



857.320 (Practical Course)

Remote Sensing and GIS in Natural Resource Management

ArcGIS

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Timetable

Group 1					Key elements:
	Tue	<u>04.10.2016</u>	13:00	16:30	Introduction, ArcGIS & data
	Thu	<u>20.10.2016</u>	09:00	13:00	Preparation to fieldwork
	Thu	<u>27.10.2016</u>	08:30	16:00	Fieldwork
	Wed	<u>16.11.2016</u>	14:00	17:00	Data organization & geodatabase
	Wed	<u>07.12.2016</u>	11:30	13:00	Land cover mapping
	Wed	<u>14.12.2016</u>	16:30	20:00	Land cover mapping
	Mon	<u>19.12.2016</u>	13:00	16:30	Analysis
	Wed	<u>11.01.2017</u>	08:30	12:00	Map layout and summary

Assessment



- Field work 10 points
 - Selection of training areas (5 P.)
 - Interpretation key
 - GPS measurements (5 P.)
 - Data search 5 points
 - Geodatabase 5 points
 - Image Interpretation/Digitizing 10 points
 - Geospatial Analysis/Map Layout 5 points

Minimum of 20 points for a positive mark. All 5 topics have to be completed!



Create the Geodatabase

PART 1

ArcCatalog – Geodatabase (GDB)



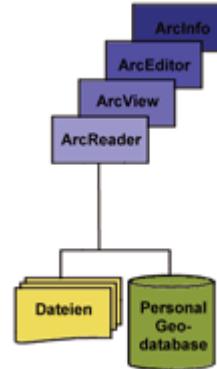
A **Geodatabase** is the „data format“ (model) of **ArcGIS** for storing spatial data and its attributes.

The Geodatabase is a comprehensive series of logic applications and tools for analyzing and managing GIS data.

Personal or File Geodatabase (single use)

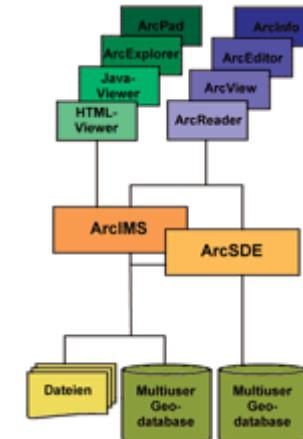
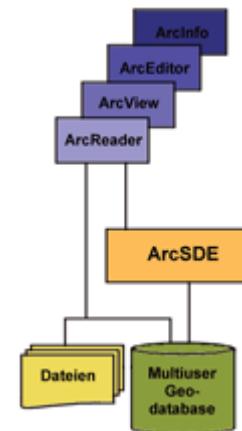
(Microsoft Access .mdb

or File GDB .gdb)



Multiuser Geodatabase

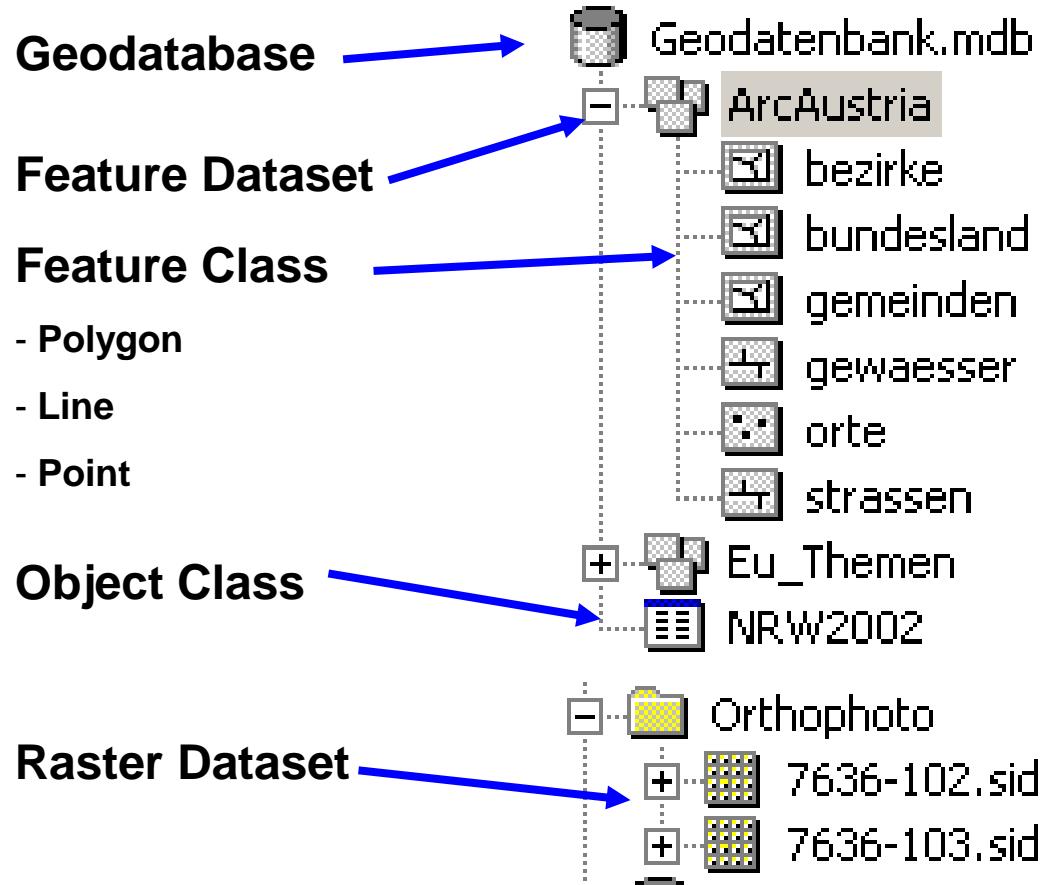
(Oracle, Microsoft SQL Server,
IBM DB2 oder IBM Informix)



ArcCatalog – Elements of a GDB



A Geodatabase comprises one or more **datasets** (Feature or Raster), **feature classes** or **object classes**.



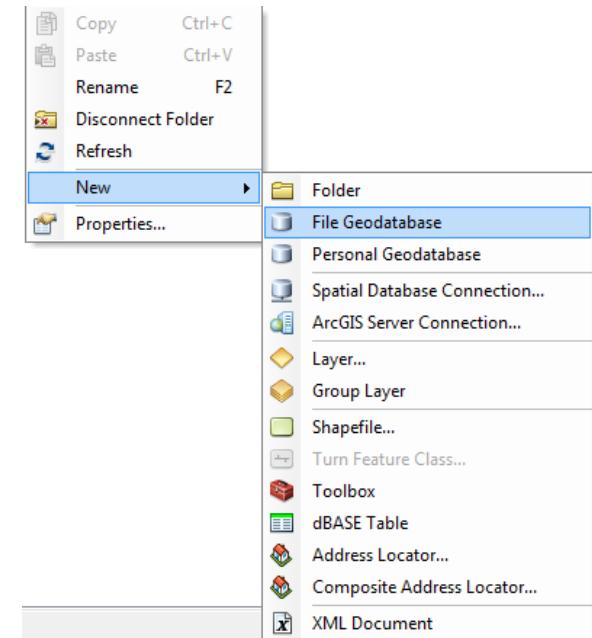
ArcCatalog – GDB and Dataset

Creating a new geodatabase

→ An empty Access database is created on the hard disk

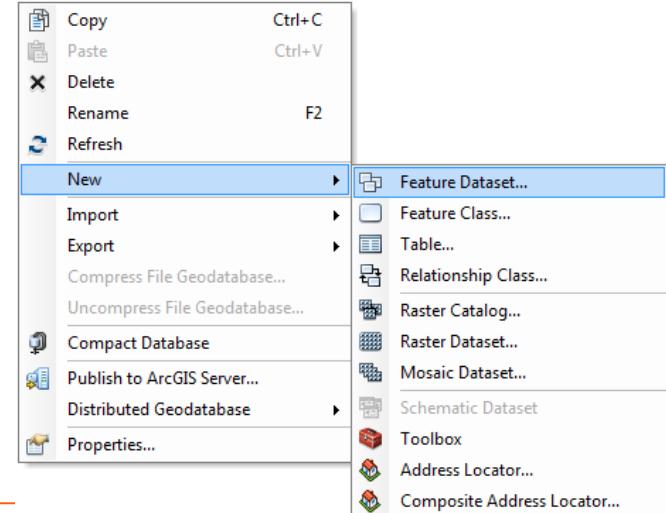
→ Right mouse click

D:\RSGIS1415\Group_X\your_name.gdb



Feature Dataset

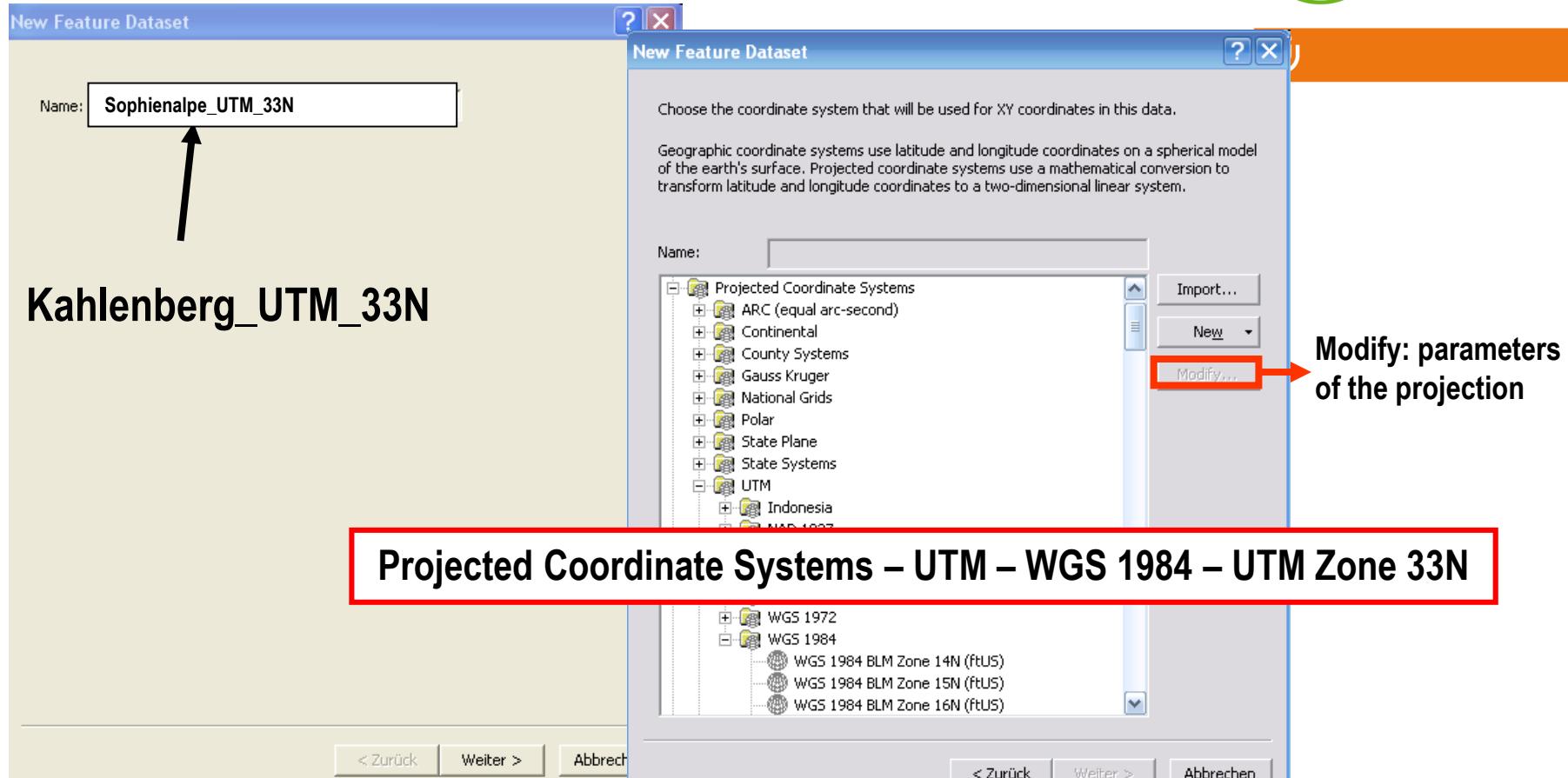
A feature dataset is a collection of feature classes (points, lines or polygons), within the same coordinate system and within the same spatial extent.



Raster Dataset

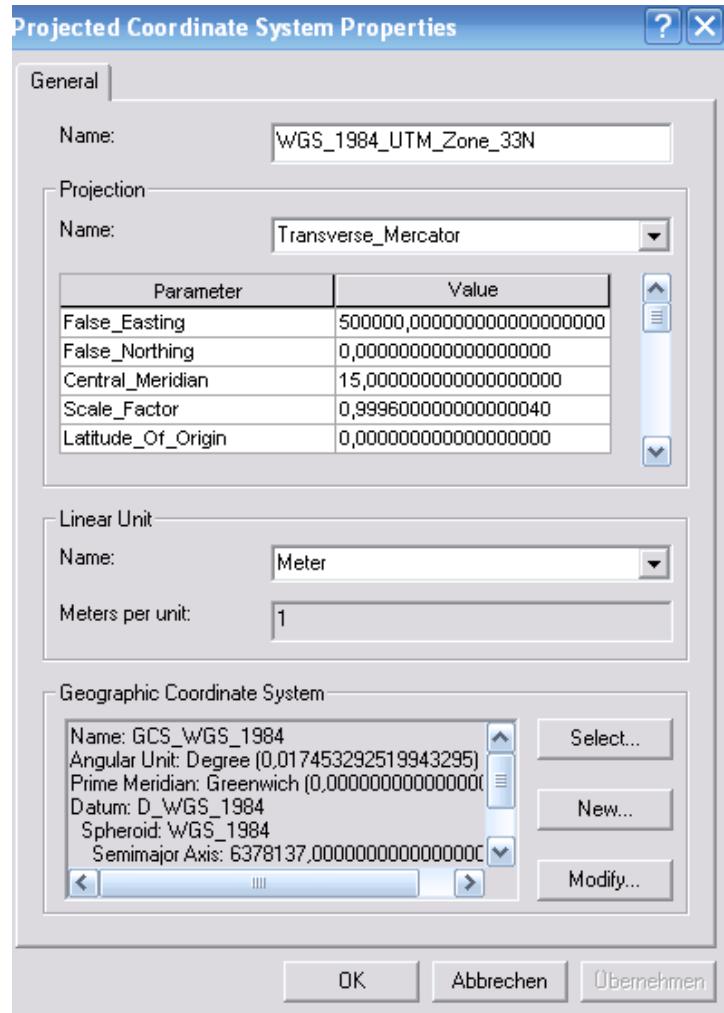
A raster dataset comprises raster data (e.g. TIFF, MrSID, ERDAS Imagine, ...). Also raster datasets should have a projection defined!

ArcCatalog – Feature Dataset



A projection should always be defined, as data exchange is easier and the so called *projection-on-the-fly* in ArcMap works properly!

ArcCatalog – Projection for this project

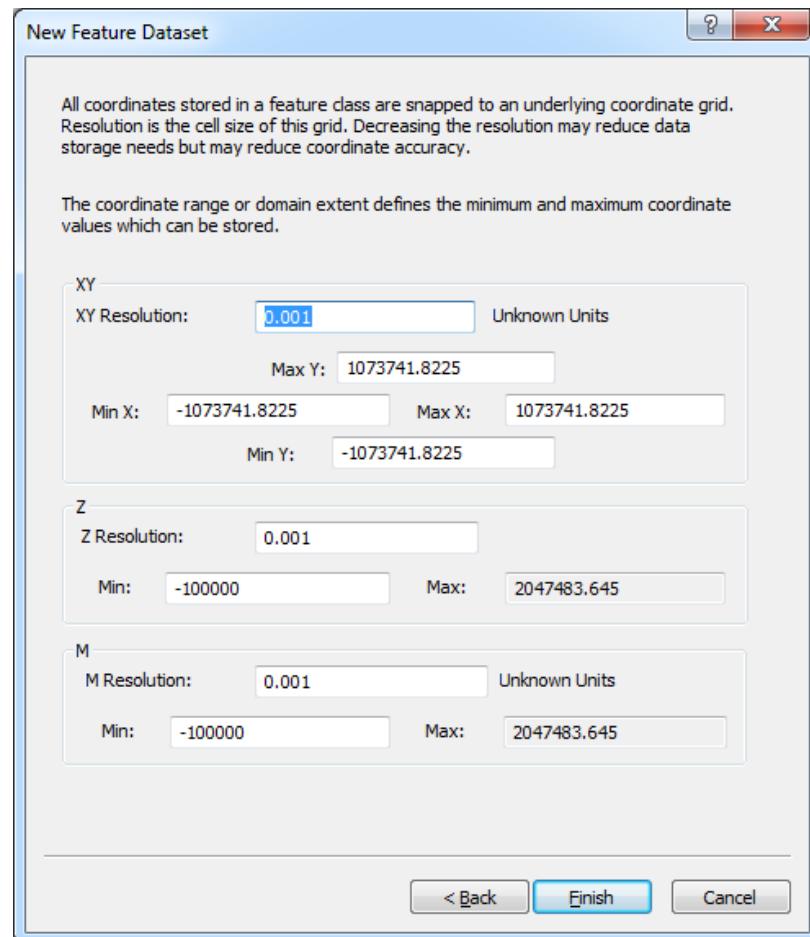
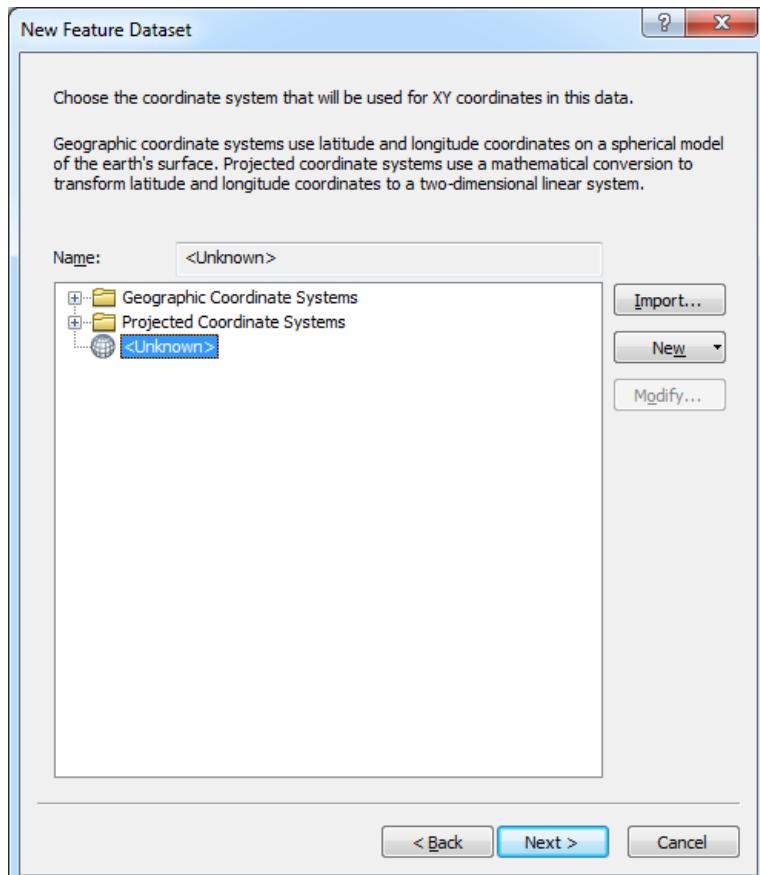


UTM based on WGS 1984 ellipsoid,
zone 33 North (N)

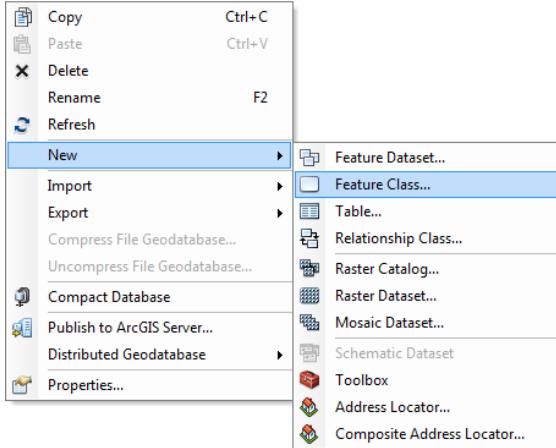


Area of
investigation

Arc Catalog – Feature Dataset



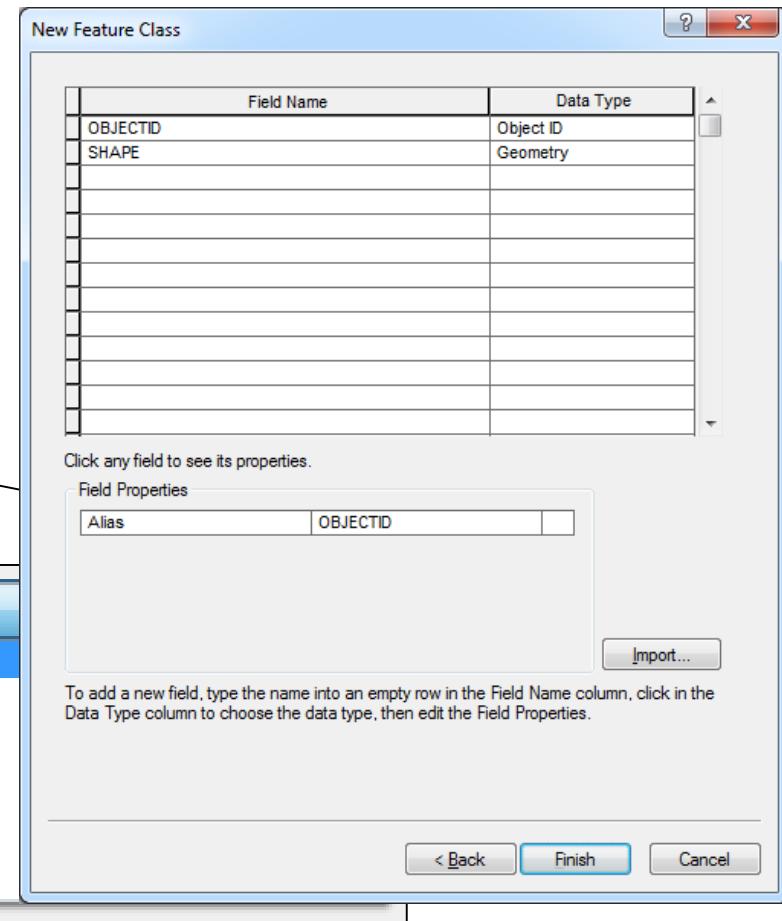
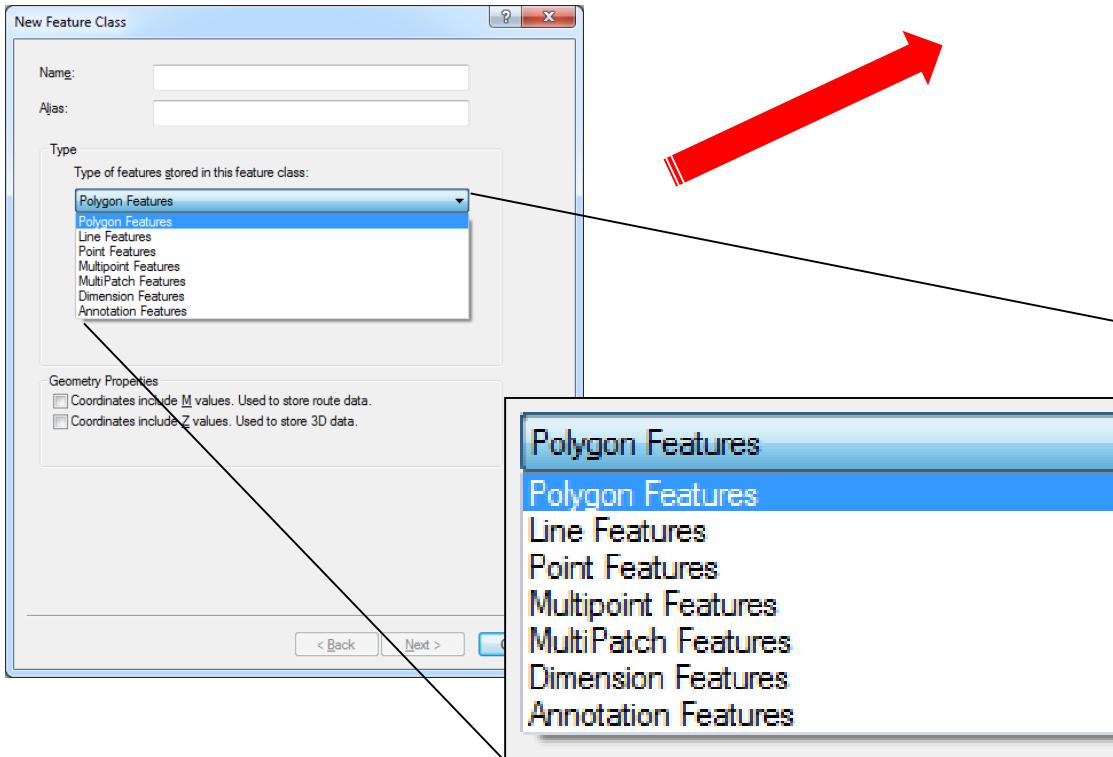
ArcCatalog – Feature Class



A **Feature Class** is a collection of geometric objects of the **same type** (points, lines or polygons).

For a Simple Feature Class no topological relationships between objects exist.

Define Attributes



ArcCatalog – Defining the Project



Create 2 new feature classes:

TYPE LINE (name: road_network)

Attributes:

Field name	Type of data	Remarks
<i>type</i>	<i>short integer</i>	
<i>Remarks</i>	<i>text</i>	

TYPE POLYGON (name: land_cover)

Attributes:

Field name	Type of data	Remarks
<i>Landcover</i>	<i>text</i>	
<i>Code</i>	<i>short integer</i>	
<i>Remarks</i>	<i>text</i>	

ArcCatalog - Metadata

Metadata are **descriptive information** about data and are used for **data documentation**. This is very important when more GIS operators are working on the same data set.

Metadata – Editor

Contents Preview Description

Save Cancel

Item Description

Title Europe Level 3 Provinces

Tags

polygon, provinces, area, boundaries, Europe, 2005, 2005, 1990

Summary

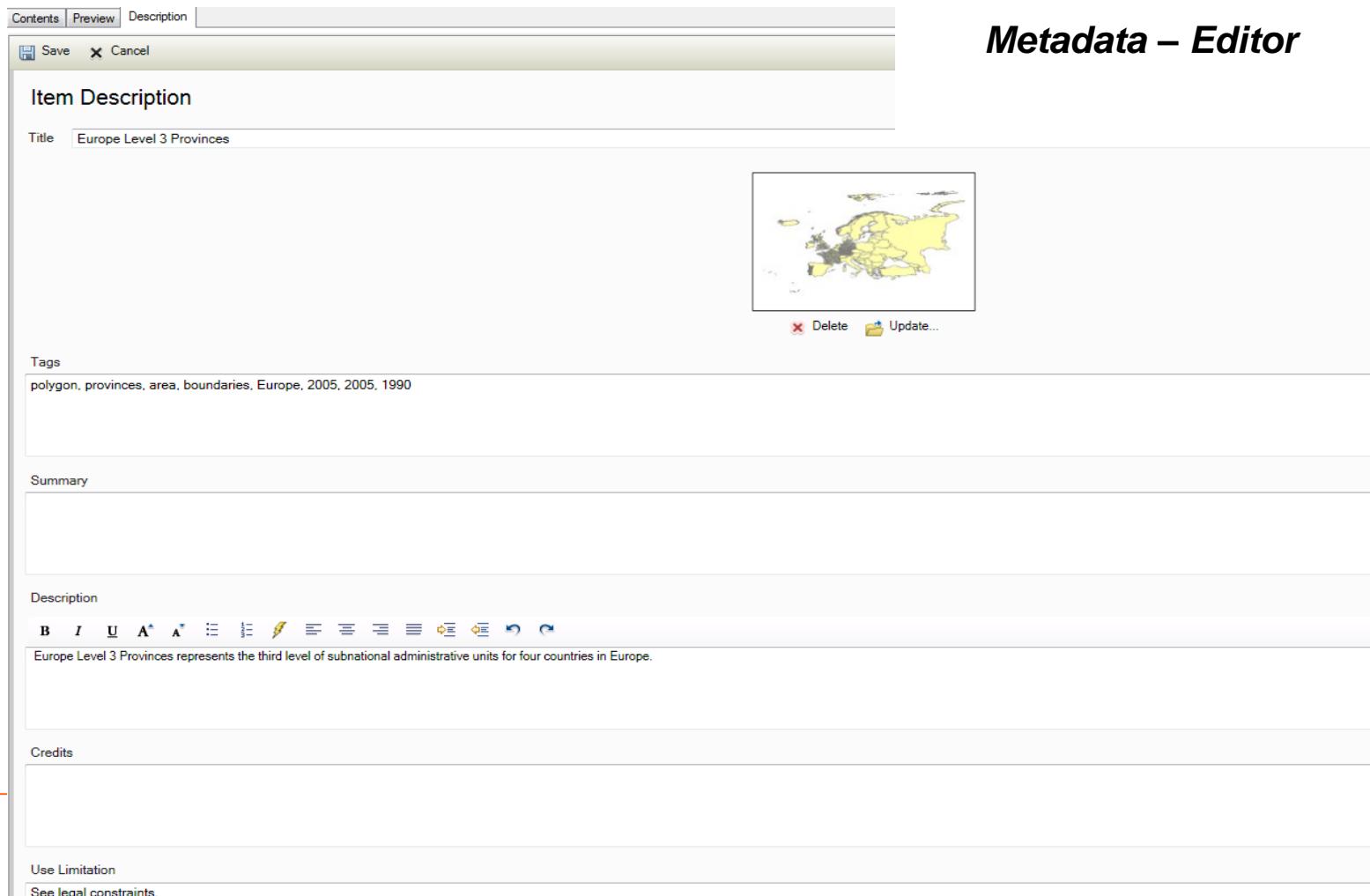
Description

Europe Level 3 Provinces represents the third level of subnational administrative units for four countries in Europe.

Credits

Use Limitation

See legal constraints.





Display GPS point data collected during the field work

PART 2

ArcMap – Import of GPS data



Process and display the GPS point measurements from your field work.

- **Recommendation:** create a MS Excel sheet
- Example number/code, coordinates (x, y), plant species, etc...

A screenshot of Microsoft Excel showing a database table titled "gps_coordinates.dbf". The table has columns labeled A through H. Column A is "EXAMPLE", B is "X_COORD", C is "Y_COORD", D is "SPECIESCOM", E is "HEIGHT", F is "CROWN", G is "AGE", and H is "REMARKS". The data includes entries for four points (A, B, C, D) with their respective coordinates, species names (Grass, Beech, Spruce), and height, crown, and age values.

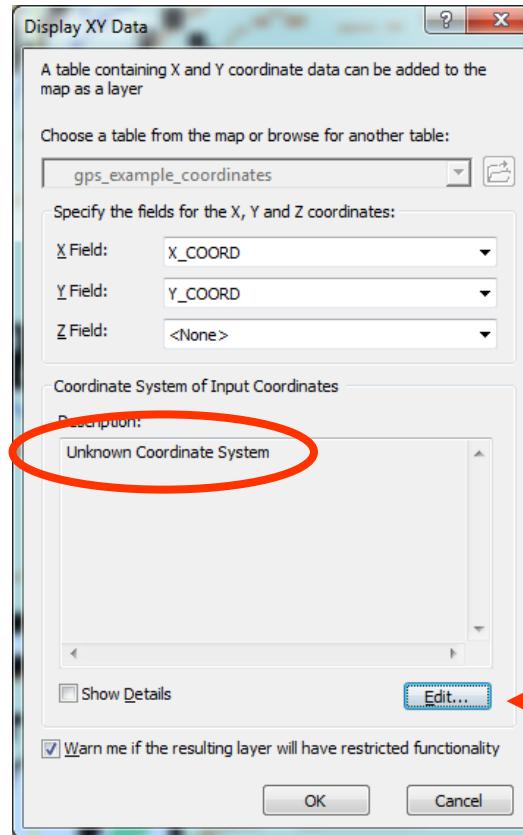
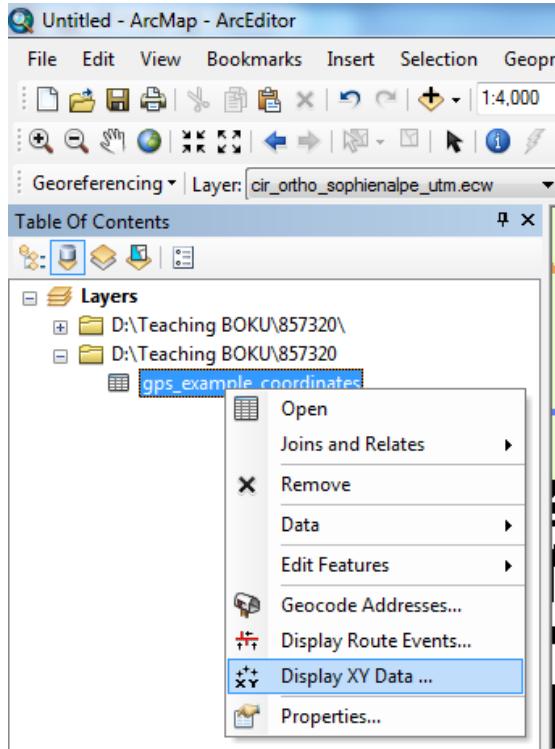
	A	B	C	D	E	F	G	H
1	EXAMPLE	X_COORD	Y_COORD	SPECIESCOM	HEIGHT	CROWN	AGE	REMARKS
2	A	742321.000000000000	345331.000000000000	Grass	0	0	0	
3	B	742913.000000000000	345559.000000000000	Grass	0	0	0	
4	C	741979.000000000000	345158.000000000000	Beech	5	75	5	
5	D	741892.000000000000	344233.000000000000	Spruce	25	50	50	
6								
7								
8								
9								
10								

ArcMap – Import of GPS data



1. Add the Excel file to a new ArcMap document (Add Data)

2. Display XY-Data



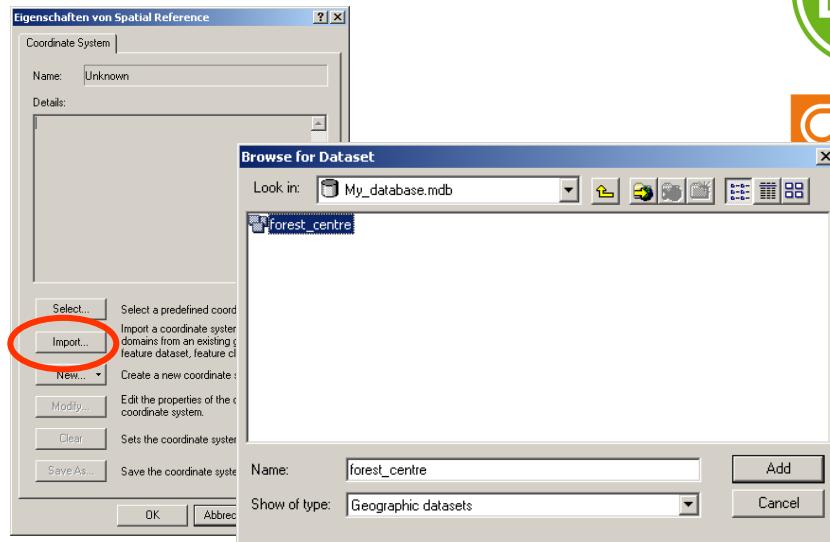
Define a
projection!

ArcMap – Import of GPS data



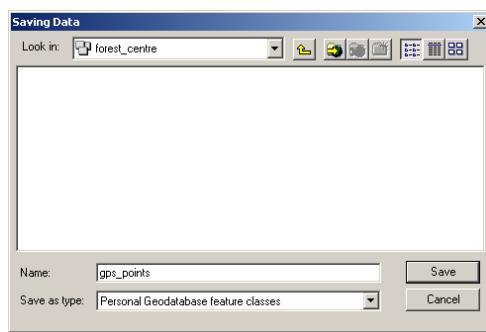
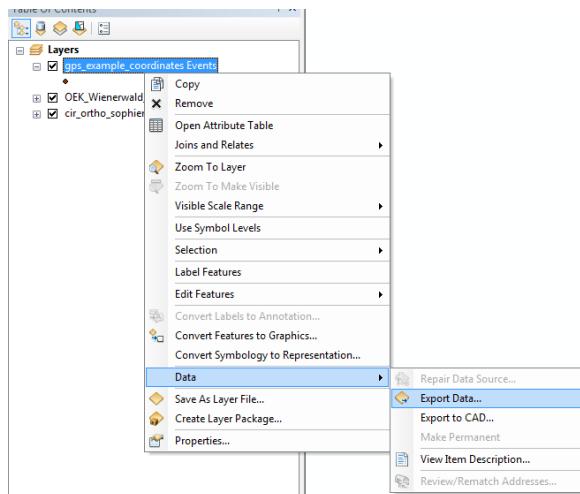
4. Defining a projection *Import...*

My_database/Kahlenberg



Points will be displayed as an **Event Theme**.

5. Exporting Event Theme as Feature Class





Display GPS track and waypoints (use of data from GPS devices)

Your tracks can be downloaded as DXF-file from BOKUlearn

ArcCatalog – Import/Export

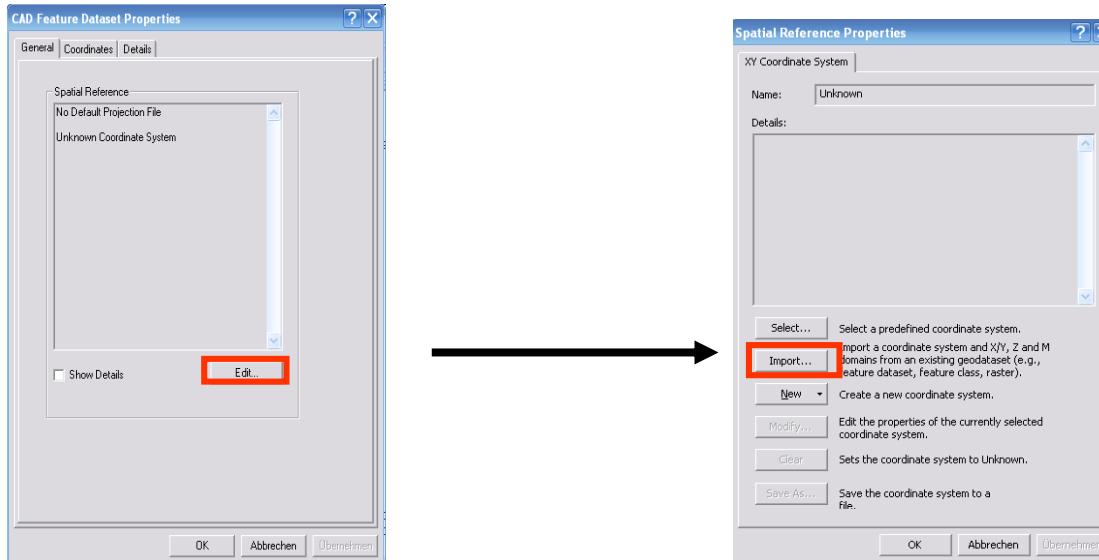


Import GPS track measurements into the database

1. step: assign projection to DXF-dataset

Select DXF-dataset:

Right mouse button – Properties



→ Import
settings from
GDB-Feature
Dataset

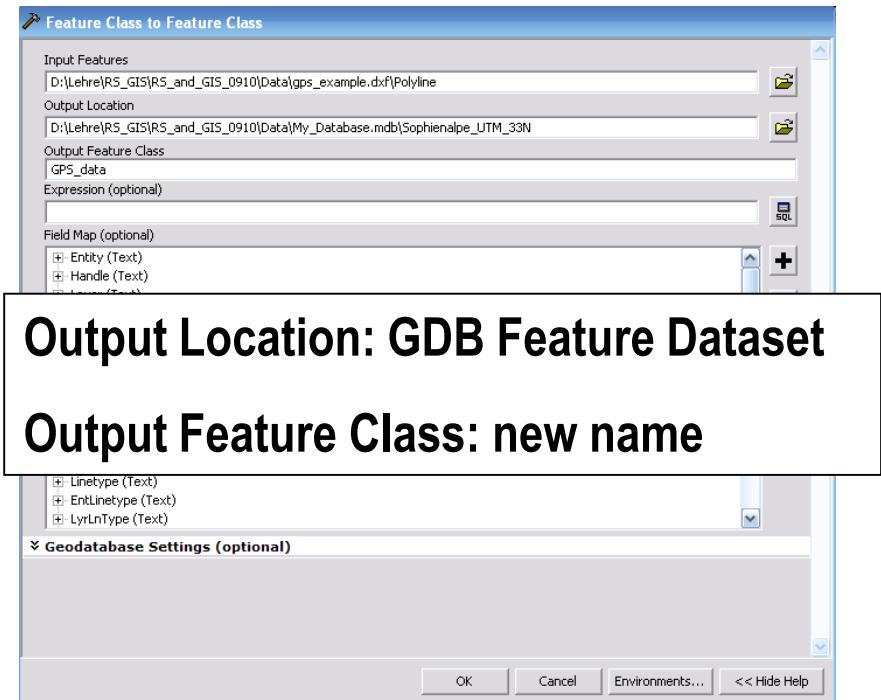
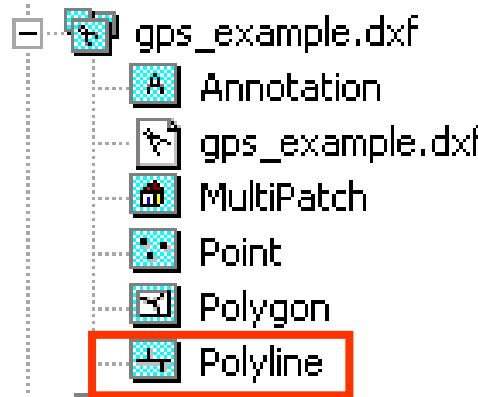
ArcCatalog – Import/Export



2. step: export DXF to Geodatabase – Feature Dataset

Select Polyline from DXF-dataset:

Right mouse button – Export... - to Geodatabase (single)



Learning outcomes Part 2



- I have completed the excel file with a list of coordinates
 - I can import and display the GPS data from the excel file
 - I can import and display the GPS data (Points and Track) from the GPS device
 - I saved these features classes in my Geodatabase (this is part of the evaluation)

■ Geodatabase with GPS points 5 points



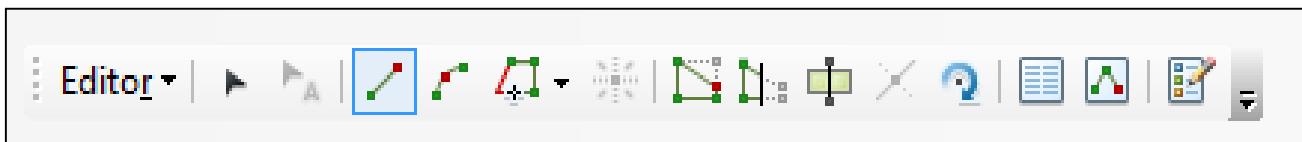
Feature class data editing in ArcMap

PART 3

ArcMap – Editing Data



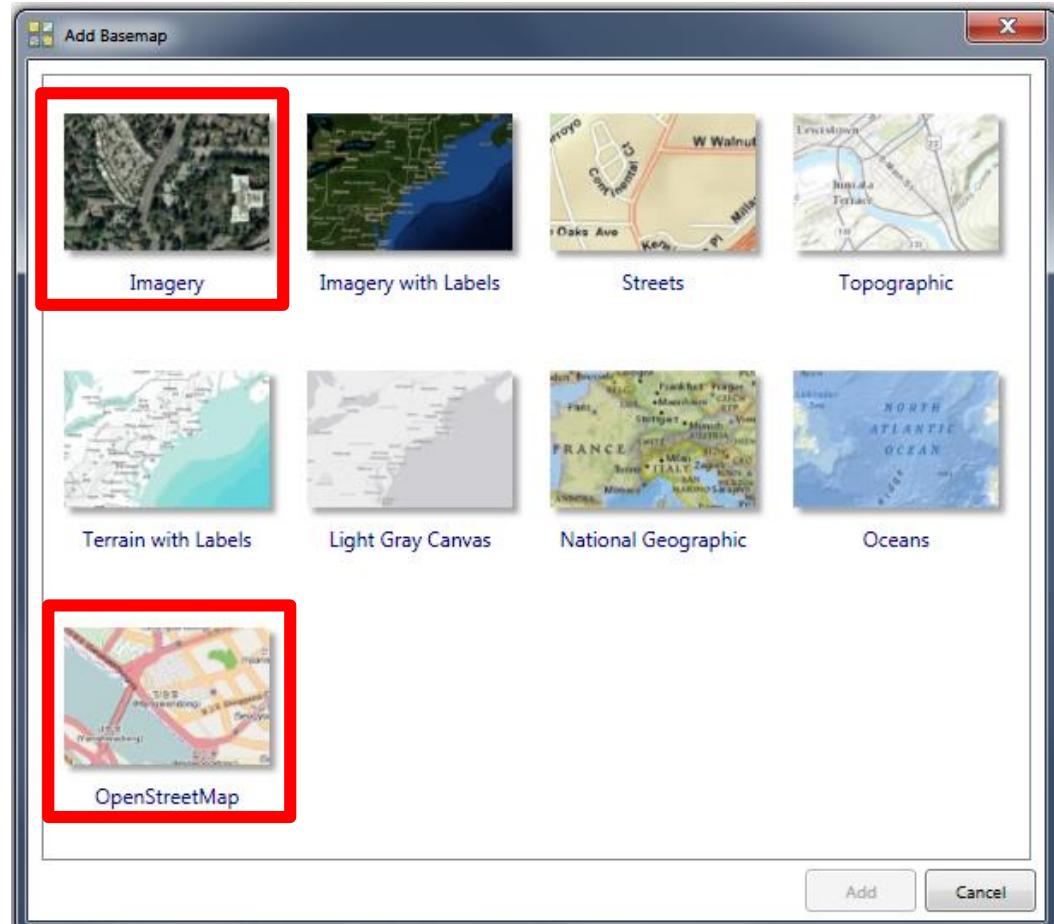
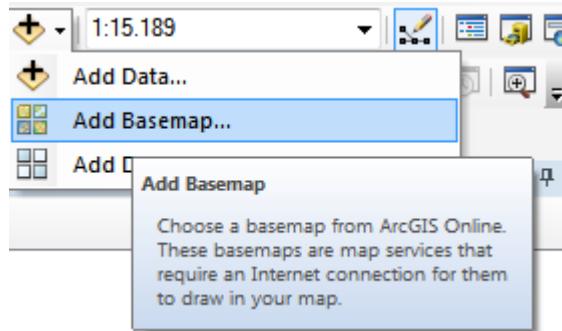
- Load the following data sets to a new Data Frame:
 - Feature Classes of Your Geodatabase (roads, land_cover)
 - Boundaries of area of interest (Exercise_Kahlenberg – AOI)
 - Orthophoto (Exercise_Kahlenberg – OP_Kahlenberg)
 - Map (Exercise_Kahlenberg – OSM_Kahlenberg)
 - Satellite images
- Open the Editor-Toolbar: **Customize – Toolbars – Editor**



ArcMap – Editing Data



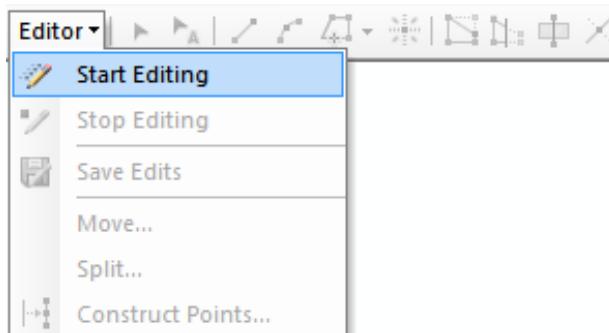
■ Loading online-basemaps



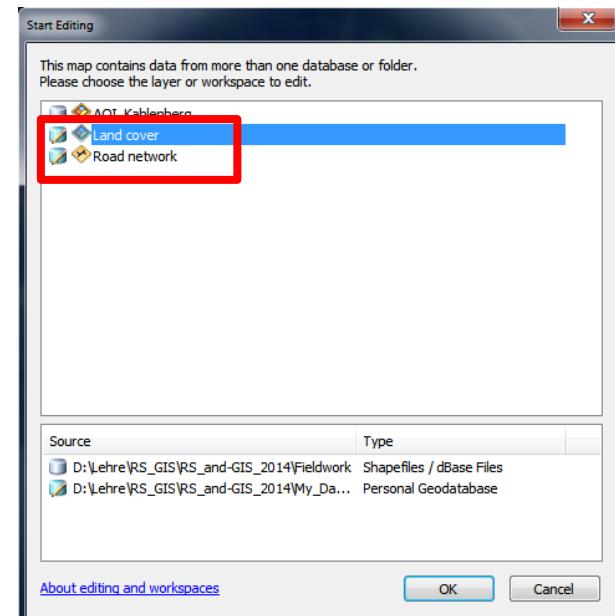
ArcMap – Editing Data



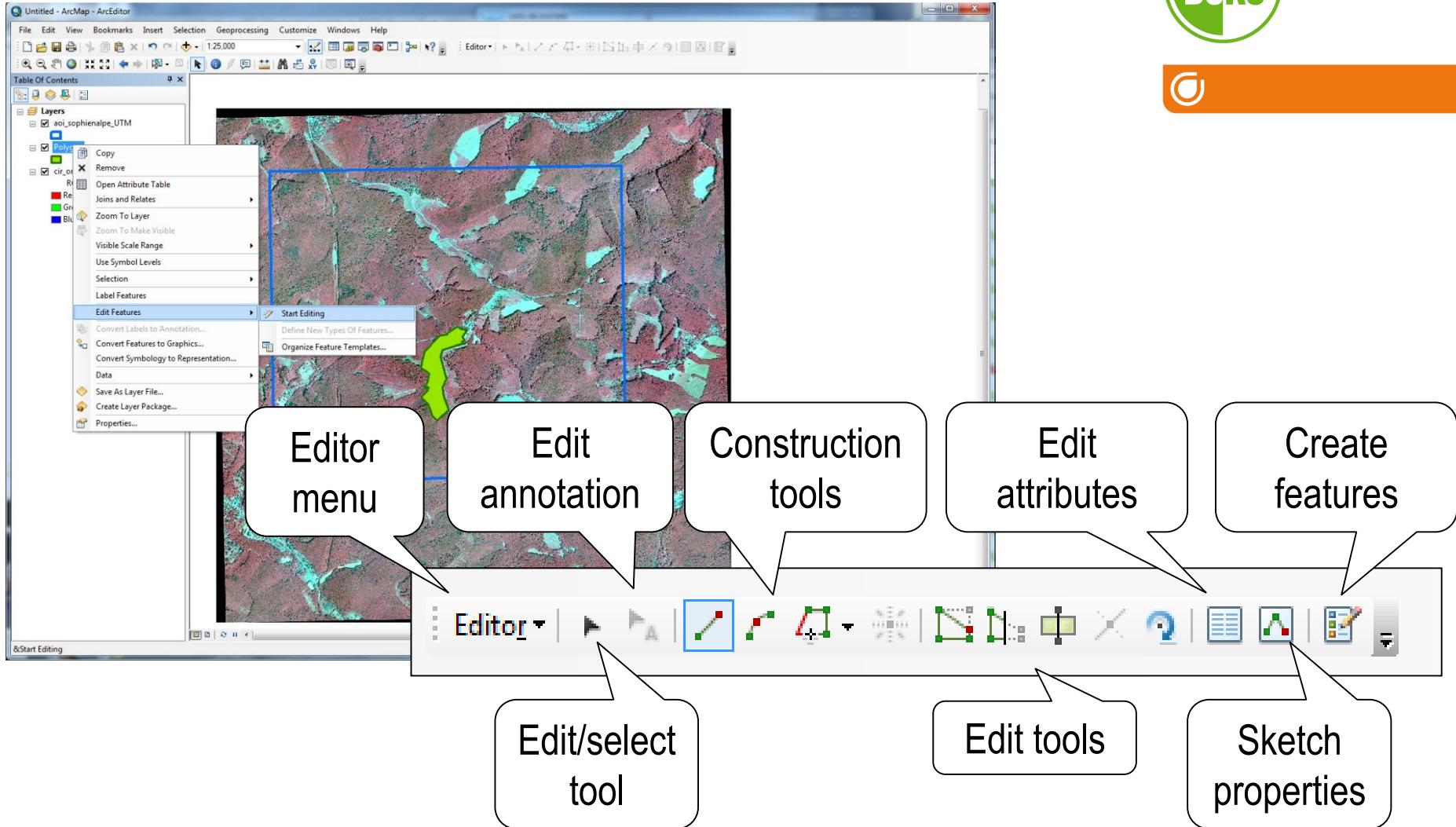
■ Start Editing



- Select the data you want to edit:
 - **land cover**
 - **road network**



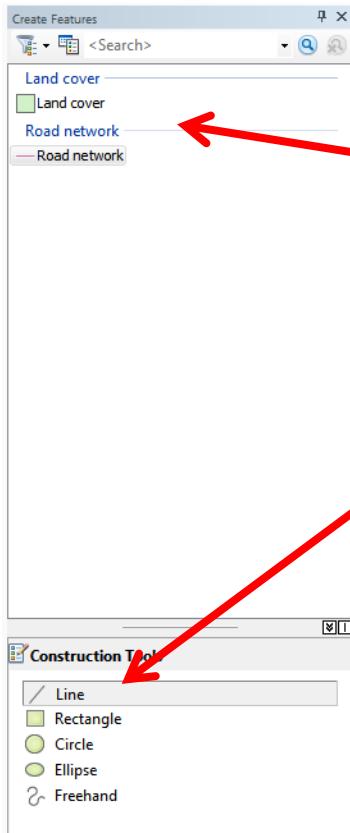
ArcMap – Editing Data



ArcMap – Editing Data



■ Create new features

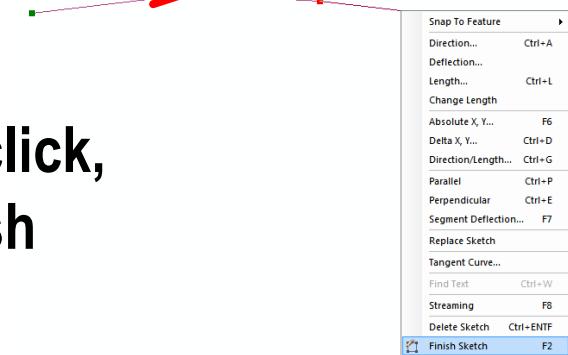


1. Select feature class to edit

2. Select construction tool

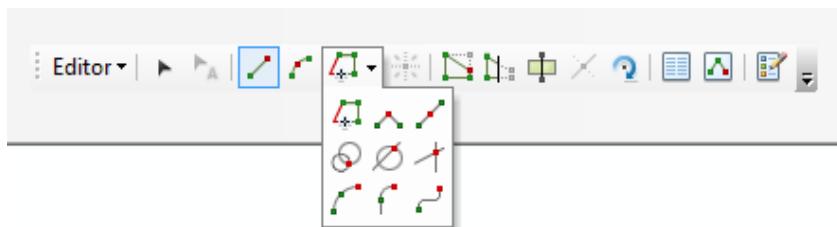
3. Left mouse button: add vertices

4. Finish sketch: double click, right mouse button – finish sketch, F2



ArcMap – Editing Data

Select the appropriate tool



A **sketch** is a feature created when editing

Sketch Tool: digitizing points, vertices of lines and polygons;

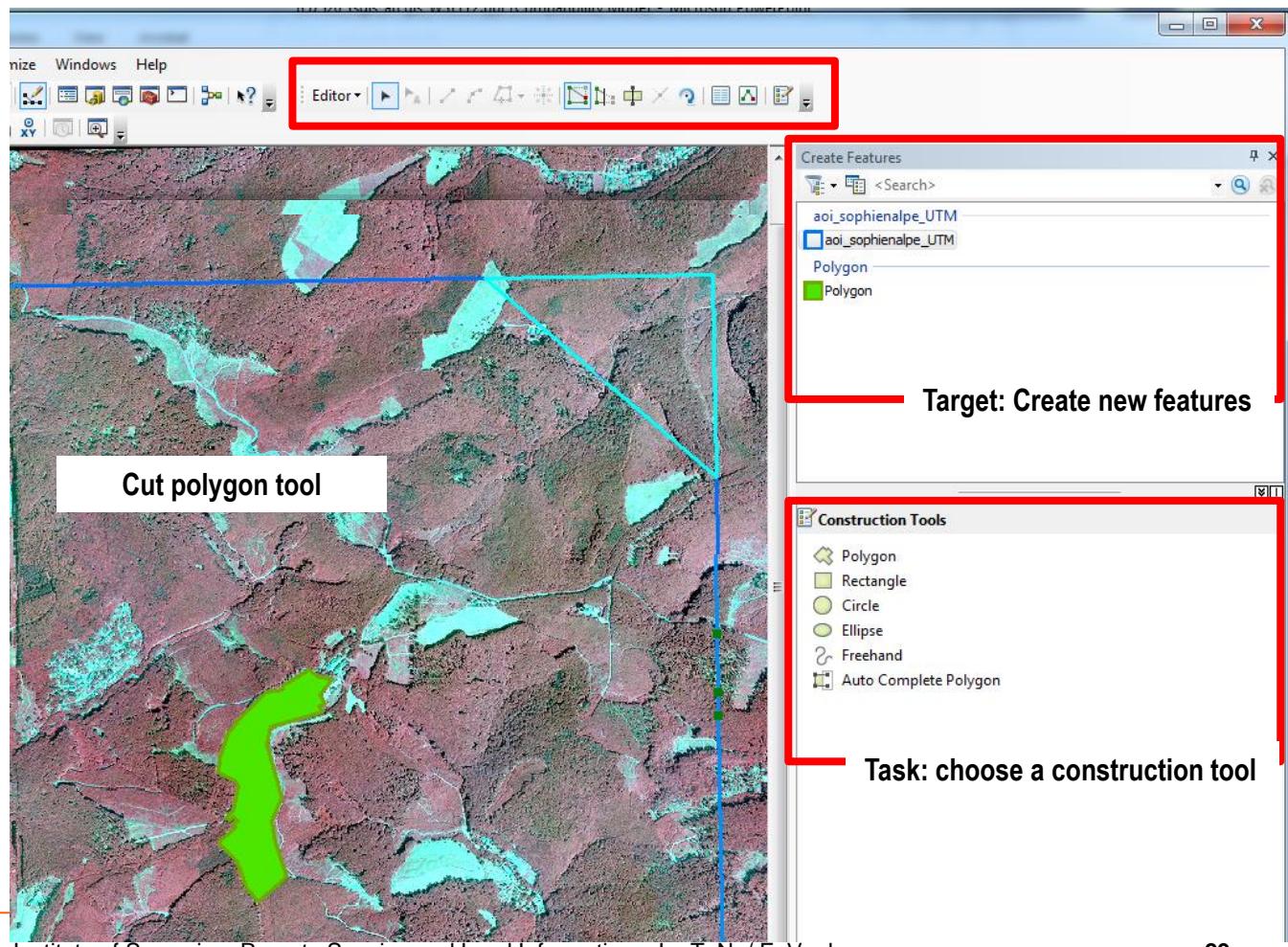
„finish with a double click or use F2“

- **End Point Arc Tool:** creates a circular arc segment in the sketch
- **Trace:** creates segments by tracing over the segments of selected features
- **Mid Point :** creates a new point in the sketch at the midpoint of a line segment
- **Distance – Distance:** creates a point or vertex at the intersection of two distances from two points (press R or D to set the distance)
- **Direction - Distance:** creates a point at the intersection of a direction from one point and a distance from another one
- **Intersection:** creates a point or vertex at the implied intersection of two segments
- **Arc segment:** creates a circular arc segment in the sketch
- **Tangent:** the new segment is tangential to the previous sketch segment

ArcMap – Editing Data



Overview of the editing capabilities



ArcMap – Editing Data

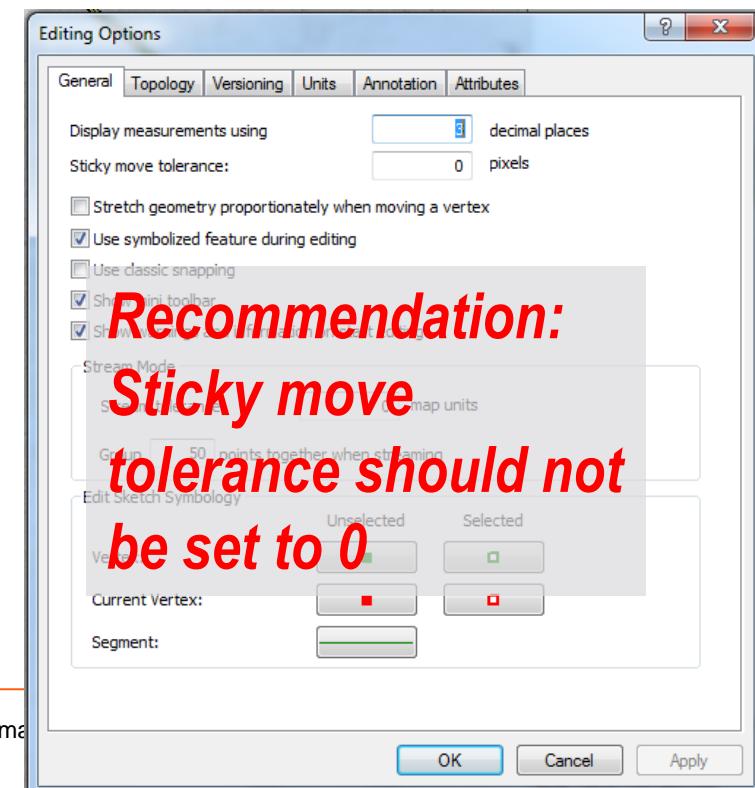


The **Snapping Environment** can help to establish exact locations in relation to other features.

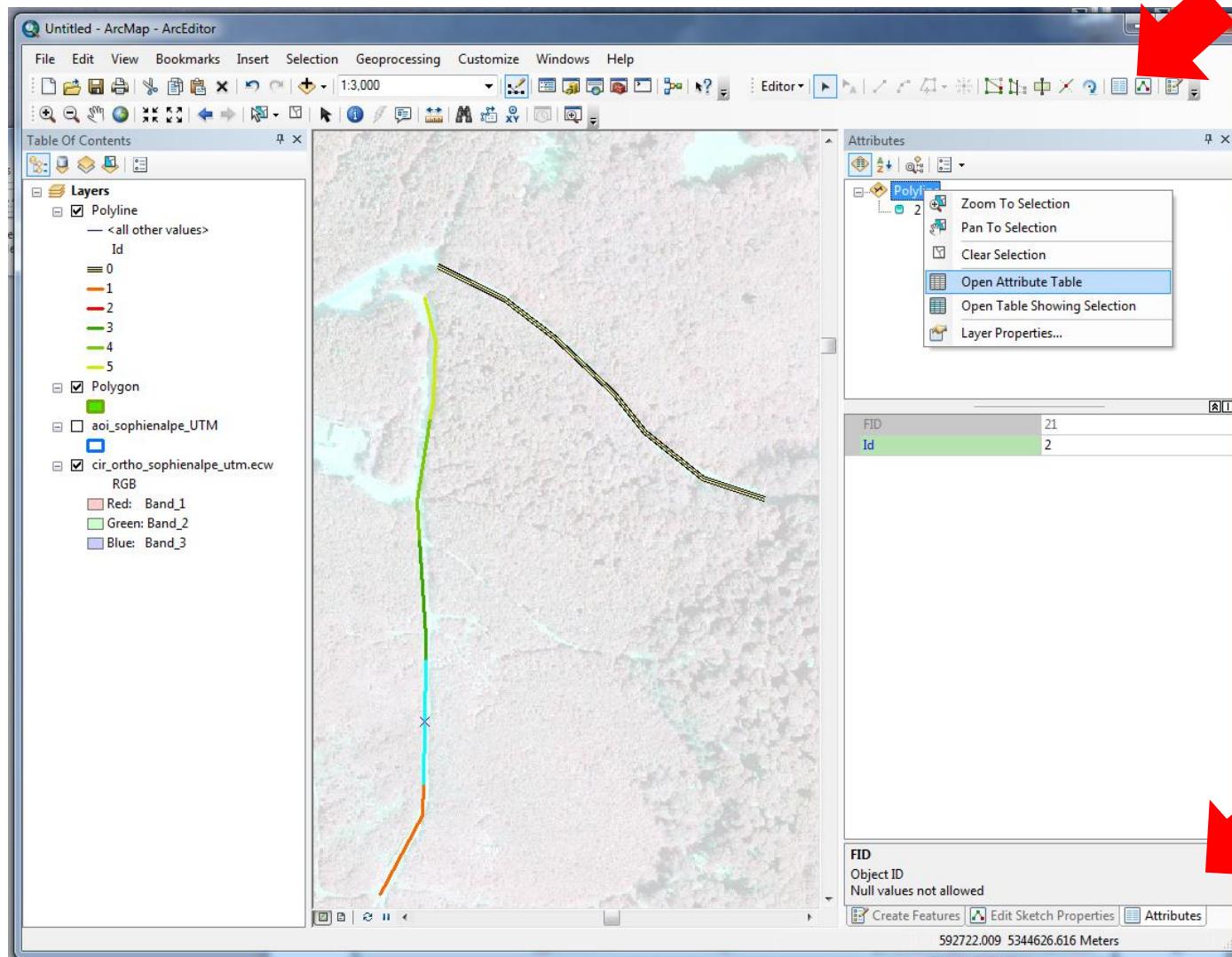
You choose which layer you want to use and the type of snap.

Use the options of the menu (Editor – Options...) to define the distance within the pointer is snapped to another location.

Sticky move tolerance: when an object is moved to a new location (mouse)



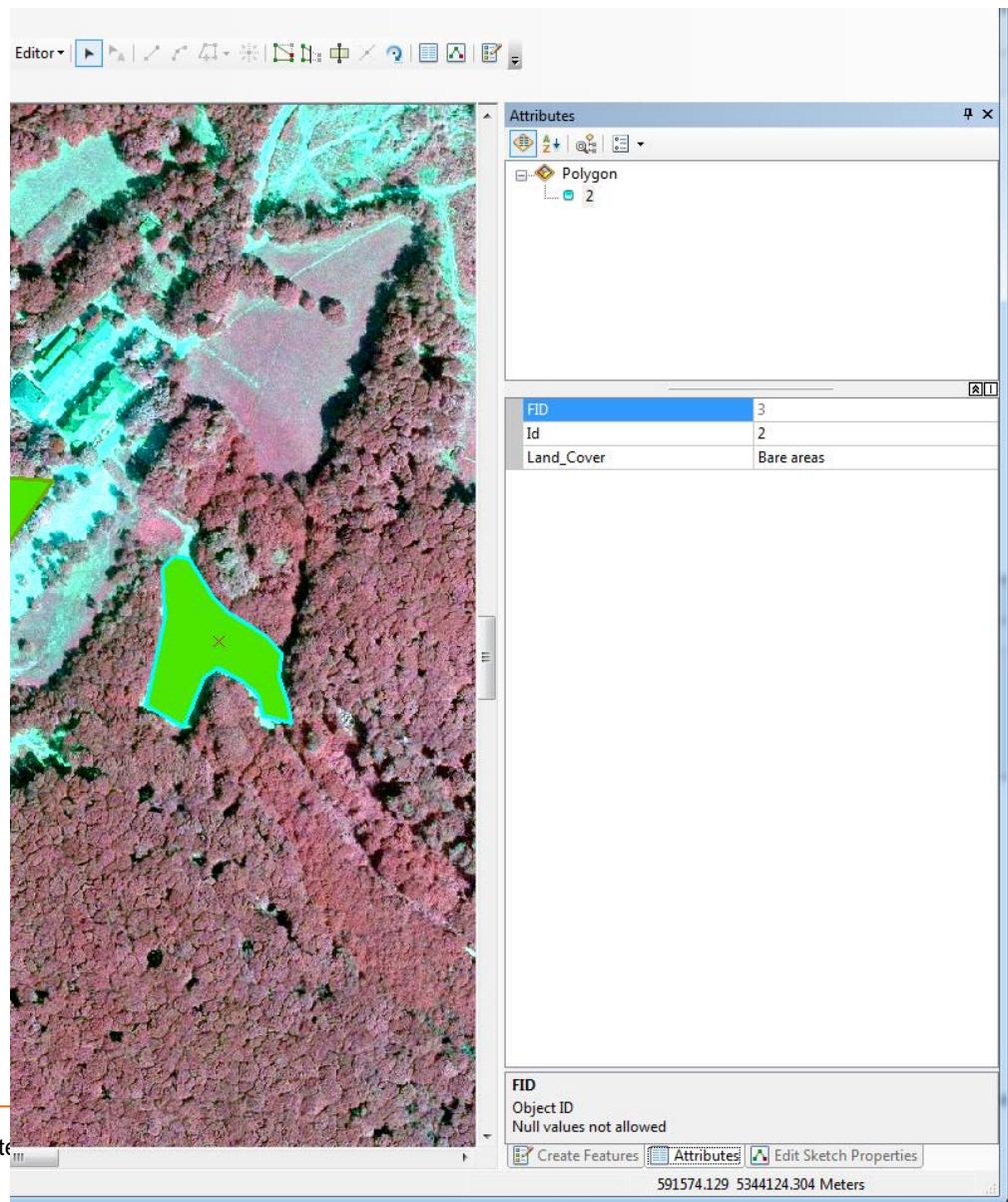
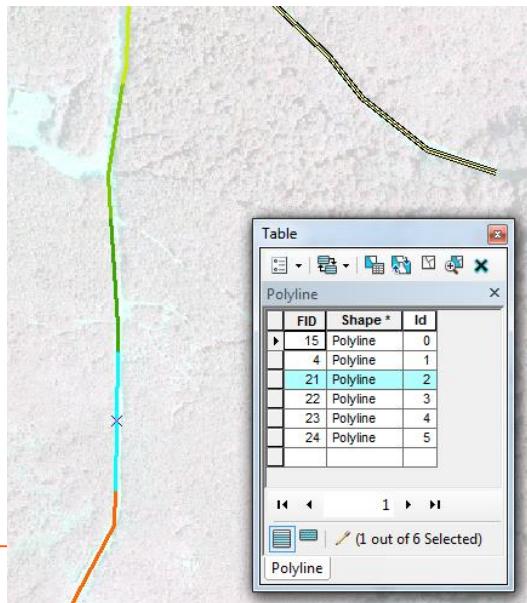
ArcMap – Editing Data add attributes



ArcMap – Editing Data add attributes

Create a new or line polygon and add attributes to the feature (must be selected)

→ Attributes are written to the database and the corresponding tables can be edited later.



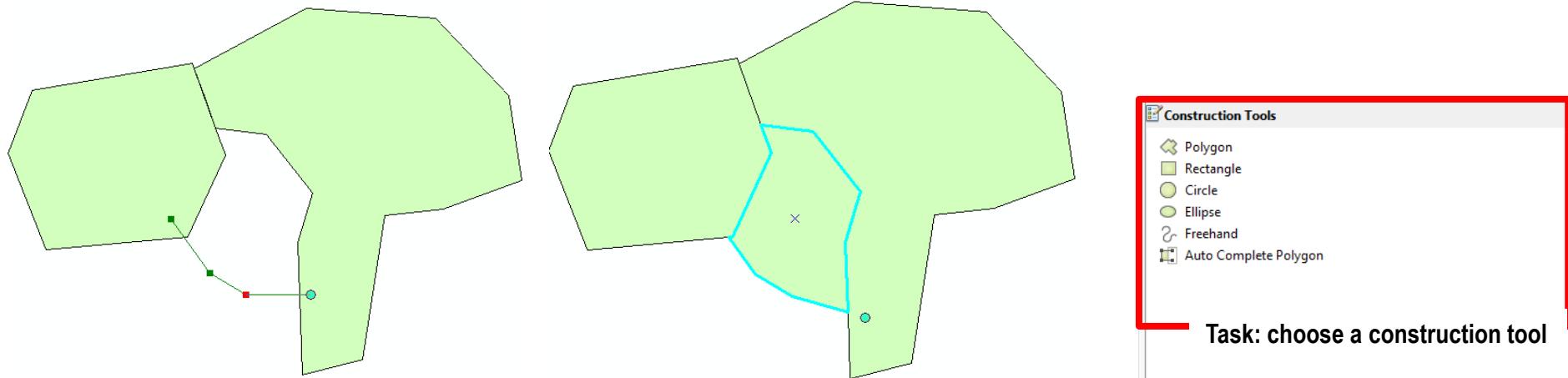
ArcMap – Editing Data



Topology

For topological editing numerous functions are available (in addition there is a separate toolbar). One of the most important functions is **Auto Complete Polygon**.

- **Auto Complete Polygon:** polygons are automatically completed using existing polygon geometry.



Arc Map – Editing Data



Road network – based on the OpenStreetMap:

Type of road:

1 – Major road

2 – Secondary road

3 - Path

4 - Other

Land cover – based on the interpretation key as created after field work :

Species :

1 – Built-up 6 - ...

2 - Agriculture

31 - Forest/Broad leave

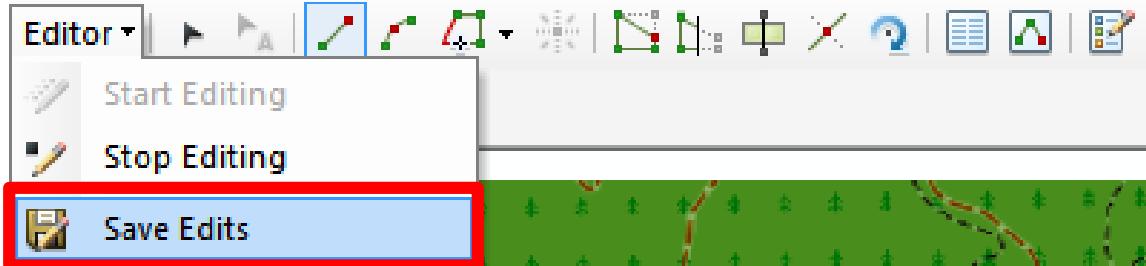
32 - Forest/Coniferous

33 – Forest/Mixed

Arc Map – Editing Data



■ Save Edits



- New features are first kept in the cache
- Save edits: new/modified features are written to the GDB
- There is no automatic save!!!!
- Stop editing: „emergency exit“ in case of unwanted modification of the data set → don't save edits.

Mapping rules



- **Minimum Mapping Unit (MMU):** 1 ha (see *attribute table!*)
- **Minimum width:** 40 m (*measure tool*)
- Small objects will be part of larger neighbouring objects
- Object boundaries: meaningful generalisation! Dont' delineate single tree crowns!

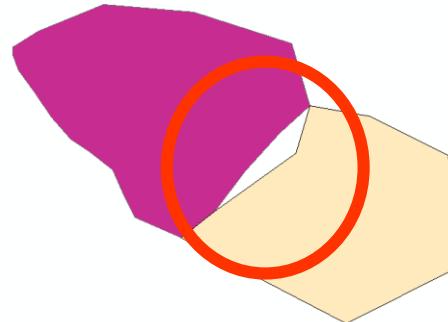
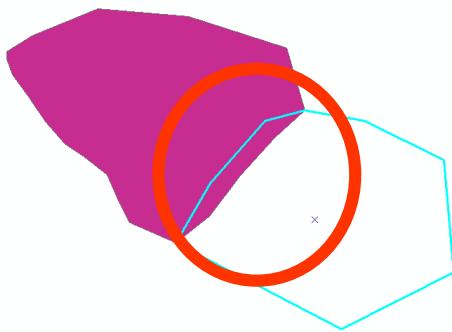
Most common mistakes



- Accuracy, generalisation



- Overlaps, gaps



Learning outcomes Part 3



- How to activate the editing mode
- How to draw a line or polygon, modify the vertices, cut a polygon, snapping
- I am aware of The Minimum Mapping Unit and of the common mistakes!



Advanced feature class editing

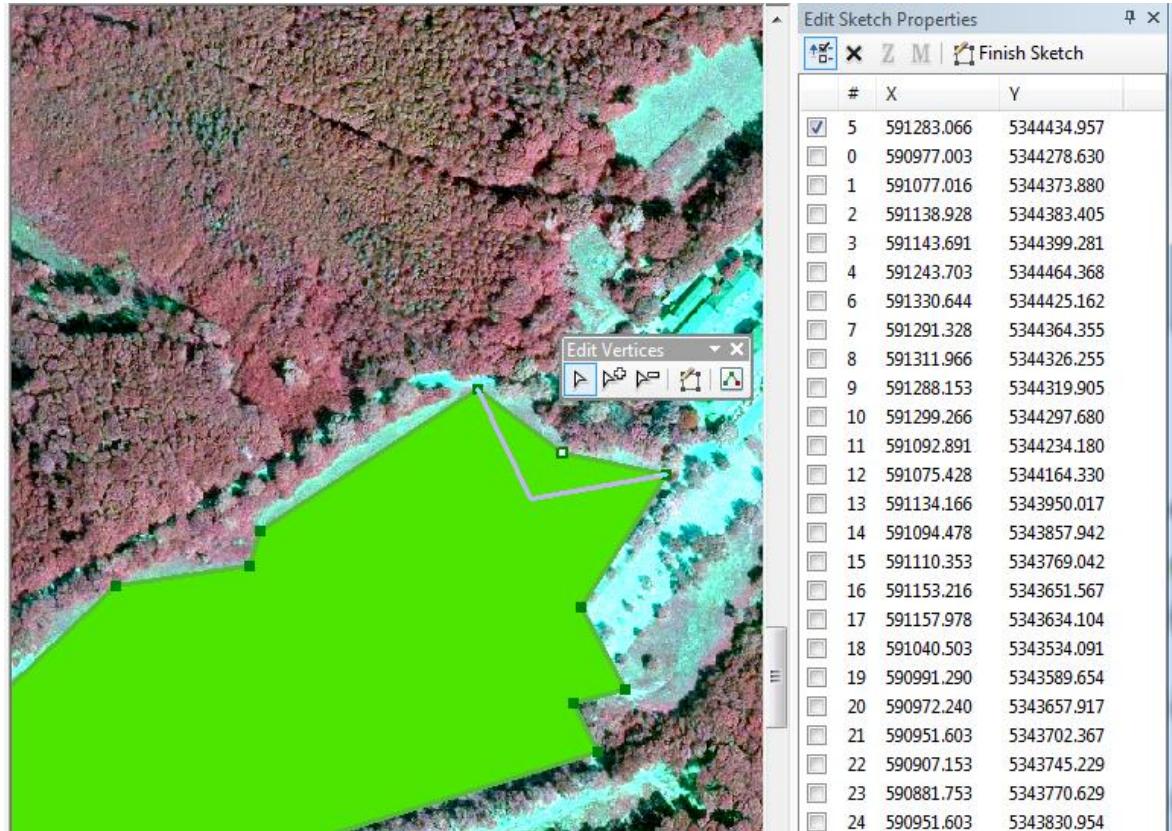
PART 4

ArcMap – Editing Data Properties of a sketch 1

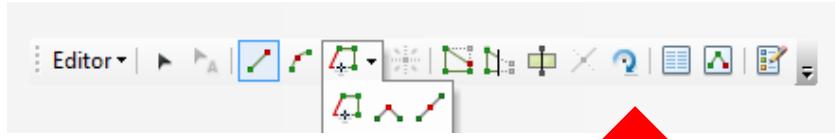


A double click with the **Edit/select Tool** shows the vertices of a line or a polygon.

The vertices can be edited:
Use the edit verticesmini
bar to modify vertices.



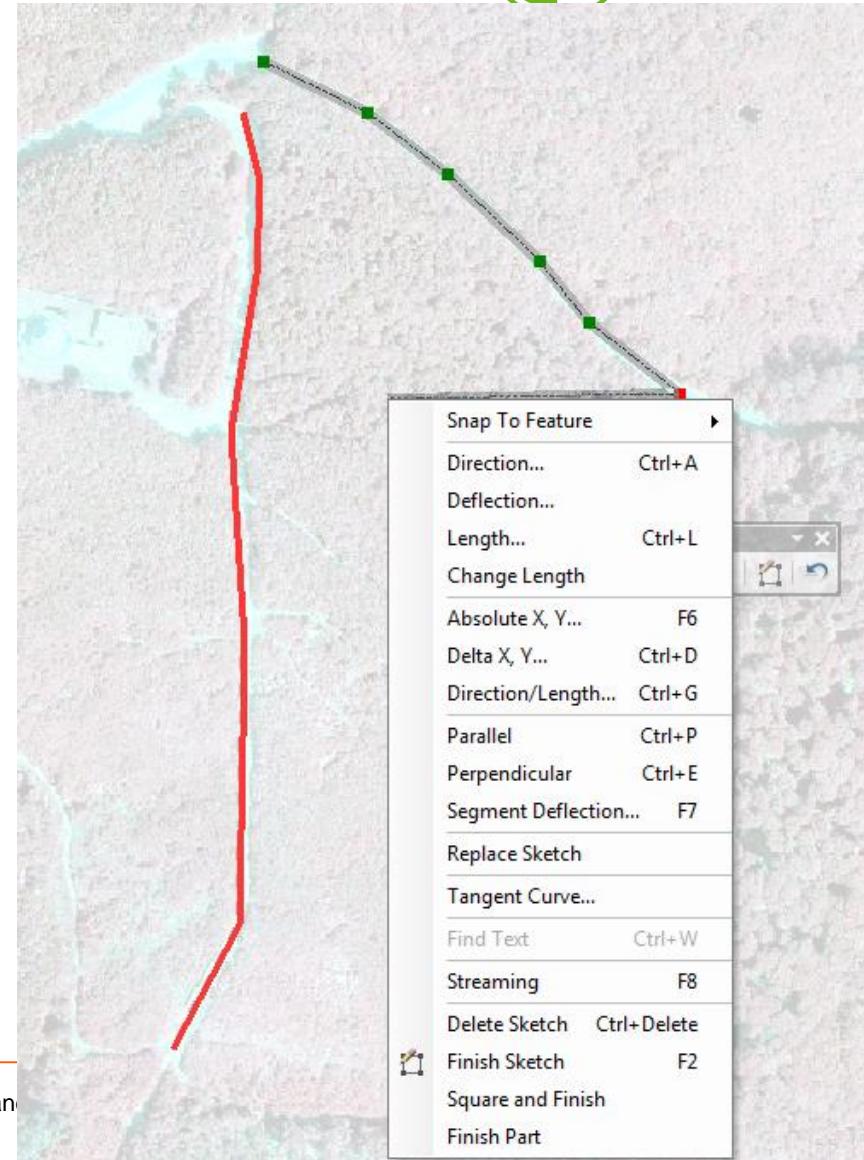
ArcMap – Editing Data Properties of a sketch 2



Rotate Tool: selected object is rotated. The anchor point can be moved. When pressing A, an angle can be defined.

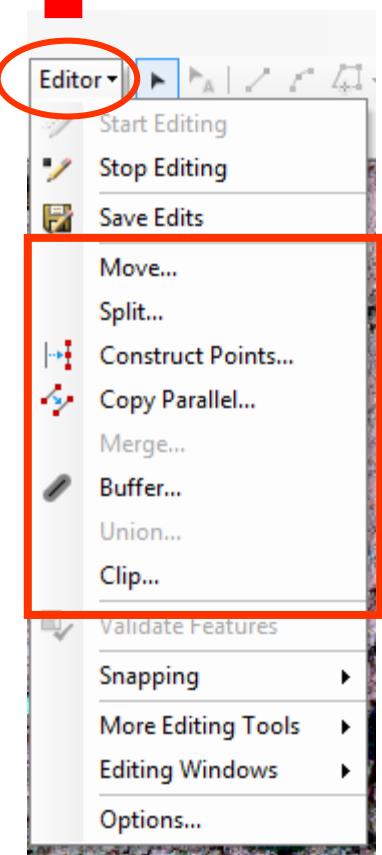
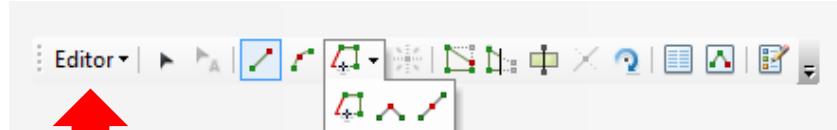
Sketch Tool Context Menu

Pressing the right mouse button during the editing session, opens the sketch tool context menu.



ArcMap – Editing Data

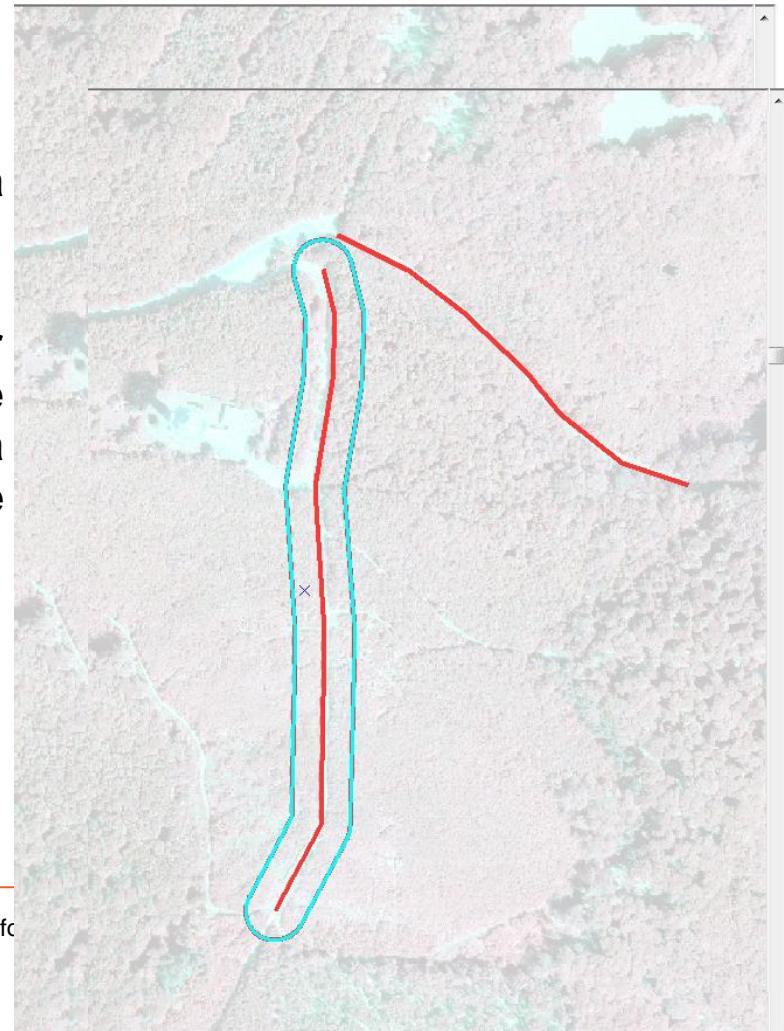
Editor menu



- **Move:** enter delta x and y
- **Split:** splits a line using a distance or a percentage
- **Buffer:** calculates a buffer around a selected line. The result is either line or a polygon, depending on the type of the target layer.

A list of commands to modify already existing features.

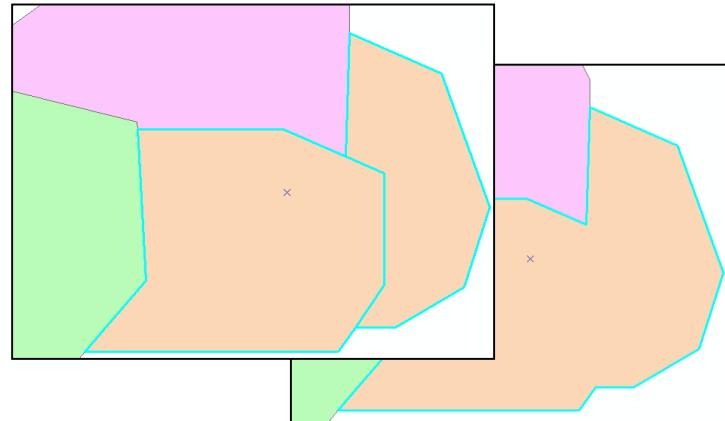
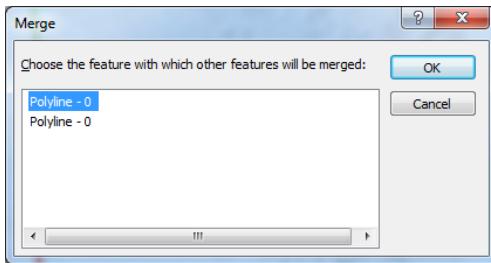
Select features first!



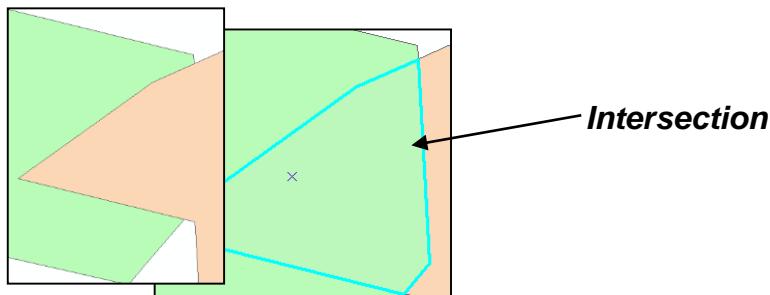
ArcMap – Editing Data

- **Merge:** merging selected features

When features are not adjacent,
a multipart feature is created.



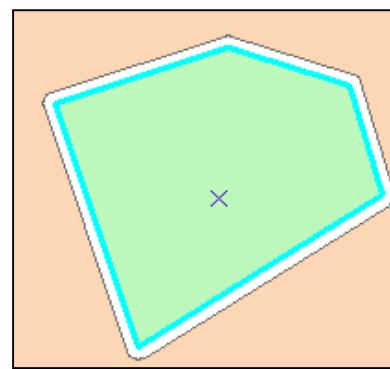
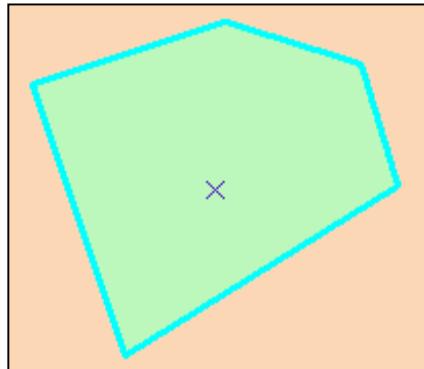
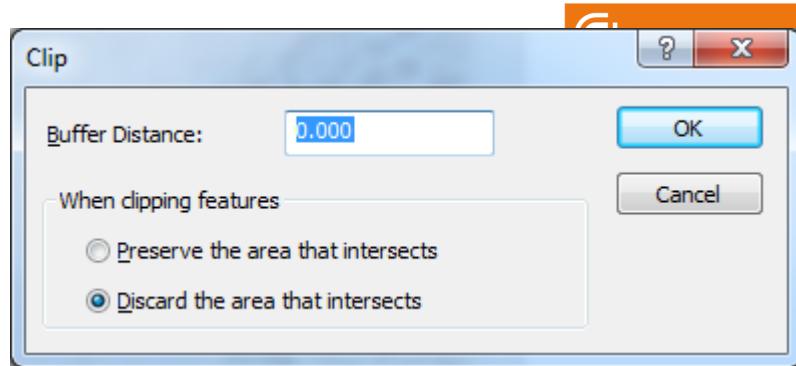
- **Union:** combines features of the same shape type that may be from different layers into one feature in the target layer. The original feature and attributes are maintained.
- **Intersect:** creates a new feature from the area where features overlap.



ArcMap – Editing Data



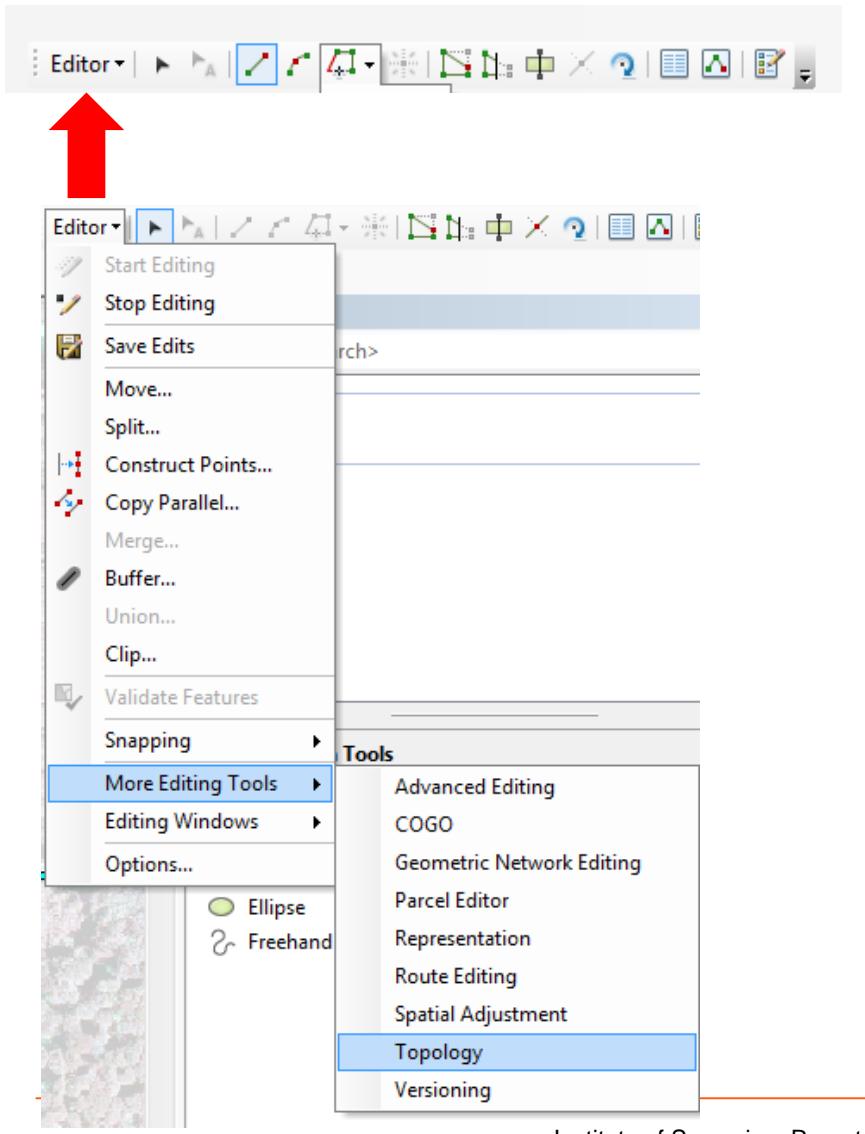
- **Clip:** select the object/feature with which you want to clip.
- Optionally a buffer value can be chosen.



Two options:

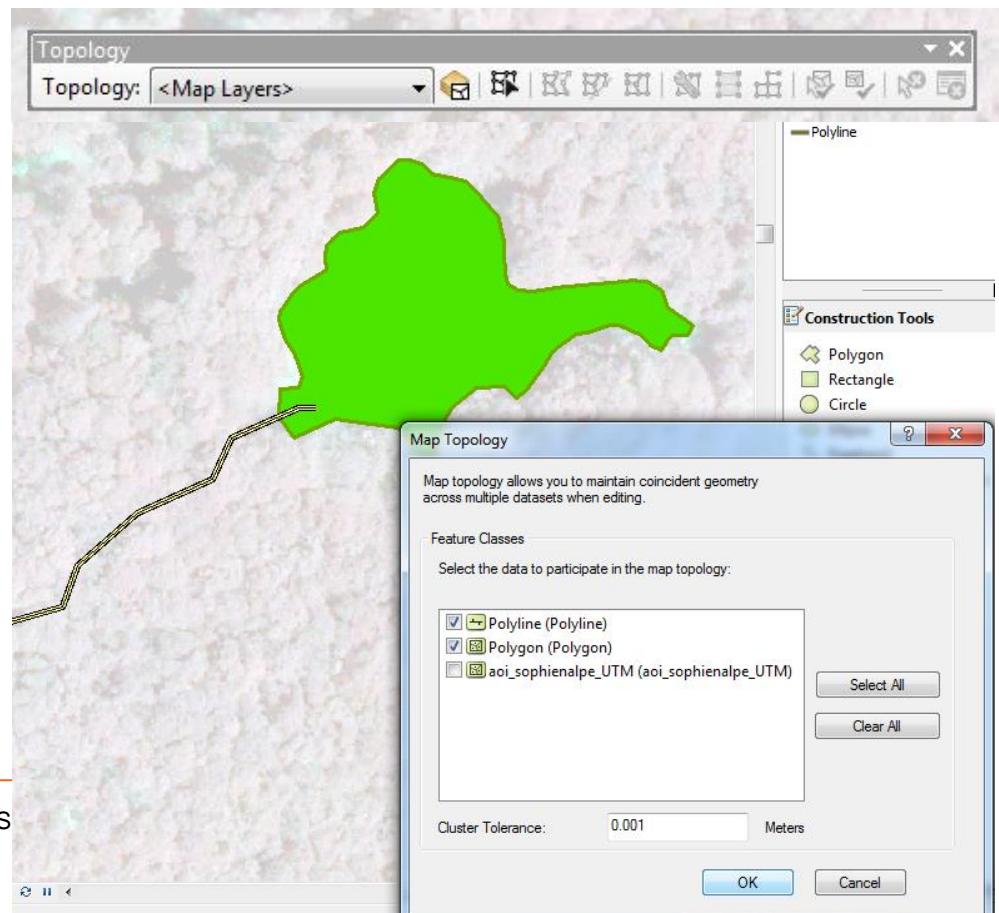
- ***Preserve the area that intersects***
- ***Discard the area that intersects (cookie cutter)***

ArcMap – Editing Data Topological Editing

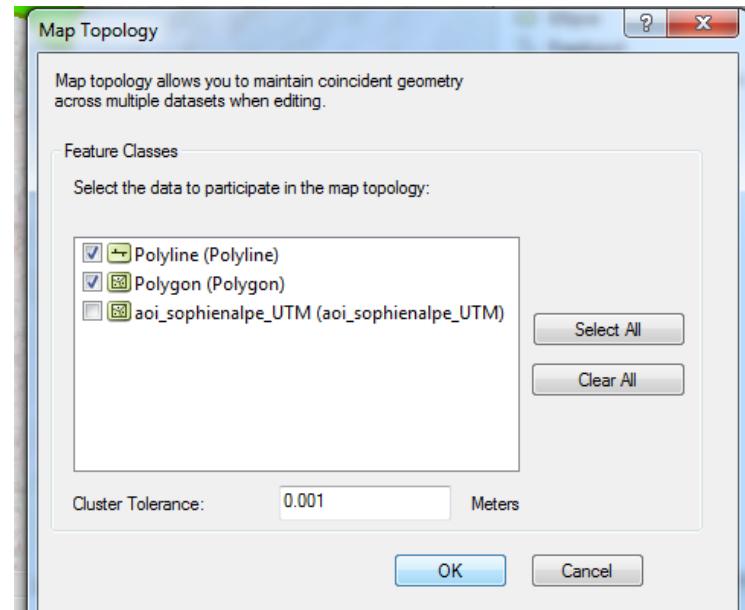


Topological Editing

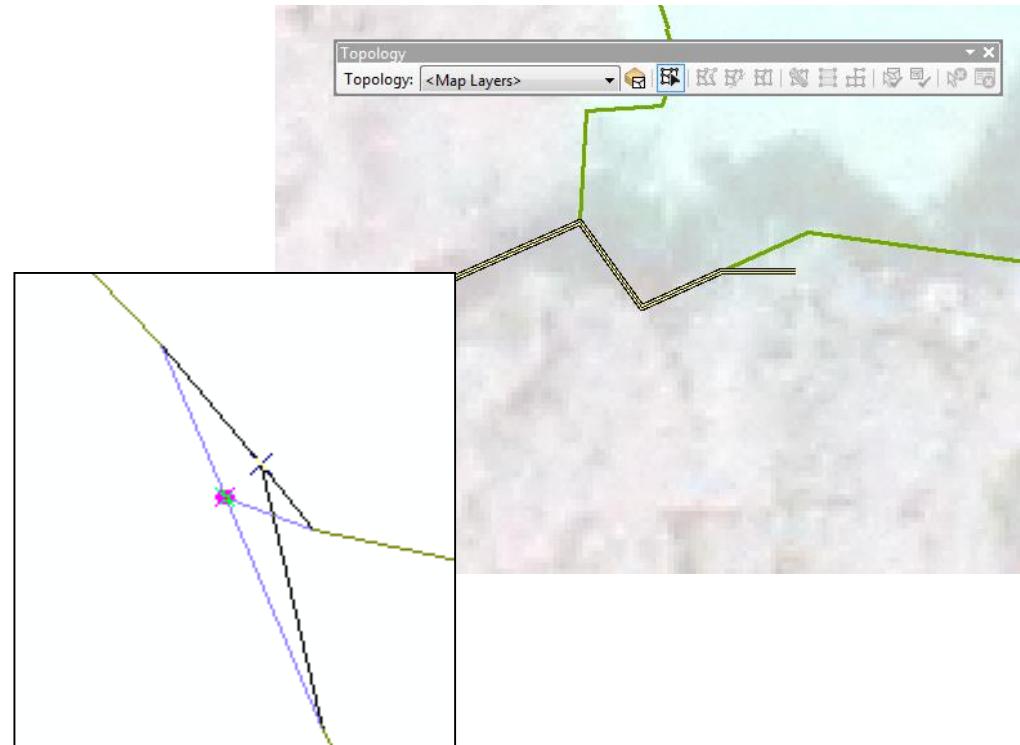
This tool allows you to select and modify edges and nodes that may be shared by one or more features.



ArcMap – Editing Data Topological Editing



... with the **Edit Tool** edges or nodes are edited



First select the layers that share more than one feature.

The Cluster Tolerance is the minimum horizontal distance between vertices of features that are not coincident.



Data view and layout view – in practice

PART 5

ArcMap – Layout



text, graphics, etc. → Drawing Toolbar

The screenshot shows the ArcMap interface with a map of Austria titled "Österreichkarte". Several features are highlighted with red arrows:

- Map elements:** A red arrow points to the "Insert" menu in the top toolbar, specifically the "Text" option under the "Data Frame" dropdown.
- Grid: properties of the data frames**: A red arrow points to the vertical scale bar on the left side of the map frame.
- Extent Rectangle: properties of the data frames**: A red arrow points to the extent rectangle in the bottom right corner of the map frame.

The map itself displays numerous place names and geographical features. A legend box on the right side defines three types of locations: DORF (white diamond), MARKT (black circle), and STADT (red circle). A small inset map in the bottom right corner shows the location of Austria within Europe.

Extent Rectangle:
properties of the data
frames



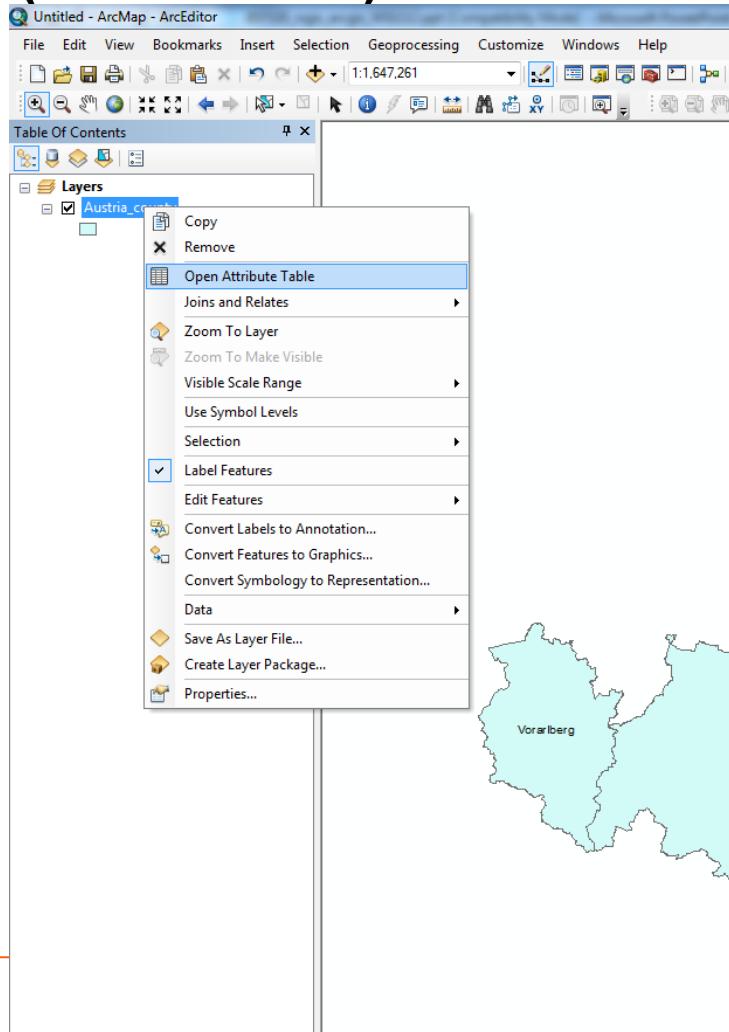
Working with tables and data selection

PART 6

ArcMap – Working with Tables



You can edit all kind of tables (Access, Excel, ...). Start the editing mode (Editor Toolbar).



Supported database tables are inserted with the Add Data command. All other tables are linked via a database connection.

Tables without any geographic information (e.g., Excel) can be joined with geographic data using a **key field** (Join/Relate).

ArcMap – Working with Tables

Columns created automatically

The screenshot shows the ArcMap application interface with a table window open. The table contains 10 rows of data with columns labeled: SUBJECT_ID, AREA, PERIMETER, LND_, LND_ID, ENKLAVE, STAAT, LAND_ID, and NAME. A context menu is open on the right side of the table, listing options like Sort Ascending, Sort Descending, Advanced Sorting..., Summarize..., Statistics..., Field Calculator..., Calculate Geometry..., Turn Field Off, Freeze/Unfreeze Column, Delete Field, and Properties... A red arrow points from the 'Show Field Aliases' option in the bottom-left toolbar to the 'Show all rows or just selected' text at the bottom right.

SUBJECT_ID	AREA	PERIMETER	LND_	LND_ID	ENKLAVE	STAAT	LAND_ID	NAME
1	19185299000	1153250	2	1	N	AT	3	Niederösterreich
2	11981300000	864035	3	2	N	AT	4	Oberösterreich
3	414734020	136075	4	3	N	AT	9	Wien
4	3962449900	741868	5	4	N	AT	1	Burgenland
5	7156429800	769895	6	5	N	AT	5	Salzburg
6	16401300000	923495	7	6	N	AT	6	Steiermark
7	10622500000	797442	8	7	N	AT	7	Tirol
8	2599749900	331408	9	8	N	AT	8	Vorarlberg
9	2018670000	237465	10	9	J	AT	7	Tirol
10	9538390000	683967	11	10	N	AT	2	Kärnten

Table

Austria_county

Table

SORT BY:

Find & Replace...

Select By Attributes...

Clear Selection

Switch Selection

Select All

Add Field...

Turn All Fields On

Show Field Aliases

Arrange Tables

Restore Default Column Widths

Restore Default Field Order

Joins and Relates

Related Tables

Create Graph...

Add Table to Layout

Reload Cache

Print...

Reports

Export...

Appearance...

Sort Ascending

Sort Descending

Advanced Sorting...

Summarize...

Statistics...

Field Calculator...

Calculate Geometry...

Turn Field Off

Freeze/Unfreeze Column

Delete Field

Properties...

(0 out of 10 Selected)

Show all rows or just selected

Selection of features, adding new fields, export table, display related tables, ...

Sorting, Calculate values, delete columns, ...

ArcMap – Working with Tables



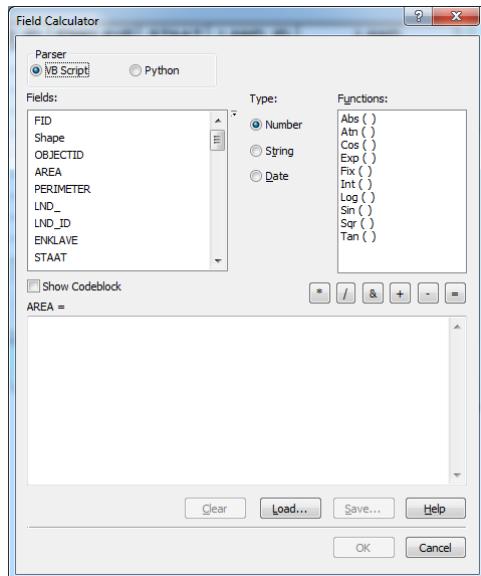
Editing a table



Start the Editing Mode

→ single fields can now be edited

New columns are added with the command **Add Field** (→ no editing mode!)



Calculations are carried out for all fields or just selected rows. Advanced option: VB script.

Calculations can be saved and loaded again.

**Calculations outside an editing session
→ no UNDO!**

ArcMap – Selection and Queries



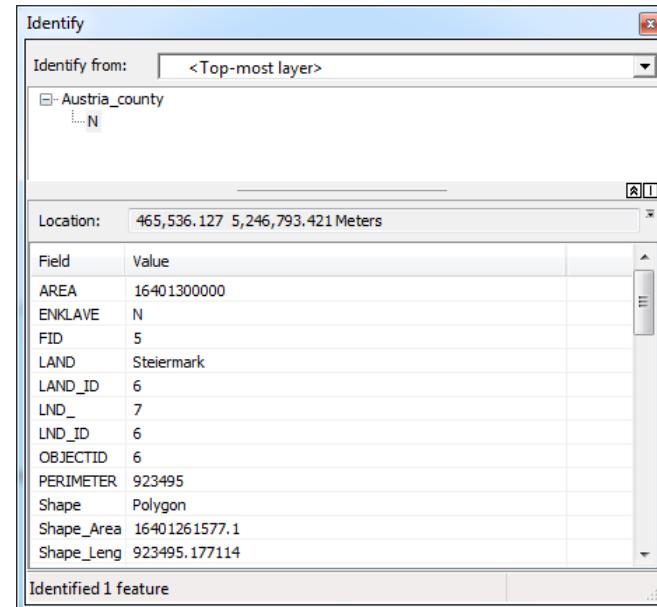
Identifying objects

Identifying features by pointing to them.

Leave the window open and use it for further queries. Select the layer you want to analyze.

Display MapTips:

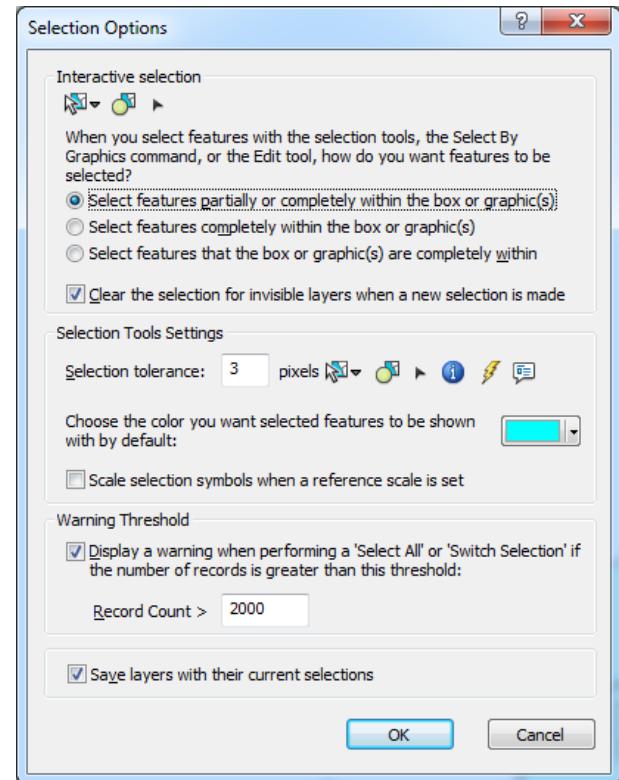
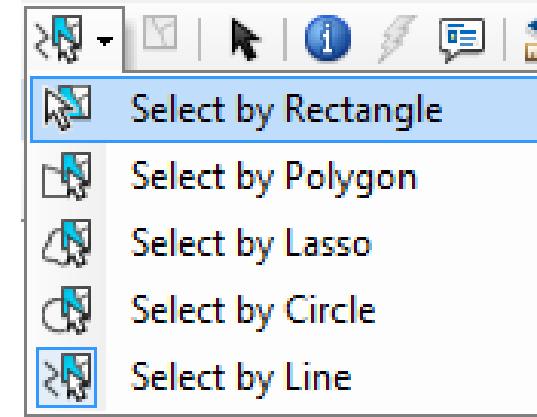
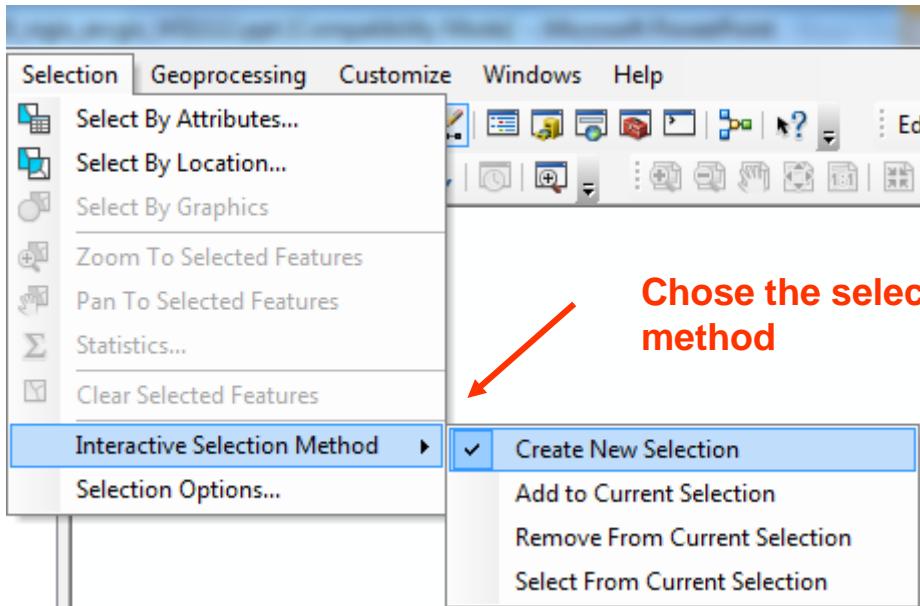
Enable MapTips (Properties) and select Primary Display Field. When moving the mouse pointer over a feature. The selected attribute is displayed.



ArcMap – Selection and Queries

Selections

- graphical: click with the selection button on the feature or define a box
- logical: based on an attribute table
- spatial: based on the location to other layers.



ArcMap – Selection and Queries



Select by Attributes: SQL Query Manager

The screenshot shows the 'Select By Attributes' dialog box on the left and a map of Austria on the right.

Dialog Box (Select By Attributes):

- Layer:** Austria_county
- Method:** Create a new selection (highlighted with a red arrow)
- Available Fields:** "LND_ID", "ENKLAVE", "STAAT", "LAND_ID", "LAND".
- Operator Buttons:** =, <>, Like, >, >=, And, <, <=, Or, -, %, (), Not.
- Value List:** 'Burgenland', 'Känten', 'Niederösterreich', 'Oberösterreich', 'Salzburg', 'Steiermark'.
- Buttons:** Is, Get Unique Values, Go To:, Clear, Verify, Help, Load..., Save... (circled in red), OK, Apply, Close.

Map View:

- The map shows the outline of Austria with several states highlighted in different colors: Salzburg (light blue), Oberösterreich (light green), Niederösterreich (light orange), Steiermark (pink), Känten (yellow), and Burgenland (cyan).
- The state 'Wien' is labeled in the center of Vienna.
- A cyan border highlights the state 'Burgenland'.
- A red callout box points to the 'Create a new selection' option in the context menu.
- A red text box at the bottom right of the map area contains the instruction: "Save the logical expression and use it again for later queries".

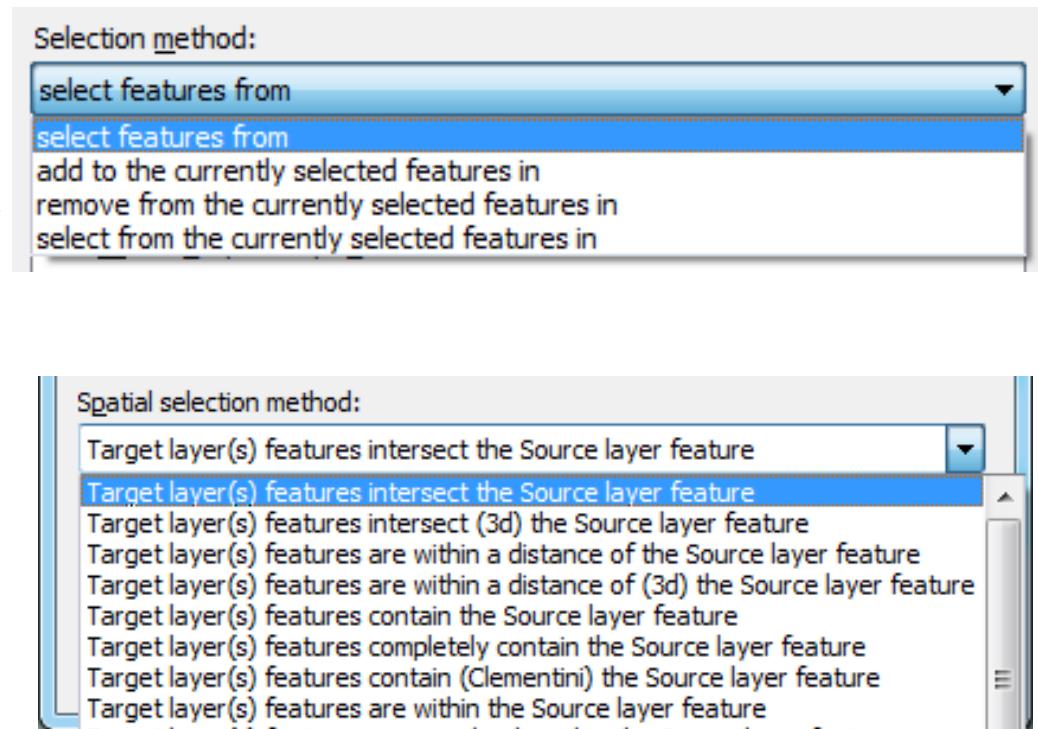
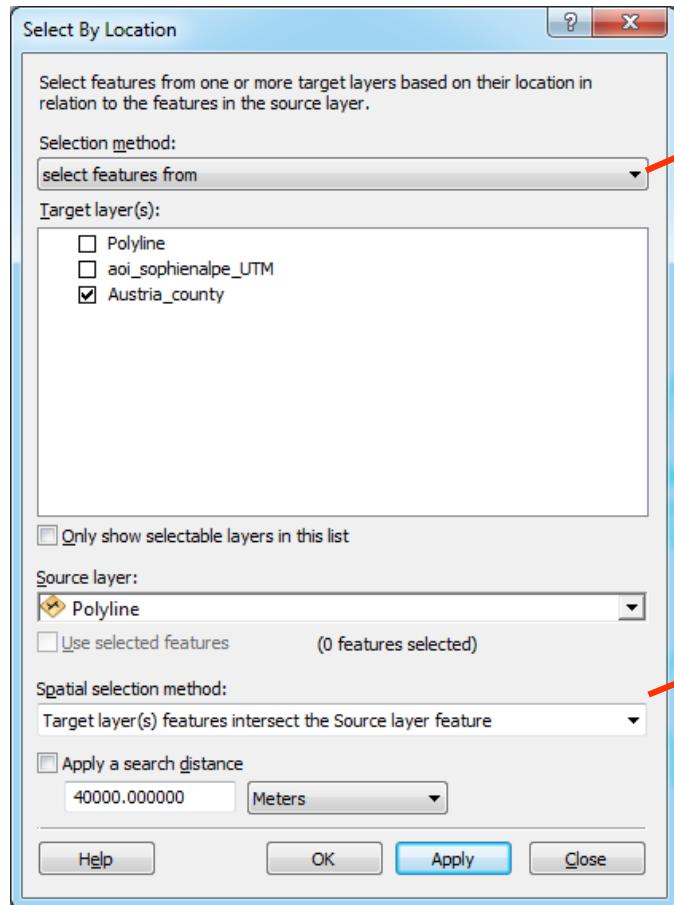
Text Overlay:

The syntax depends on the selected attribute!

ArcMap – Selection and Queries



Select by Location



ArcMap – Selection and Queries



Selection using the attribute table

Elements can be selected directly in the attribute table.

Selected features are automatically displayed in the graphic view.

The screenshot shows the ArcMap interface with the 'Austria_county' table open in the foreground. The table lists 10 polygons, each with a unique FID, Shape type, OBJECTID, AREA, PERIMETER, LND_ID, ENKLAVE, STAAT, LAND_ID, LAND, and several STD_01A through STD_0E columns. Rows 1, 2, 3, 4, 5, 6, 7, 8, and 9 are selected, highlighted in light blue. The status bar at the bottom indicates '(2 out of 10 Selected)'. In the background map view, the state of Tyrol is highlighted in light blue, and the city of Wien and the state of Burgenland are also labeled. The map shows the complex boundaries of Austria's states.

FID	Shape *	OBJECTID	AREA	PERIMETER	LND_	LND_ID	ENKLAVE	STAAT	LAND_ID	LAND	STD_01A	STD_02A	STD_03A	STD_04A	STD_0E
0	Polygon	1	19185299000	1153250	2	1	N	AT	3	Niederösterreich	554286	1473813	715709	758104	3511
1	Polygon	2	11981300000	864035	3	2	N	AT	4	Oberösterreich	481646	1333480	650489	682991	3412
2	Polygon	3	414734020	136075	4	3	N	AT	9	Wien	746760	1539848	714525	825323	2933
3	Polygon	4	3962449900	741868	5	4	N	AT	1	Burgenland	94951	270880	131485	139395	649
4	Polygon	5	7156429800	769895	6	5	N	AT	5	Salzburg	178573	482365	232348	250017	1239
5	Polygon	6	16401300000	923495	7	6	N	AT	6	Steiermark	425570	1184720	573132	611588	2874
6	Polygon	7	10622500000	797442	8	7	N	AT	7	Tirol	219783	631410	307249	324161	1666
7	Polygon	8	2599749900	331408	9	8	N	AT	8	Vorarlberg	112313	331472	164150	167322	931
8	Polygon	9	2018670000	237465	10	9	J	AT	7	Tirol	219783	631410	307249	324161	1666
9	Polygon	10	9538390000	683967	11	10	N	AT	2	Kärnten	199124	547798	264902	282896	1373

ArcMap – Selection and Queries



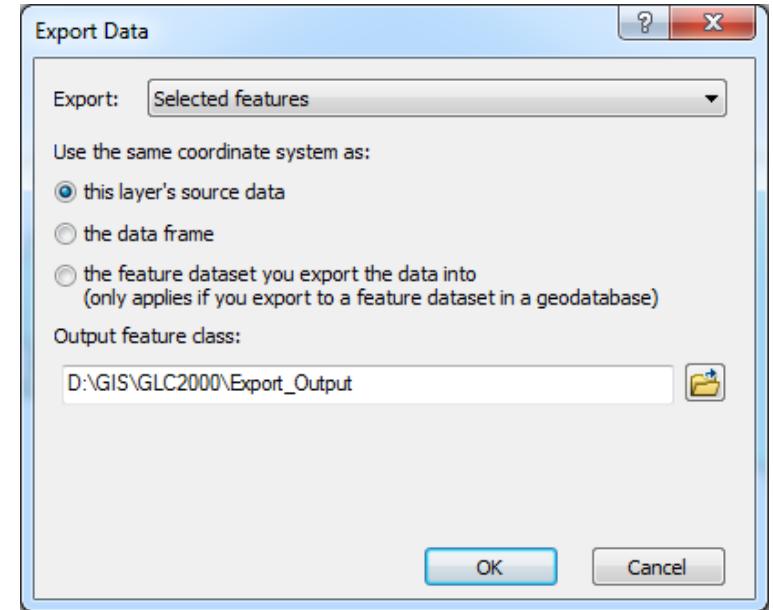
Exporting selected features

The screenshot shows the ArcMap interface. In the Table of Contents, there are three layers: 'Polyline', 'aoi_sophienalpe_UTM', and 'Austria_county'. The 'Austria_county' layer is selected, indicated by a blue border. A context menu is open for this layer, with 'Selected features' highlighted. Other options in the menu include Copy, Remove, Open Attribute Table, Joins and Relates, Zoom To Layer, Zoom To Make Visible, Visible Scale Range, Use Symbol Levels, Selection, Label Features, Edit Features, Convert Labels to Annotation..., Convert Features to Graphics..., Convert Symbology to Representation..., Data (which is expanded), Save As Layer File..., Create Layer Package..., and Properties... . Below the menu, a small map view shows a green polygon labeled 'Tirol'.

Table

FID	Shape *
0	Polygon
1	Polygon
2	Polygon
3	Polygon
4	Polygon
5	Polygon
6	Polygon
7	Polygon
8	Polygon
9	Polygon

Austria_county



**Chose the format to export
(shape or feature class)**



Geoprocessing

PART 7

Geoprocessing – Final exercise



Exercise

„Identify sites for possible timber storage“

Condition:

- must be located in a non-urban and non-forested area
- must be around 150 meters (maximum) of a paved road
- must be close to the forest (100 meters).



Geoprocessing – Analysis Tools



Analysis tools allows to define, manage, and analyze the information used to form decisions → basic component of a GIS

A screenshot of the ArcMap interface. The title bar says "Untitled - ArcMap - ArcEditor". The menu bar includes File, Edit, View, Bookmarks, Insert, Selection, Geoprocessing, Customize, Windows, and Help. Below the menu is a toolbar with various icons. A red circle highlights the "ArcToolbox window" button in the toolbar. The main workspace shows the "ArcToolbox" panel on the left. Under "ArcToolbox", the "Analysis Tools" folder is expanded, showing sub-tools like Extract, Clip, Select, and Overlay. A red box highlights the "Analysis Tools" folder. To the right of the toolbox is a "Table Of Contents" pane. A callout box with a black border and white background contains the text "Most important tools:" followed by a list of analysis tools.

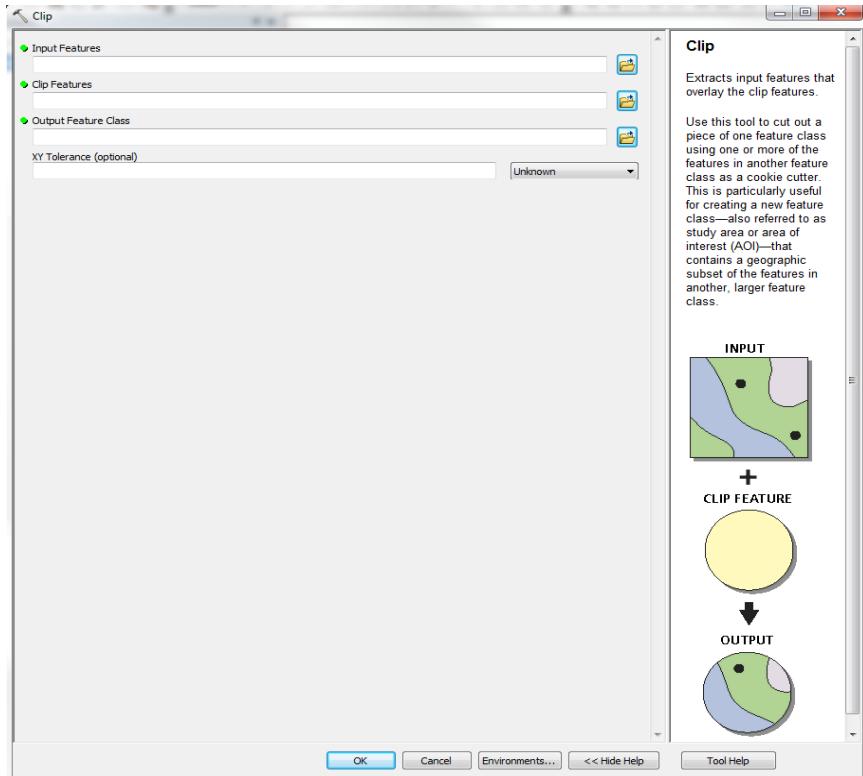
Most important tools:

- Clip: clip one layer based on another
- Buffer: buffer polygons around features
- Dissolve: dissolve borders
- Intersect: geometric intersection of input features
- Union: intersection, similar to intersection;
→ geometry of output layer depends on the input layer

ArcMap - Clip



ArcToolbox - Analysis Tools - Extract



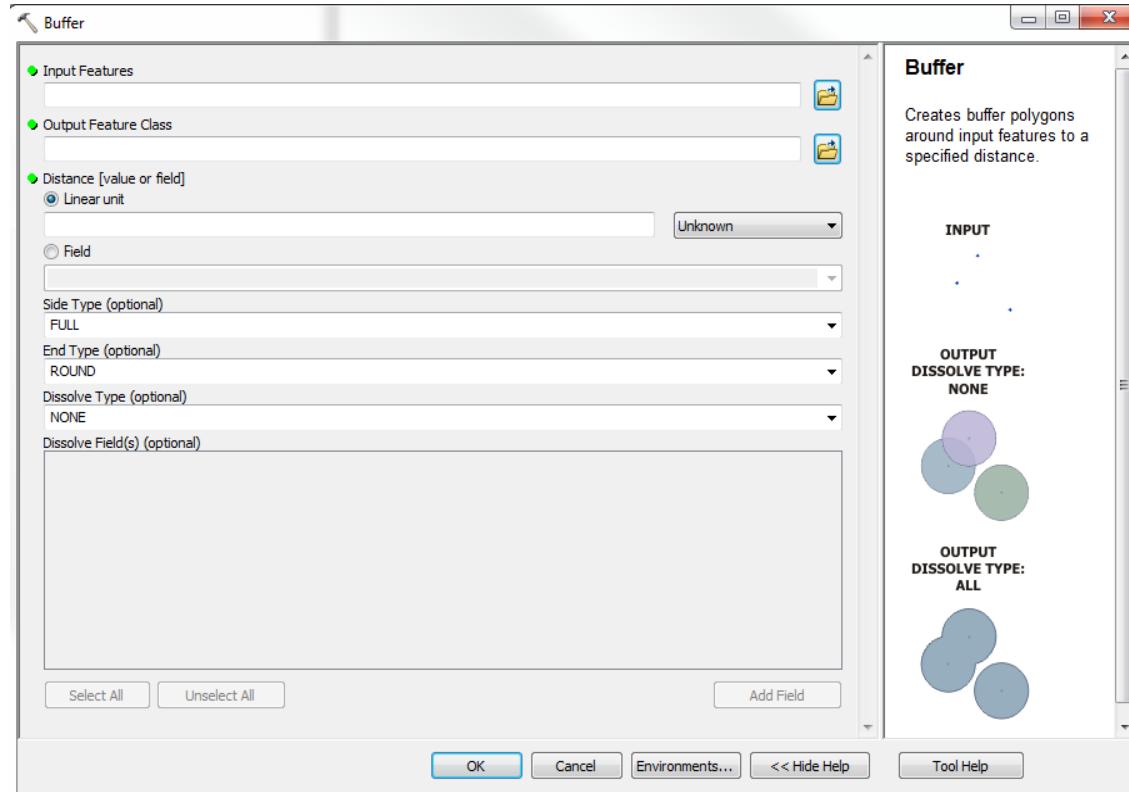
Extract parts of a large data set

Clip Layer: e.g. area of investigation

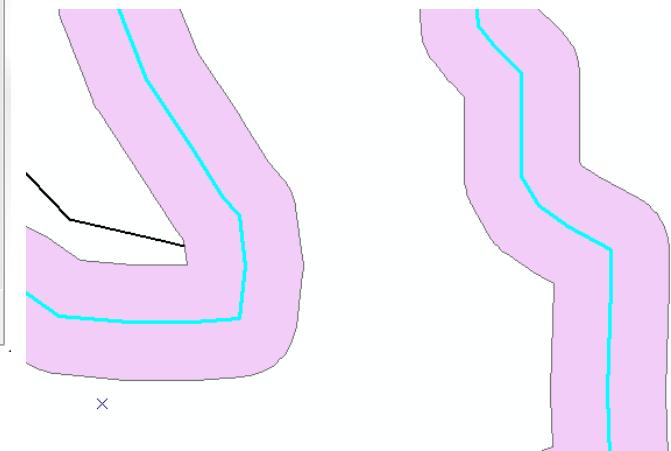
ArcMap - Buffer



ArcToolbox - Analysis Tools - Proximity



**Buffer: all or only selected features
→ select first**

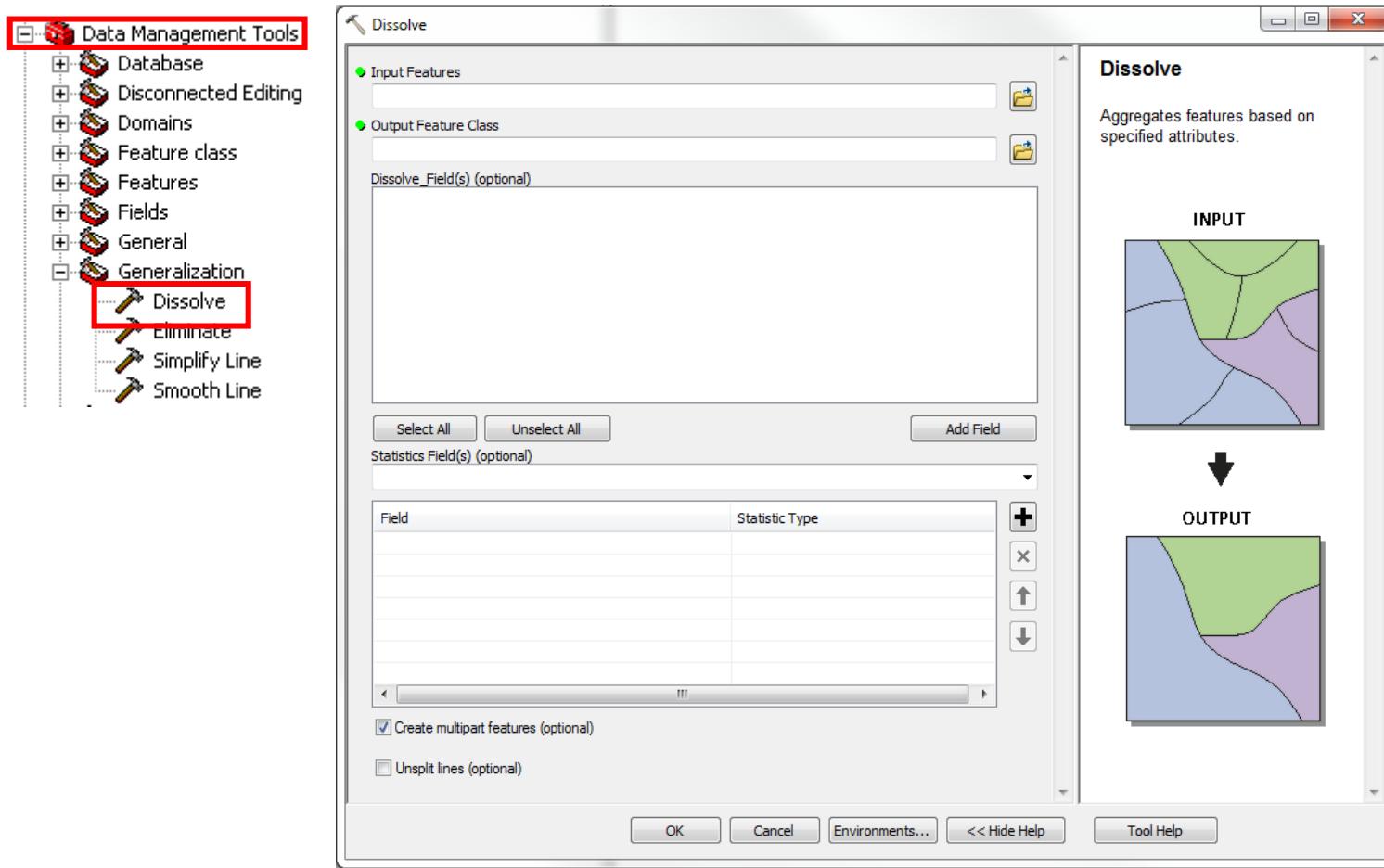


Output Feature Class: polygon

ArcMap - Dissolve



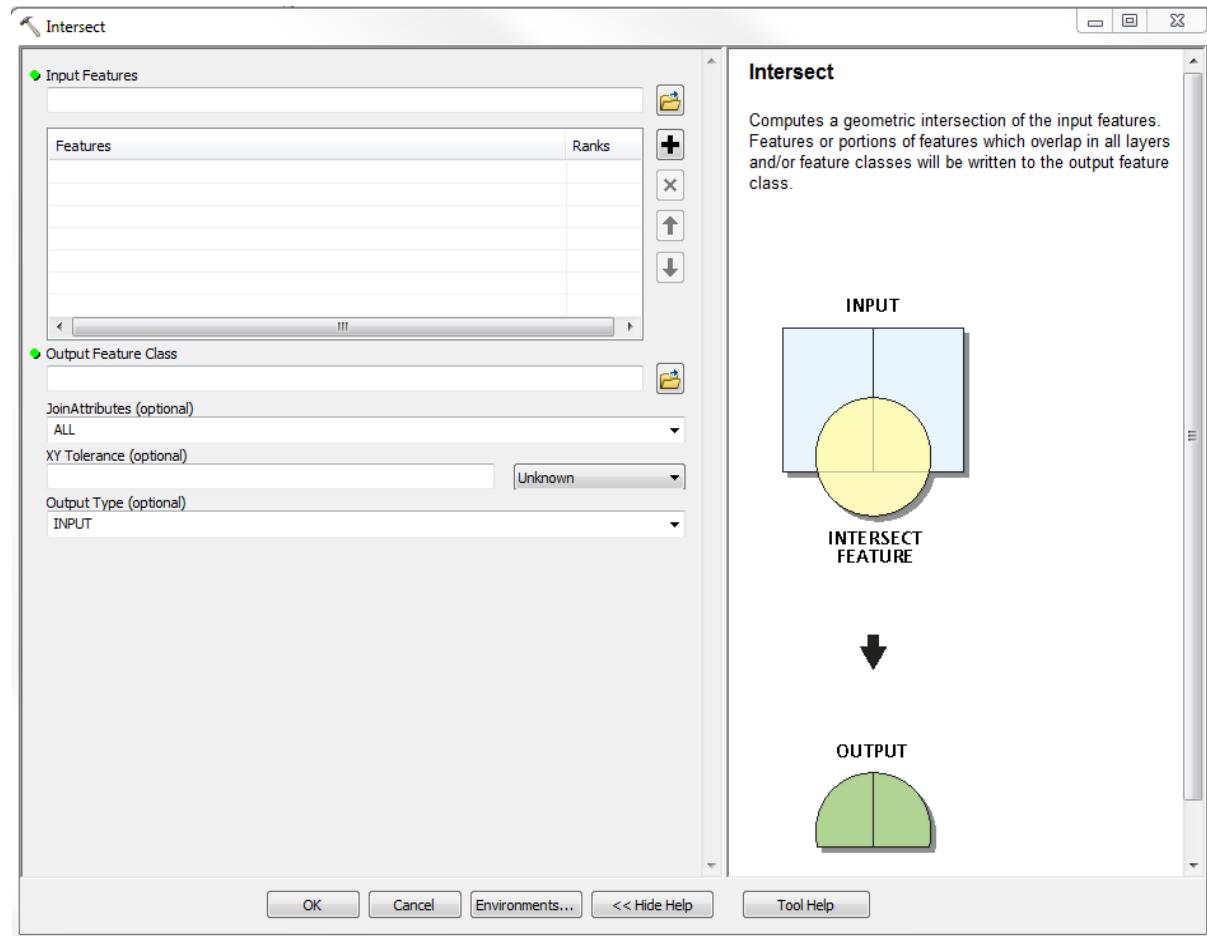
ArcToolbox - Data Management Tools - Generalization



ArcMap - Intersect



ArcToolbox - Analysis Tools - Overlay

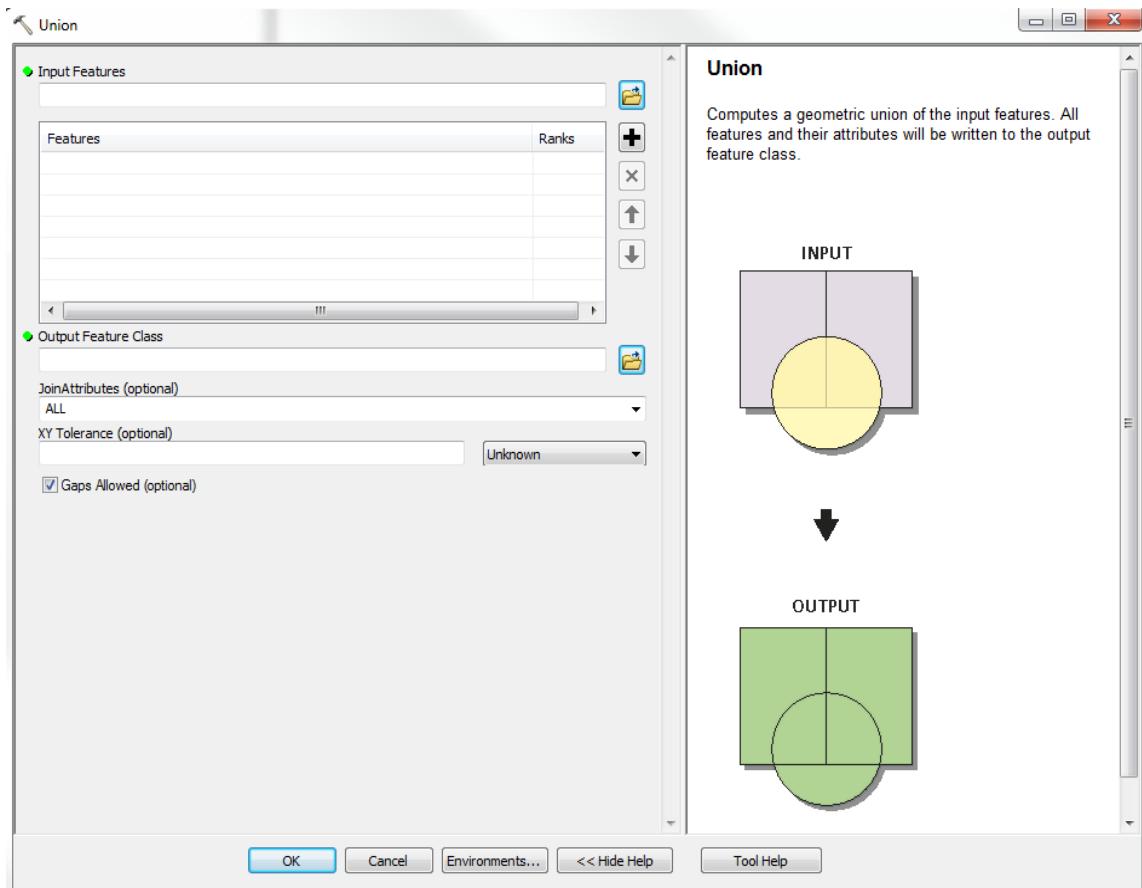


Intersect two or
more layers

ArcMap - Union



ArcToolbox - Analysis Tools - Overlay



Geoprocessing – Final exercise



Exercise

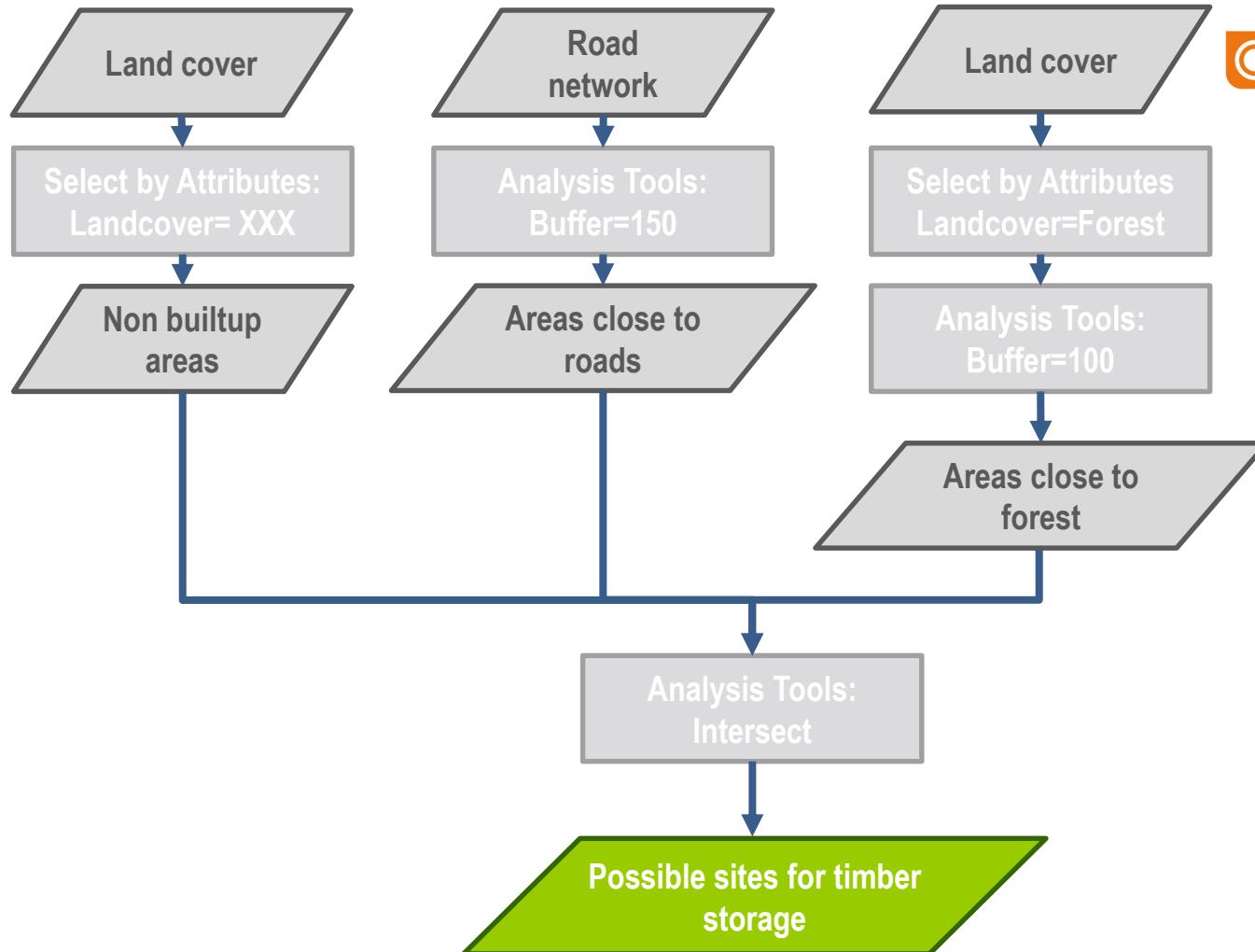
„Identify sites for possible timber storage“

Condition:

- must be located in a non-urban and non-forested area
- must be around 150 meters (maximum) of a paved road
- must be close to the forest (100 meters).



Geoprocessing – Work Flow





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