then to select features within the drawn polygon, In the *Selection* menu, and click on *Select by Graphics*.



9.1.3 Selection By Attributes

When you create an expression in the *Select By Attributes* dialog box, you create it in a version of SQL (Structured Query language); the one you use depends on the format of the data you are querying. The structure of a SQL query is of the form: SELECT, FROM, WHERE

- Click *Select By Attributes* from the Selections menu to open the selection By Attributes dialog box.
- In the dialog box, click the Layer dropdown arrow and click the layer containing the features you want to select.
- Click the Method dropdown arrow and click a selection method.
- Double-click a field to add the field name to the expression box.
- Click an operator to add it to the expression. If you have a very large number of values, click the *Get Unique Value* button to see them all. Double-click a value to add it to the expression.

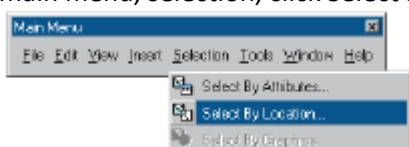


For example, in the dialog box above, the intention is to SELECT objects FROM Hannover_Strassen, WHERE "NAME = Wilhelm-Busch-Straße" (See SQL section in appendix).

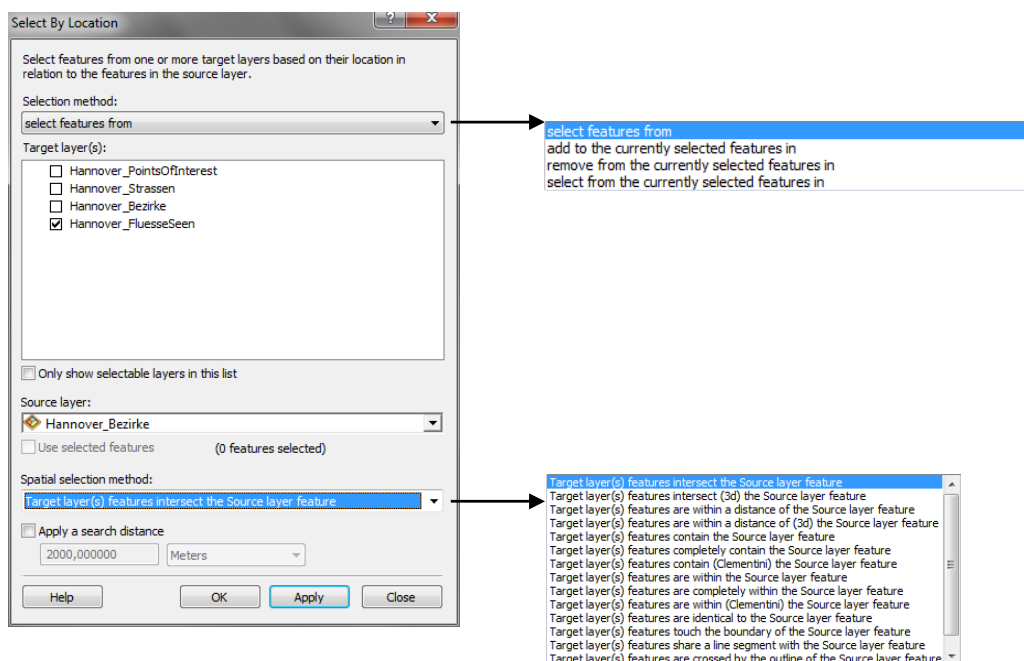
9.1.4 Selection By Location

With the *Select By Location* dialog box, you can select features based on their location relative to other features. You can use a variety of methods to select point, line, or polygon features in one layer that are near or overlap the features in the same or another layer.

In the main menu, selection, click Select By Location.



The *Select By Location* dialog box that opens guides you through creating a geographic query.



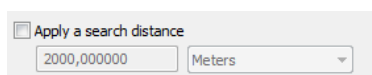
In the *Select By Location* dialog box:

- choose the Selection method: selecting form, adding to current selection, remove form current selection, or select from currently selected features
- Then specify the layer where the selection will be made
- choose the relationship for the selection, for example, intersection, area within a distance of etc
- Once again, you have to choose the layer that is used in the selection.
- You can also apply a buffer distance in the selection

In the next line, you select the spatial relationship for the selection. For example, any of the following query criteria can be used:


- Intersect the source layer feature
- Area within a distance of
- Contain -
- Contain Completely contain
- Area within
- Area completely within
- Area identical to
- Are the boundary of
- Share a line segment with
- Area crossed by the outline of
- Have their centroid within

With all choice criteria, you can also give any distance (buffer distance) which should be considered with the selection.



9.2 Clear selection

There are several possibilities to clear selected features in a Layer:

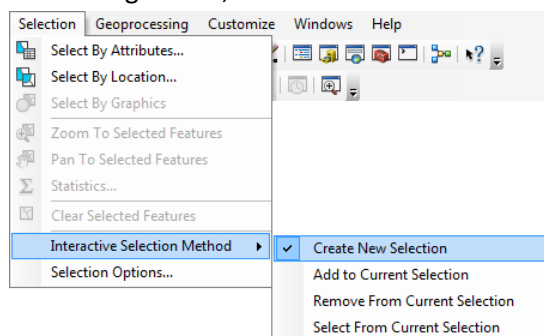
- In the attribute table under Options select Clear Selection
- Click in the Table Of Contents on the *List By Selection* icon select Clear selection
- In the upper area of the attribute table click the symbol 

To clear all selections in all layers, there are the following possibilities:

- In the main menu Selection - Clear Selected of feature all selections (from all layers) can be cleared all at once
- Clear Selected features from Select in the main toolbar

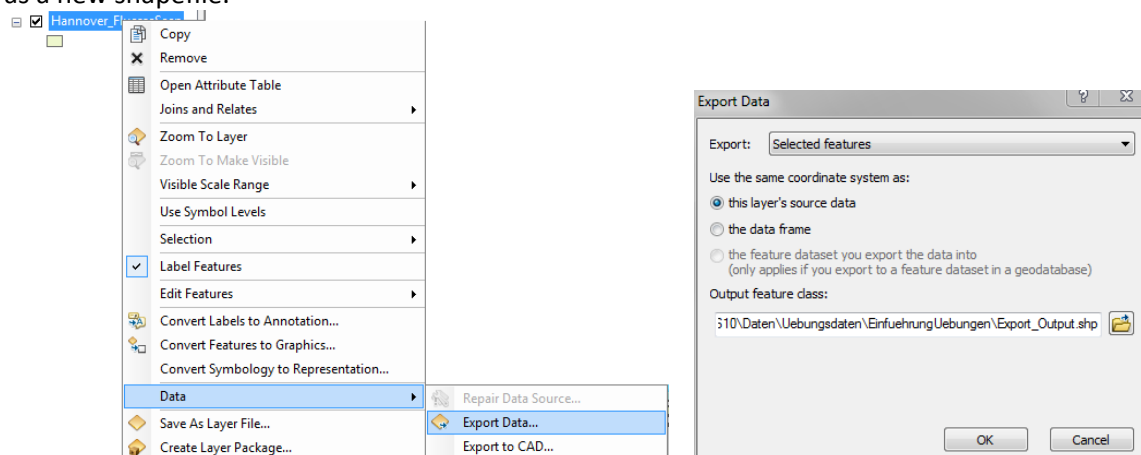
9.3 Selection options

Possible selection methods are available, in addition to the manual choice and the Selection by means of graphics elements. In the menu choose Selection – Interactive Selection Method you can select whether you extend the existing choice, want to reduce or select from an existing choice.



9.4 Saving the selected features as a New Dataset

Through the context menu of the layer in the Table of Contents, you can export the selected features as a new shapefile.



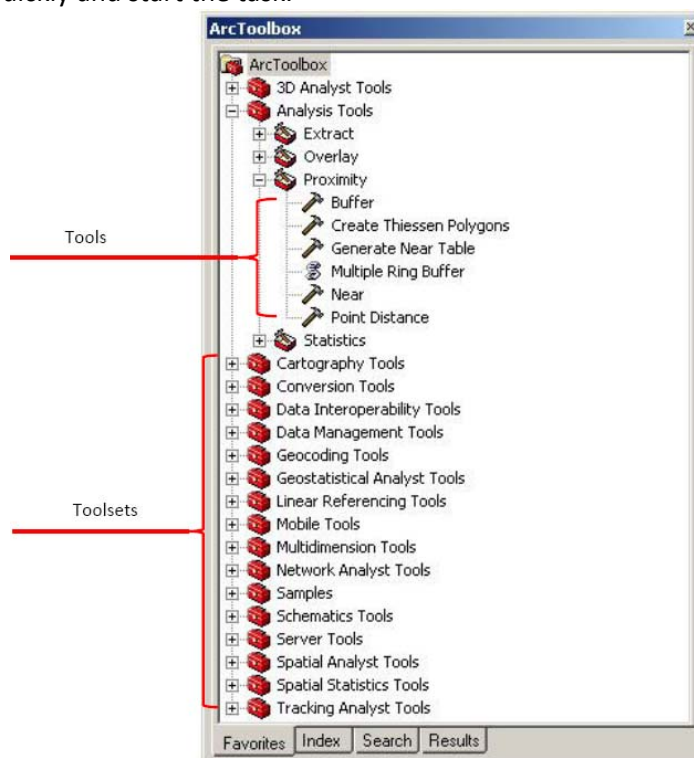
10. Spatial Analysis of Vector Data

Selection by location can be used for spatial analysis. However, for neighbourhood topological, overlay analysis and data processing, different tools are required.


10.1 Using the ArcToolbox

ArcToolbox is a simple application containing many GIS tools used for geo-processing. There are two versions of ArcToolbox: the complete ArcToolbox that comes with ArcInfo and a lighter version that comes with ArcView and ArcEditor.

ArcToolbox lets you work with data from different sources, run a tool or wizard on multiple datasets, and direct where the processing will occur. *Tools* and *wizards* are arranged in a logical manner to help you find them quickly and start the task.



ArcToolbox can be started in two different ways:

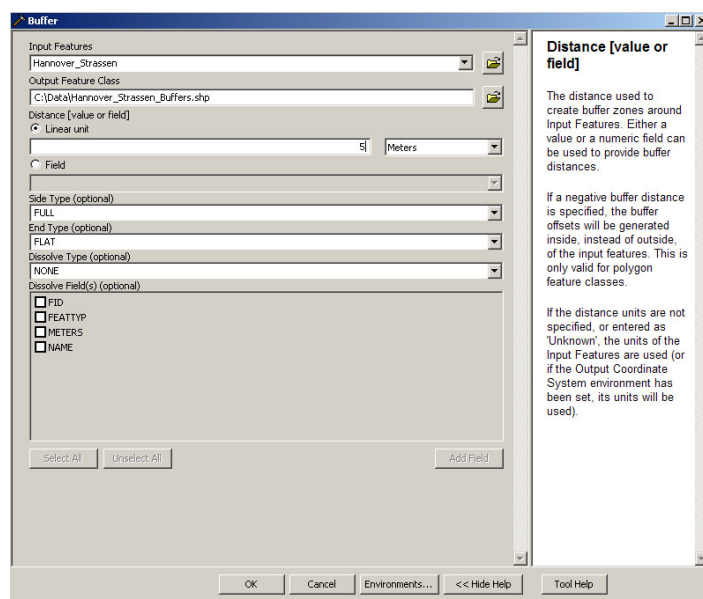
- In ArcMap or ArcCatalog Standard toolbar, click on the icon  to start ArcToolbox.

The tools in ArcToolbox are organized into toolsets, for example, Data Management Tools, Analysis Tools and Conversion Tools.

10.2 Example: Creating Buffers

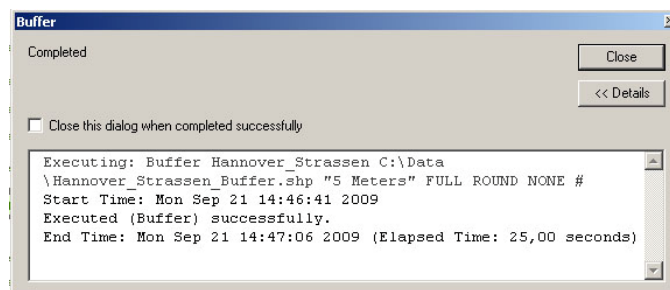
A Buffer is a polygon around one or more features. A buffer can be defined by specifying the distance from a feature.

When no feature in a given layer is selected, a buffer is created around all the features. If you want to buffer just some features, you have to select them first.

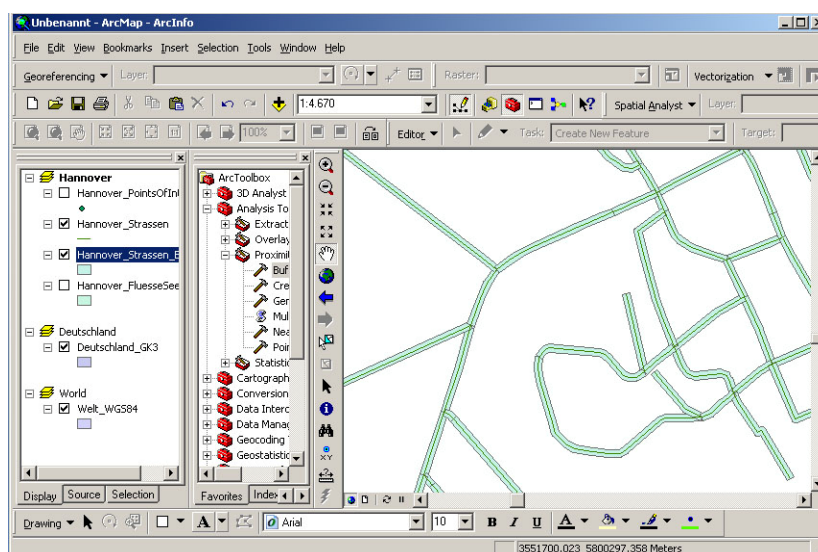


The Buffer Wizard is accessed through the Proximity in the Analysis Tools toolset. In the right hand side of the Buffer wizard, is an outline and explanation of the operation of each of the text field on left hand side of the wizard.

When all the text fields are filled, the operation is started by clicking the OK button. The progress of the process is shown in a separate status window.



Once the process is completed, the result is added as a new layer and displayed in the ArcMap Document.



11. Map Design and Layout

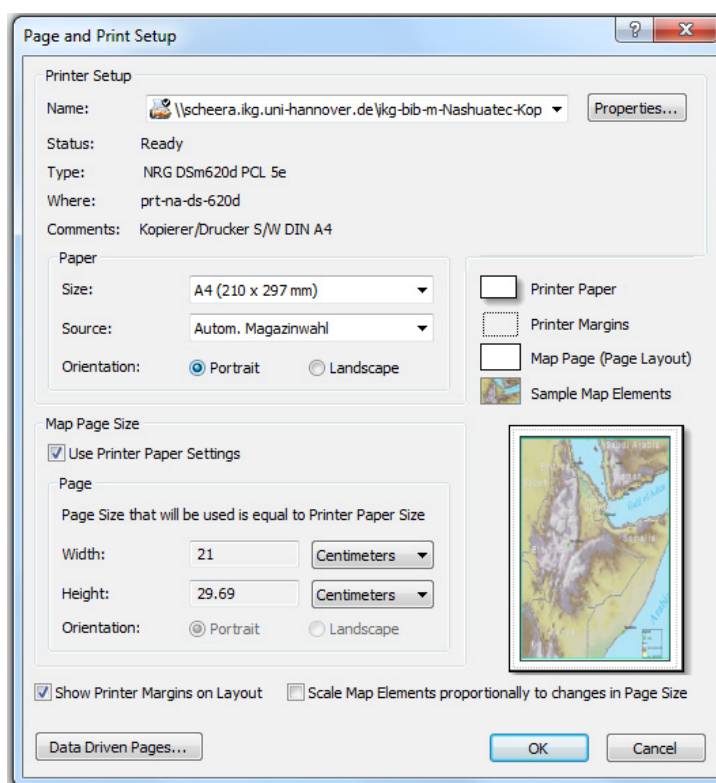
11.1 Choosing a Map Size

When designing a map the important questions to ask are:

- What the end user wants or needs?
- Is it physically possible to produce the desired size (i.e. output limitations)? If left to you to determine map size, produce it at the *smallest* size feasible.
- Are there publishing, framing, or laminating restrictions or limitations?
- Will the data be legible or useful at the desired size?

11.2 Changing Page Size & Orientation in ArcMap

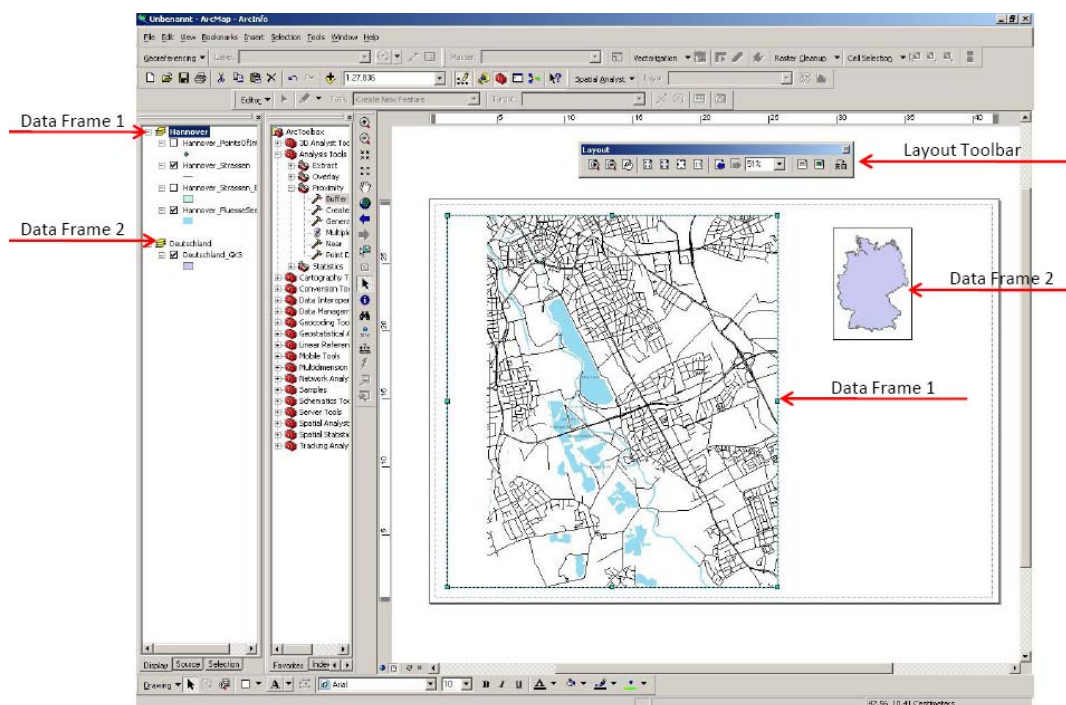
Changing the page size and orientation in ArcMap Under the *File Menu Page and Print Setup*



11.3 Layout view

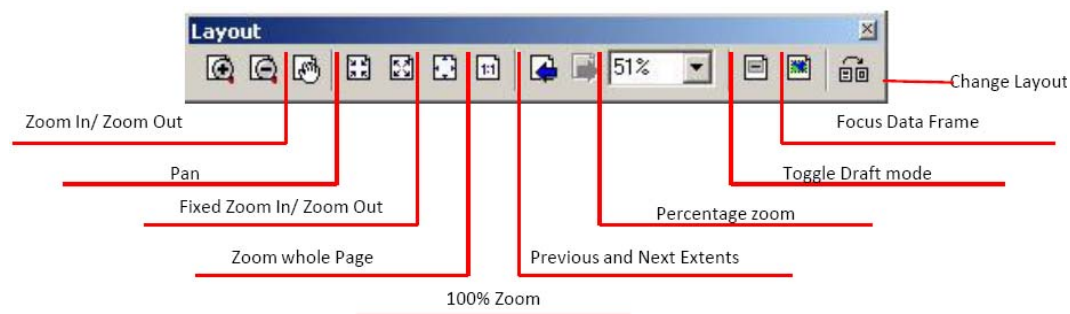
A map is created in the layout view. In the layout view, one or more maps can be created, for example, a large-scale map and an inset. Every map in the layout view depends on a data frame in the ArcMap document.

Before you begin to symbolize data for a map, you will need to think about how you want the map to look when it's printed or published. For instance, you consider the orientation of the page, the number of data frames etc. The format and orientation of the map page can be changed through *Page and Print Set Up* in the File menu.



11.4 Layout toolbar

The different map elements can be viewed at different scales by using the tools in the Layout toolbar.



11.5 Elements of a map composition

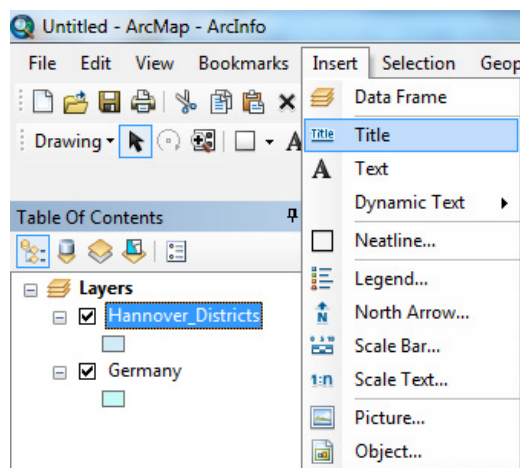
When designing a map, the basic elements that should be included are:

- Title and Subtitle
- Legend
- Scale Bar
- Credit Note
- Date
- Logo
- North Arrow
- Mapped and Unmapped Areas
- Borders and Neatlines
- Graticules and Grids
- Map Symbols
- Place Names and Labeling

Most map elements can be added, for example, the North Arrow, map scale, Legend, Title, Coordinate system and other information through the *Insert* menu.

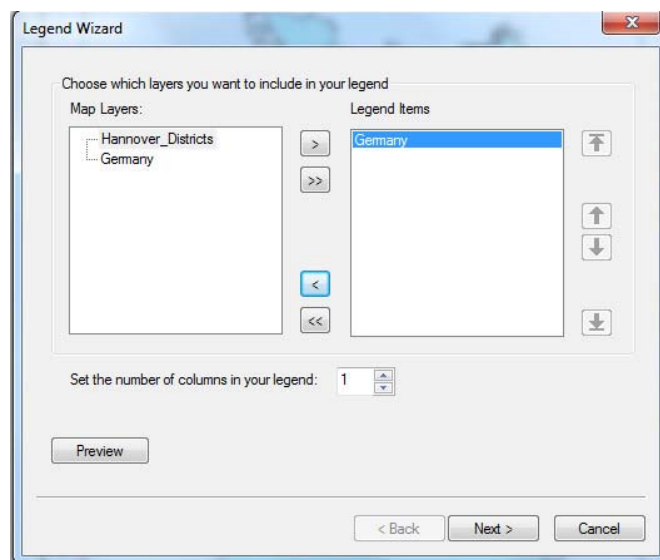
11.5.1 Title

Title - Usually draws attention by virtue of its dominant size; serves to focus attention on the primary content of the map; may be omitted where captions are provided but are not part of the map itself. Titles are important map elements, and type *size* should be *two to three times* the size of the type on the map itself. A subtitle, in smaller type, is appropriate for longer titles or more complex map subjects.



11.5.2 Legends

The legend is the graphic guide that you provide to your audience. You do not always need to provide symbols for all of the information used in your maps. It is the principal symbol-referent description on the map; subordinate to the title, but a key element in map reading; serves to describe all unknown symbols used.

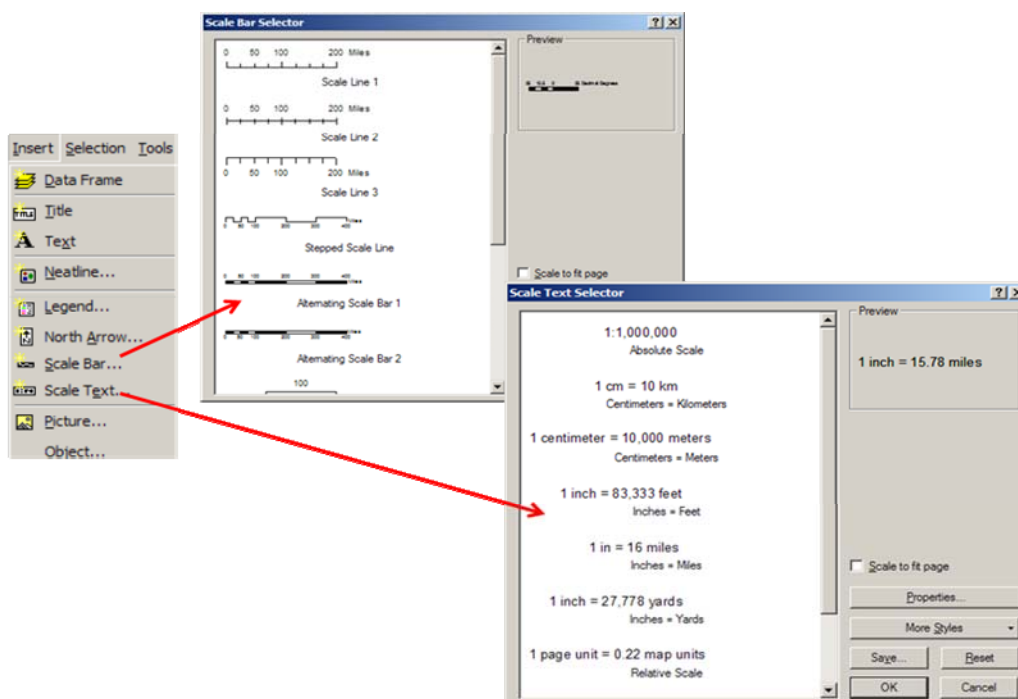


11.5.3 Scale

Large-scale maps should always include a scale. Maps that inform the user about differences in distance or area should also include a scale. Small-scale maps may not need a scale, as scale varies greatly with world or continental projections.

Verbal and visual scales make more sense to the average reader. Include a visual scale if the map will be reprinted or resized.

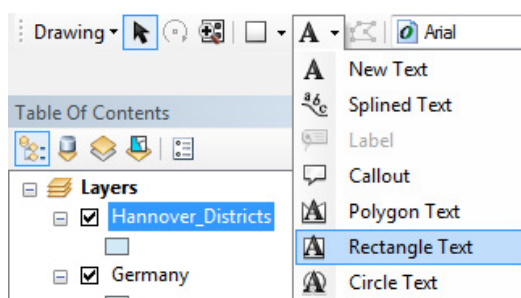
Map Scale - Usually included on a thematic map; it provides the reader with important information regarding linear relations on the map; can be graphic, verbal, or expressed as a Representative Fraction.



11.5.4 Credit Note and Date

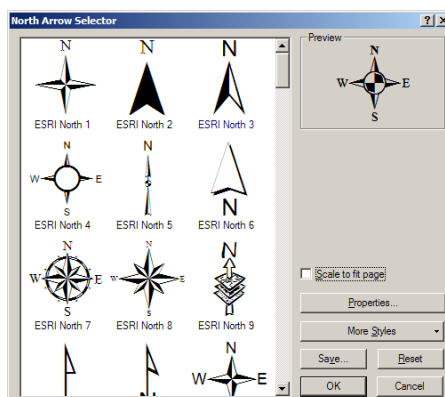
Informational or Credit Note - can include the map's data source, an indication of their reliability, dates, and other explanatory material. Also, include date if the time of a map's publication is a factor. This may also work well as part of the Sub-title.

- Text tools in ArcMap could be better
- Insert Text from the menu has very limited options
- Instead use the text tools on the draw menu (see below)
- Use New Rectangle Text tool if you want text wrapping



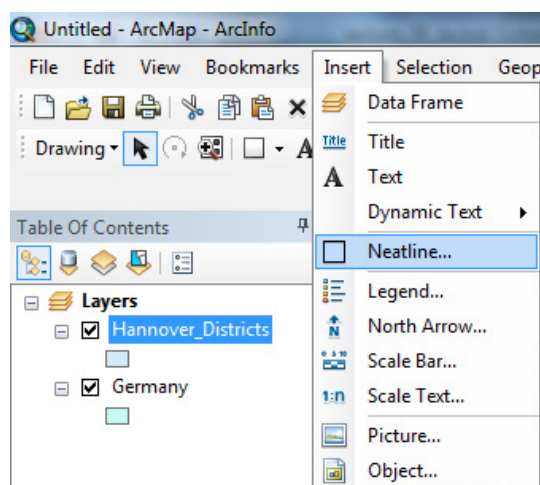
11.5.5 Directional Indicator

A directional indicator is needed on a map in two cases: when the map is not oriented north and when the map is of an area unfamiliar to your audience. Directional indicators can often be left off the map. If included, avoid large and complex directional indicators. They are relatively unimportant map elements and should not be visually prominent.



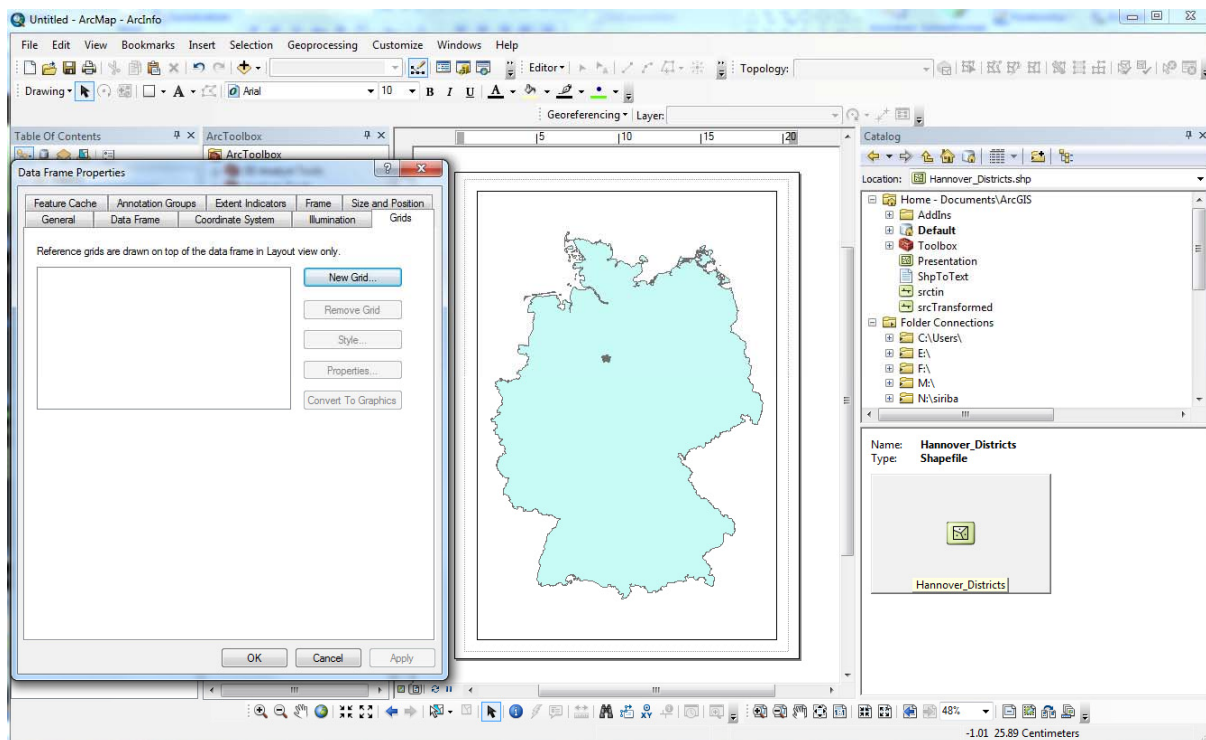
11.5.6 Borders and Neatlines

Both optional; borders can serve to restrain eye movement; neatlines are finer lines than borders, drawn inside them and often rendered as part of the graticule; used mostly for decoration.



11.5.7 Graticules and Grids

They are often omitted from thematic maps today; should be included if their location information is crucial to the map's purpose; usually treated as background or secondary information. Grids show the same information, but display it across the body of the map and not just along the neat line. Grids & Graticules are added in the data frame properties. Coordinate values will be added to the boundary of map.



11.6 Planar Organization of Visual Elements

Too many features are too much, too little features are not enough” As Rules of Thumb:

- Find a balance that portrays enough information without making the map appear cluttered or busy.
- Show the necessary features along with enough supporting features for clarity.

Readers’ eye normally follows a path from upper left through the optical center to lower right.

Point of greatest natural emphasis is where a line of space division intersects either the focus or field circles of attention.

The designer should arrange the map’s elements around the natural (optical) center, rather than the geometric center.

Visual Balance

- Visual balance results from two major factors: weight and direction.
- Visual weight depends on location.
- Elements at the center of a composition pull less weight than those lying of the tracks of the structural net.
- An object in the upper part of a composition is heavier than one in the lower part.
- Objects on the right of a composition appear heavier than those on the left.
- The weight of an object increases in proportion to its distance from the center of the composition.

Appendix A: Georeferencing Raster Images in ArcMap

You can align, or geo-reference, scanned maps to existing GIS data so that you can digitize information from them or use them as visual displays in your maps. For example, if you have a planimetric map of an area showing contour lines, building footprints, and curb lines, you can scan that map and geo-reference it in ArcMap, then digitize those features to create new GIS layers. Alternatively, you could scan an historical map or aerial photo to show change through time when compared with current orthophotos.

You should determine in advance, what points will be your control points - that is, points that you can find on both the digital image and on your GIS data layers. These will act to align the image to the data. It is important to record these points ahead of time to help guide you in the Georeferencing process.

You should have control points evenly distributed around the image, for example one at each corner and one in the middle; or several around each side and several more in the middle.

You can read more about this process in the **ArcGIS Desktop Help menu - Contents - ArcMap - Working with Rasters in ArcMap** - Fundamentals for Georeferencing a raster dataset.

NOTE: You will need at least two layers:

- a) your layer that needs to be georeferenced, and
- b) A layer that is already georeferenced (source of control points), which you will use as a basemap.

Georeferencing process in the ArcMap system includes three main stages:

1. Open ArcMap & Turn on the Georeferencing Toolbar and the Editor Toolbar
2. Adding a map/image (raster) that is needed to associate/register geographically to existing layers/new project (the raster is without coordinates).
3. Georeferencing
4. Save the geographical Georeferencing attached to the original raster (a world file and .aux file).

1. Open ArcMap & Turn on the Georeferencing Toolbar and the Editor Toolbar

- (i) Open ArcMap
- (ii) In ArcMap, add the existing shape file or the geo-referenced image that you are going to reference the new image.
- (iii) Click the **View menu, Toolbars, and Georeferencing** Toolbar
- (iv) You will see this toolbar appear. You may 'dock' it within ArcMap so that it will always be in the same place.



2. Adding a map/image (raster)

- (i) Add the image layer, which you want to geo-reference. Note that if it is a .jpg file, make sure you choose the entire image file
- (ii) On the **Georeferencing** menu, make sure that your **Layer** specified is the image you want to georeference

- (iii) From the **Georeferencing** menu, choose **Fit to Display** - the new image should fill the screen. You should see the overlapping layers, and you may want to make your shape file data layer transparent or make the features hollow, so that you can see both the un-georeferenced image and the georeferenced shape file.

3. Georeferencing

- (i) Zoom in to the area of a location (such as a street intersection) which you can easily distinguish in both the image and in one of the already geo-referenced shapefile themes. These will be the control points, or shared points between your image and your existing geographic data.

- (ii) Click on the **Add Control Point** tool



You can use the zoom and pan tools during this process to zoom in to see your points more clearly – this will also help to make your control points more accurate, rather than trying to create them with the entire area in view. **Note:** If you accidentally click the layers in the wrong order or make a bad control point, **do not hit “Undo”** or you may lose the last layer added and all of your control points.



Instead, open the View Link Table and remove the last control point created.

- (iii) You should check your control points occasionally by choosing **View Link Table** icon on the *Georeferencing* toolbar. This will show you all the control points, and when you have more than three, it will show you the Root Mean Square (RMS) error. You can delete control points that have large errors and re-enter them or enter other points, which result in a lower error.

Link	X Source	Y Source	X Map	Y Map	Residual
1	609.482788	-472.477625	217350.684070	763444.347792	1105.28445
2	1160.945783	-340.291738	271342.700726	776386.254406	3035.10526
3	1309.654905	-794.680723	285902.345667	732100.667711	507.24145
4	880.050775	-458.233108	243841.149171	764859.868828	549.75215
5	1301.393287	-330.063499	288733.387739	771533.039426	2986.81441

Auto Adjust Transformation: 1st Order Polynomial (Affine) Total RMS Error: 1995.70034
 Load... Save... OK

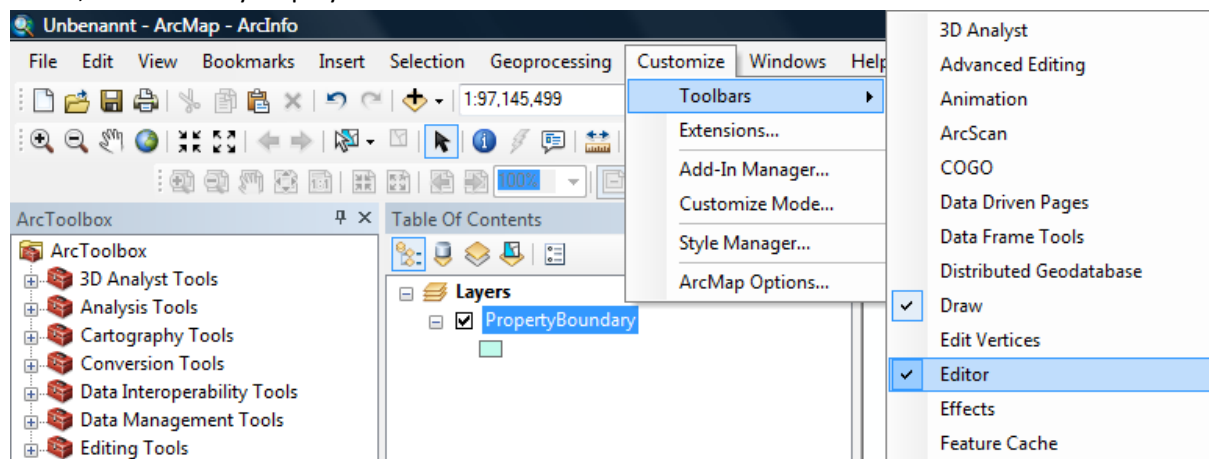
- (iv) You can choose the appropriate transformation depending on the number of points you have.
- (v) When you have the image aligned with an acceptable RMS error, you should record the RMS error for data quality reporting.
- (vi) When you have completed the Georeferencing process, you can create a permanently georeferenced image by choosing **Rectify** from the *Georeferencing* menu - you can accept the default cell size that ArcMap calculates or set your own. For scanned maps, you can leave the resampling type set to Nearest Neighbor. Specify a name and location for the new image. The result will be a .tif image and a .tfw(x) world file, which tells ArcMap where in the world this image is now located.
- (vii) With this georeferenced image, you can now digitize new features from the map.

Appendix B: Digitization

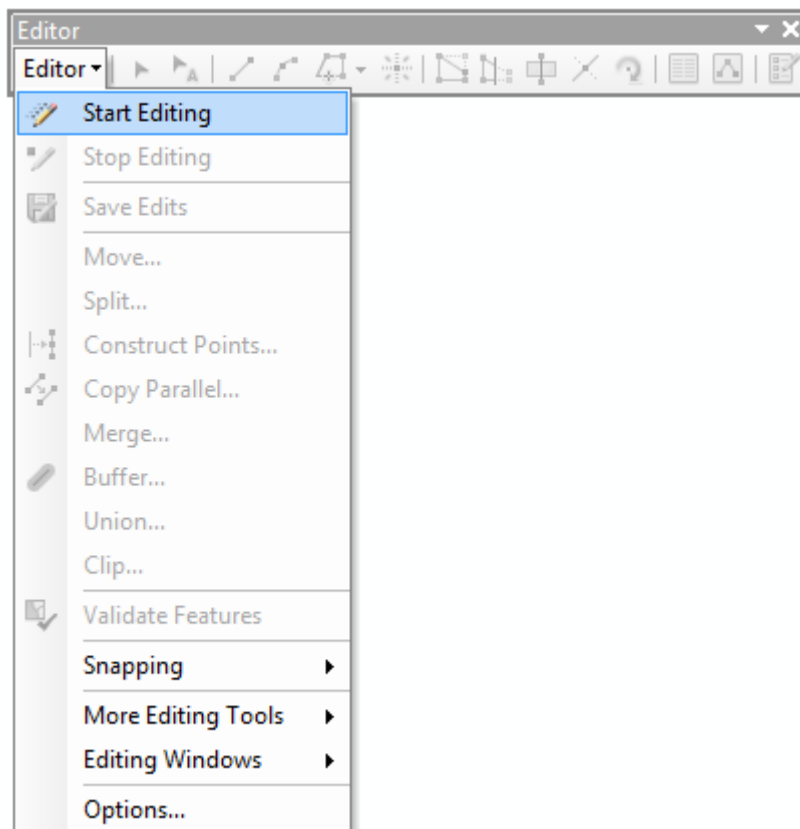
You noted that the Shapefile and Feature Class that was created in section 7 were empty. So new Features have to be created. The creation and editing of Geometric data is carried out in ArcMap.

1. Starting the Editing Session

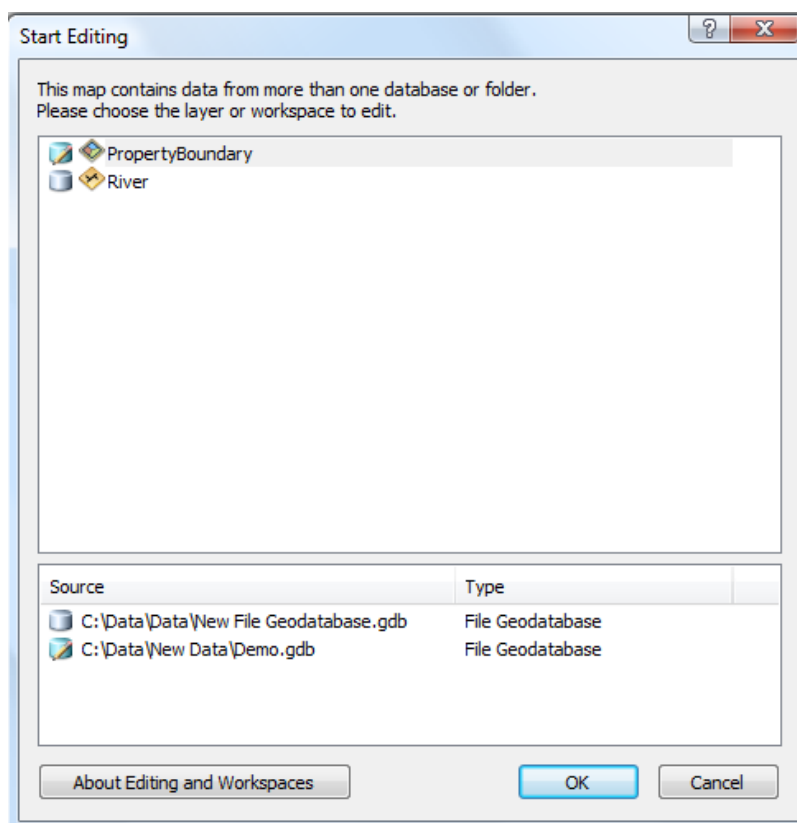
To work on Geometric data, you use the Editor Toolbar. The toolbar is available through the Tool menu, if not already displayed.



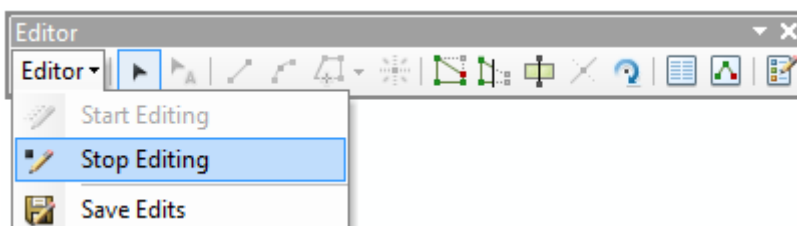
To start an editing session, you activate the Editor by clicking Start Editing from the Pull down menu of the Editor Toolbar.



Once the editing session is started, and in case there are more than one layer in the ArcMap Document, you will have to choose the layer that you want to work on.



When the data capture and editing is completed, you should end the editing session. The edits are saved at intervals.



2. Editor toolbar



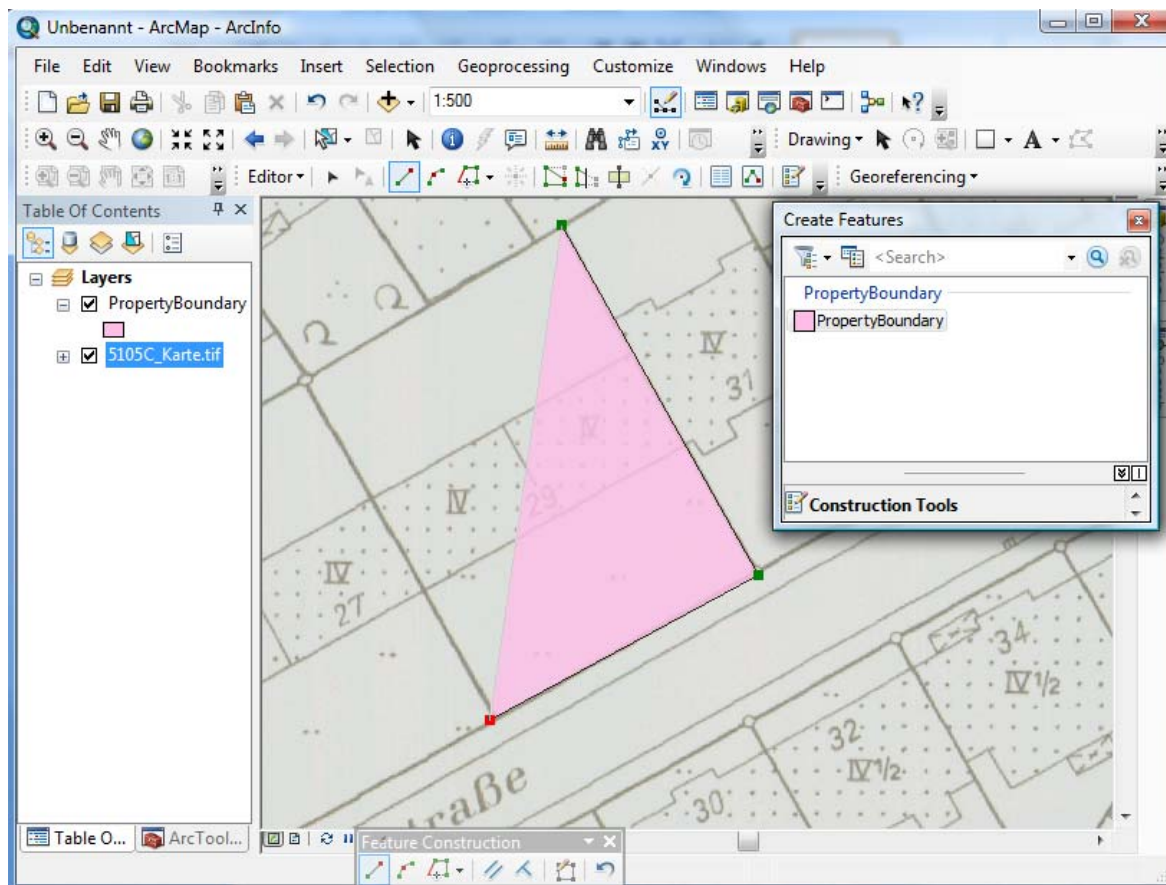
3. Digitization of features

In this section, the digitization of a polygon feature is going to be demonstrated. The same procedure can also be used to capture point and line features.

a) Adding New Features

When there is more than one layer in ArcMap, you must always select the **Target layer** in the Editor Toolbar, where the new features are going to be added. For a new feature capture, ensure that you have selected "Create New Feature". Otherwise, if a different task is selected, the sketch tool will be deactivated.

After you have selected the area to capture the features and zoomed to sufficient digitizing accuracy, you select the map editing tool. If you move the mouse over the map, the cursor will look like a crosshair pointer. Click with the crosshairs on the first corner to digitize the area, and then digitize the rest of the corners (say in clockwise direction). Double click on the last point and the polygon feature is created.



The vertices should be "as much as necessary and as little as possible". Then by clicking F2, the feature is completed.

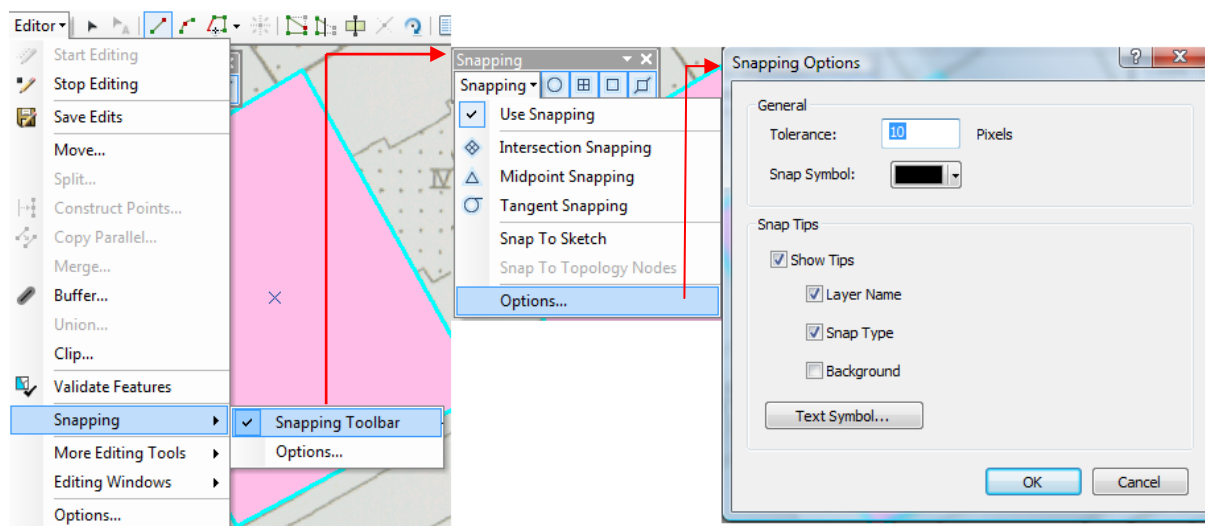


b) Snapping of Elements

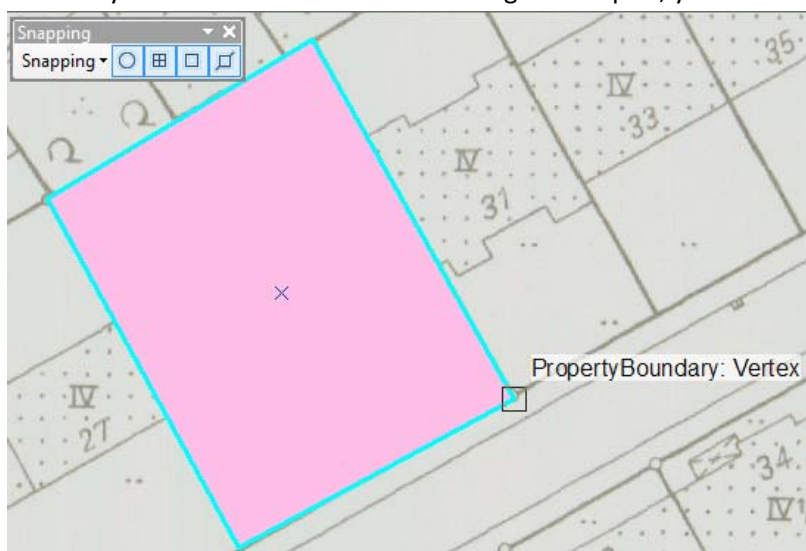
With the help of the mouse cursor, and based on tolerance settings, the vertices and nodes can be snapped to other vertices and nodes. To avoid topological errors, you should snap to adjacent features using the snapping function.

The snapping function is activated through the Editor Pull-down menu – *Snapping*. Then you set the snapping options through the Editor > Options.

In the snapping environment, choose the layer where snapping will be done and how the snapping will be done. Choose **Vertex** for the mouse cursor to snap to vertices, Edge to snap to edges and End to snap to the end points (linear objects). In the dialog box, you can select Edit Sketch, if new features are created within the snapping area, then the new features are snapped.



You specify the snapping tolerance in the Editing options dialog box. If you want to show snapping tips, for instance which layer and which vertex or which edge to snap to, you check Show snap tips.



c) Modifying features

To modify features, you choose the Task Modify Features and make sure that you select the appropriate Target Feature. Alternatively, you can double click on the feature and the vertices of the feature will be shown.

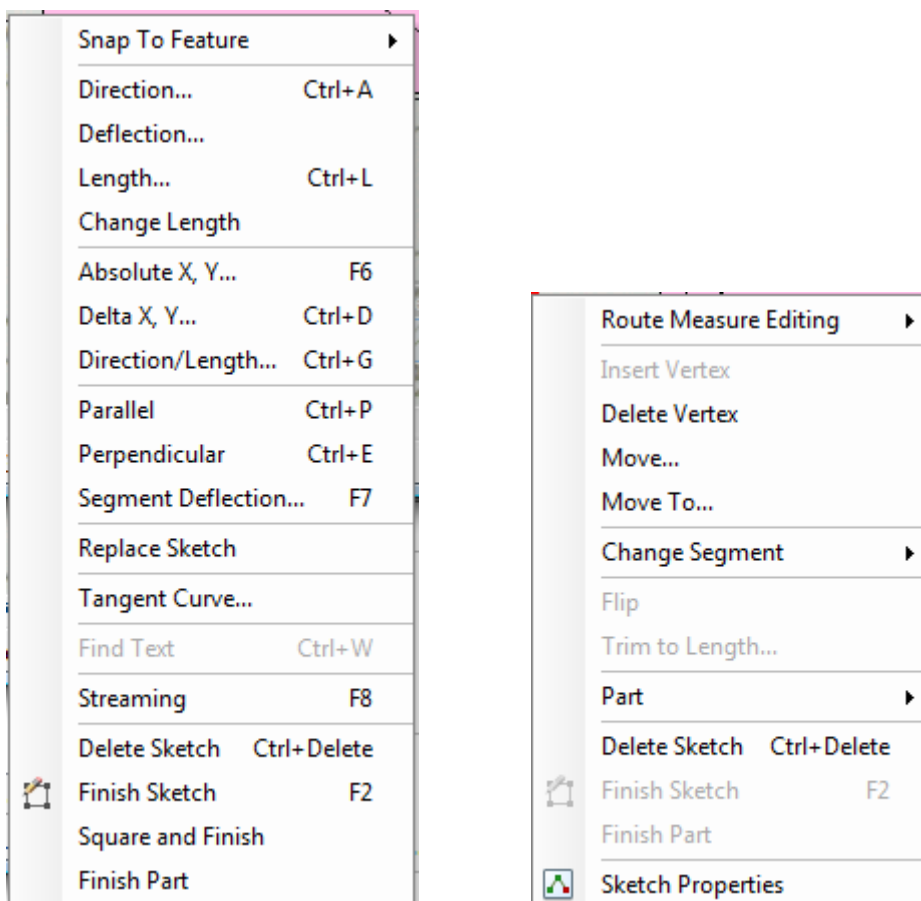
To alter the vertices, you left click the mouse on the vertex and then modify as required. Ensure that you select the intended vertex; otherwise, the entire feature will move. To complete the modification press F2.



To undo a feature modification click the undo button in the Standard toolbar or [Ctrl] + [Z]. To delete a feature, select the feature with the Editing tool and then press [Delete] on the keyboard.

4. Menu during Editing

While digitizing and editing the geometric data, more editing functions can be accessed through the context menu, which can be opened using the right mouse click. The respective context menu for digitizing and editing are shown below.



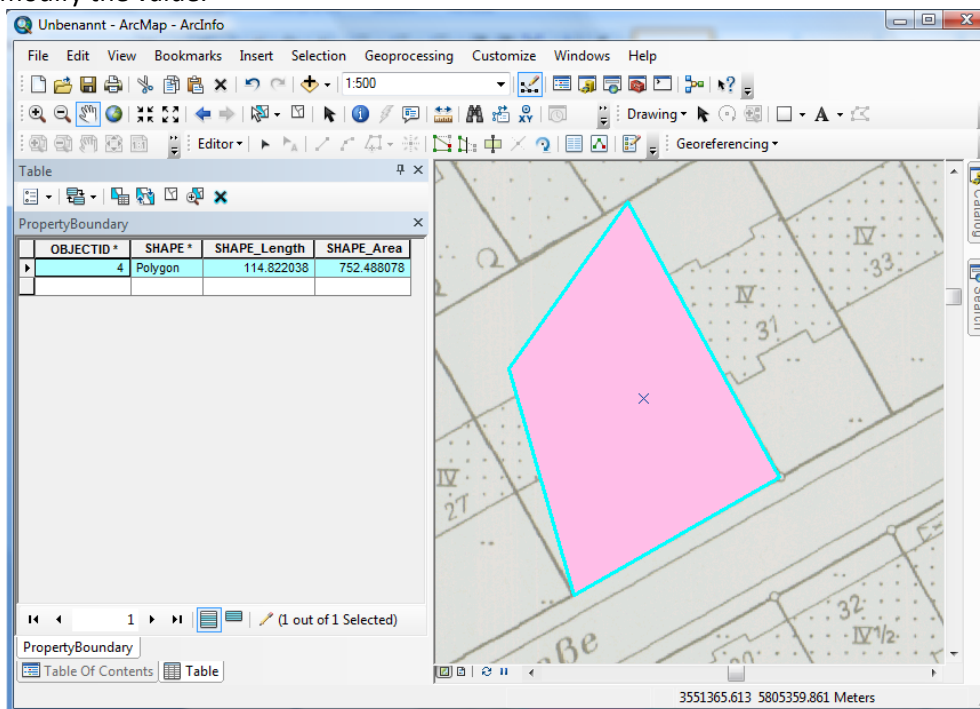
5. Capturing Attribute Data

You can manually edit each value in the attribute table, in which case every value is separately entered or modified. Alternatively, the values can be calculated automatically (geometric calculations or field calculations).

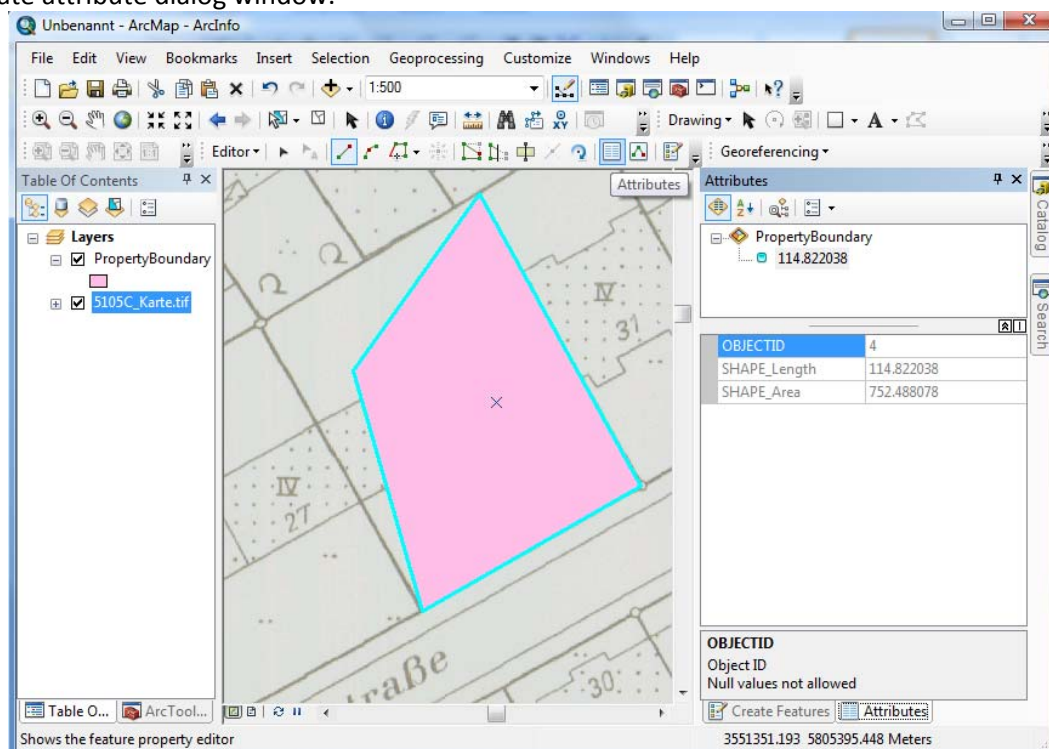
a) Entering Attributes

To enter attribute values, you must start the editing session.

The individual values for a layer can be edited directly in the Attribute table. Click in the field and enter or modify the value.

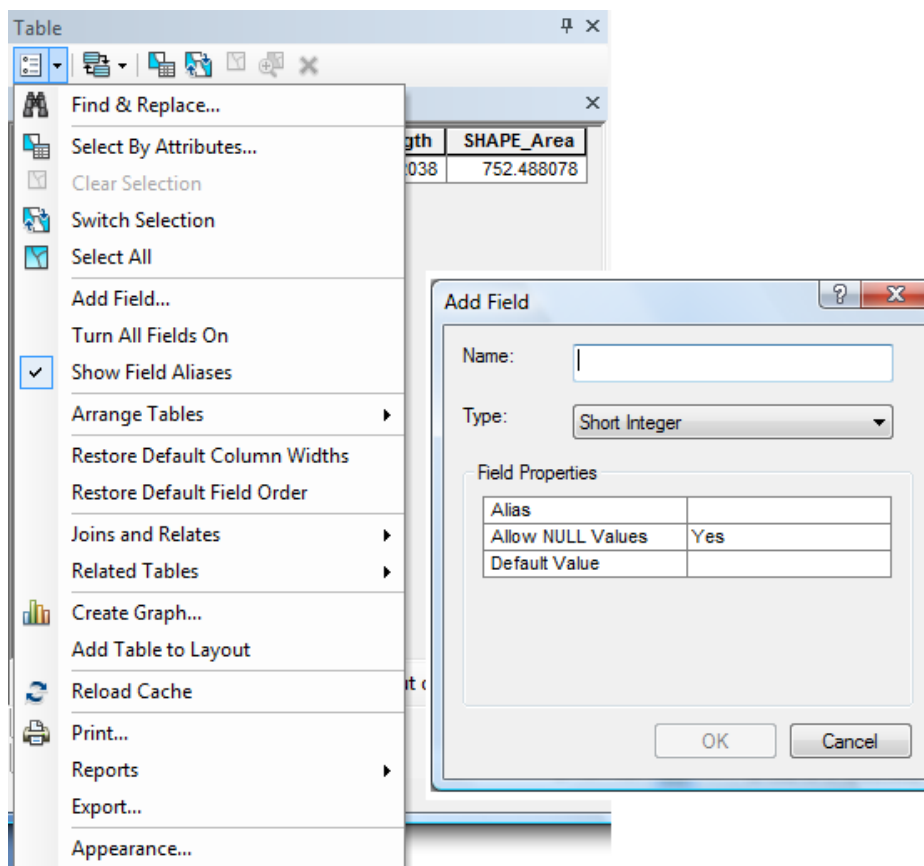


Another way to edit attributes is available in the Editor Toolbar. You can edit the attributes in a separate attribute dialog window.



b) Adding New Field

Deleting or adding a new field to the attribute table is only possible, when no other active editing session is on. A field can be deleted or added to the attribute table through the context menu of the Field.



In the Add Field dialog window, specify the name and data type of the new field and the other field properties like the precision and length.

c) Deleting Records

A record can be deleted by selecting the row of the feature and by using the right mouse click select *Delete Selected* to delete the feature.

