Vector Data and Tools

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Today's Lecture

1. Topology

- Topology expresses the spatial relationships between connecting or adjacent vector features (points, polylines and polygons) in a GIS.
- Examples of Topolgy Rules:
  - Area edges of a municipality map must not overlap.
  - Area edges of a municipality map must not have gaps (slivers).
  - Polygons showing property boundaries must be closed.

1. Topology

Spatial relationships between two regions

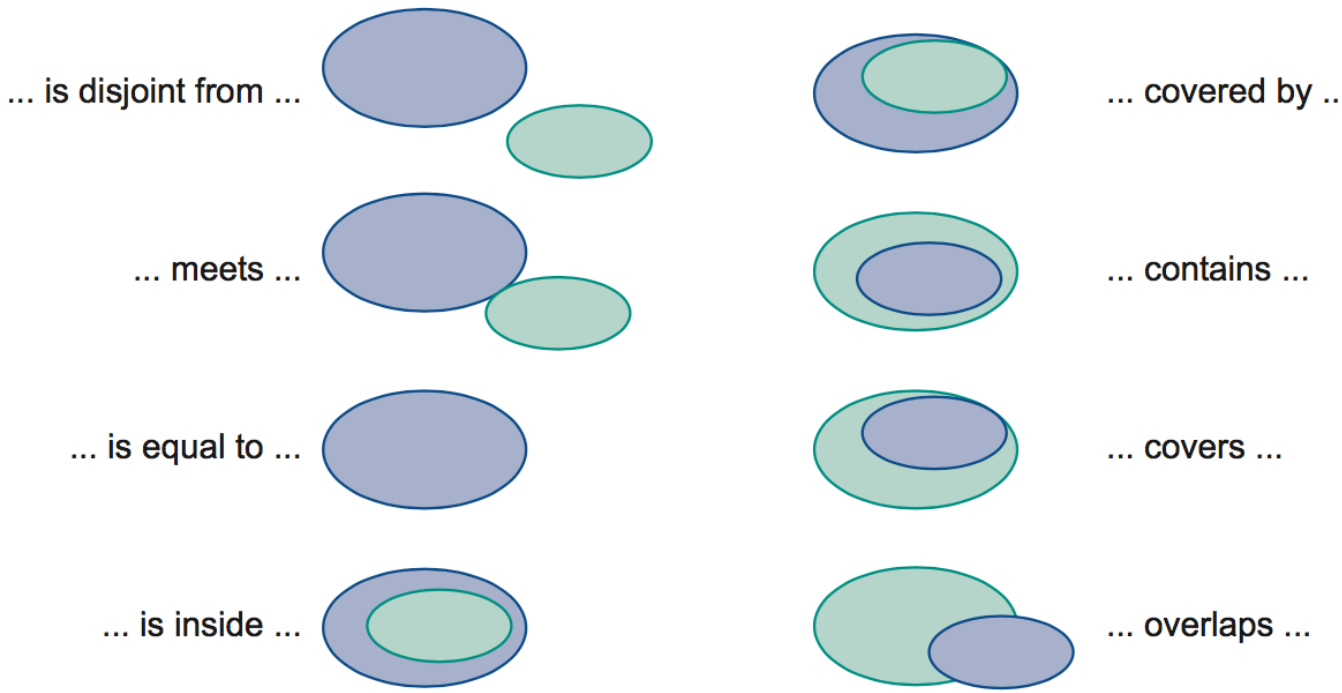


Image sources: Huisman and de By (2009)

1. Topology

Five rules of topological consistency in two-dimensional space:

1. Every 1-simplex ('arc') must be bounded by two 0-simplices ('nodes', namely its begin and end node)
2. Every 1-simplex borders two 2-simplices ('polygons', namely its 'left' and 'right' polygons)
3. Every 2-simplex has a closed boundary consisting of an alternating (and cyclic) sequence of 0- and 1-simplices.
4. Around every 0-simplex exists an alternating (and cyclic) sequence of 1- and 2-simplices.
5. 1-simplices only intersect at their (bounding) nodes.

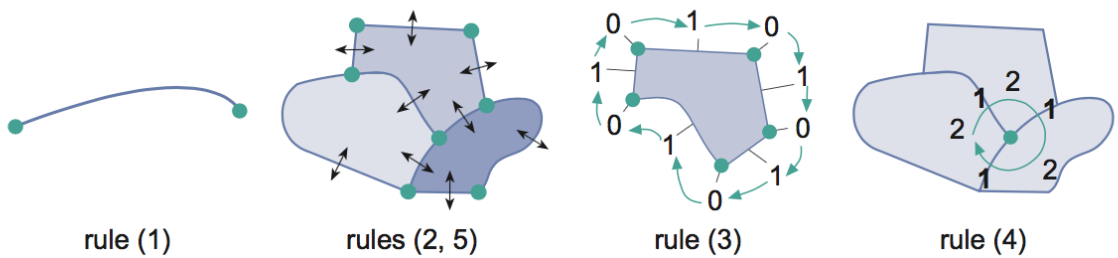


Image sources: Huisman and de By (2009)

1.1. Topology Errors

Common topological errors

- Undershoots (1) occur when digitised vector lines that should connect to each other dont quite touch.
- Overshoots (dangles) (2) happen if a line ends beyond the line it should connect to.
- Slivers (3) occur when the vertices of two polygons do not match up on their borders.

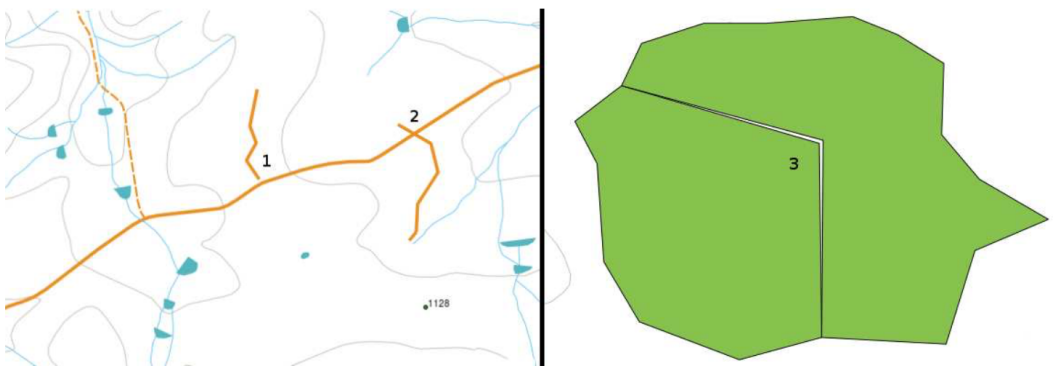


Image sources: Sutton et al. 2009

1.1. Topology Errors

Example - Sliver between country borders:

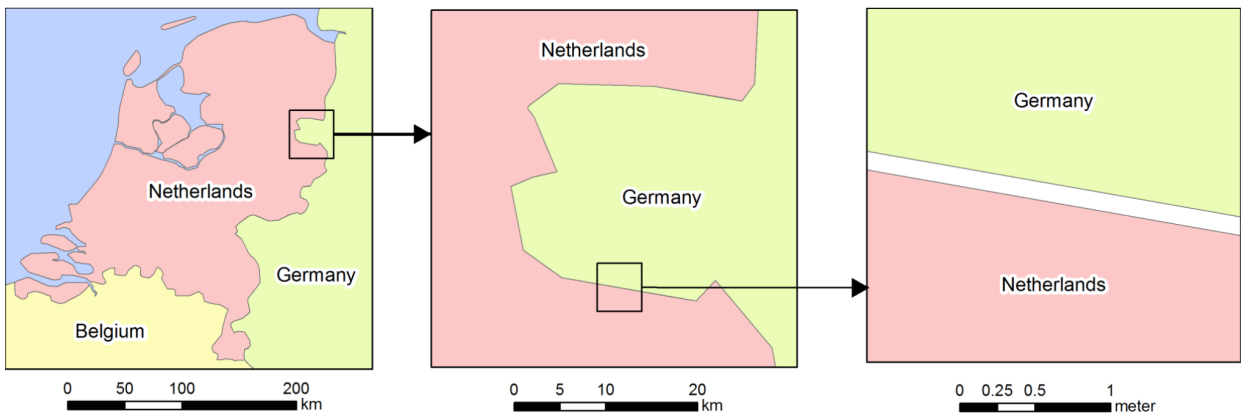


Image sources: Rod 2016

1.1. Topology Errors

Example - Sliver between coastline and ocean polygon:

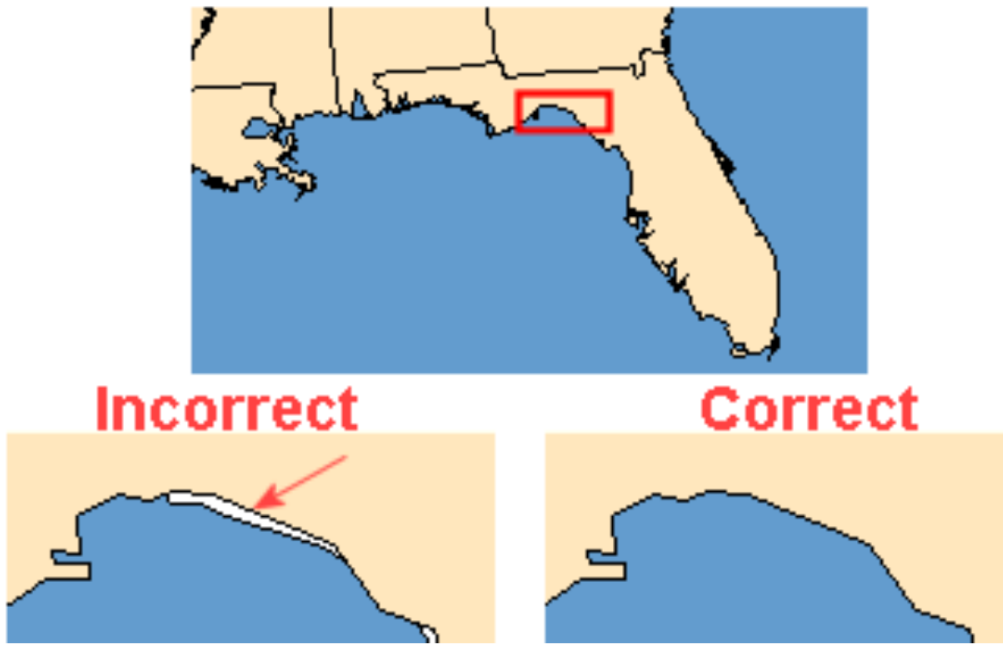


Image sources: Rod 2016

1.2. Validating Topology

Examples:

- Validating Topology:
  - Topology Checker plugin
  - Geometry Checker plugin

1.2. Validating Topology

- Many GIS applications provide tools for topological editing.
- Snapping:
  - Snapping distance is the distance a GIS uses to search for the closest vertex and / or segment you are trying to connect when you digitise.
- Cracking:
  - Cracking adds vertices to features wherever they intersect.
  - f a feature falls within the cluster tolerance of another feature's endpoint or vertex, then a new vertex is added at the intersection.

1.3. Validating Topolgy

Exercise 2A - Validating Topolgy

2. Vector Tools

1. Queries
2. Overlay
3. Extract

2.1. Queries

- A query is a question or request for information.
- Attribute query:
  - Select all buildings where buildingtype=“residential”
- Spatial query:
  - Select all buildings that are within 100m of a road.

2.1. Queries

Operators:

- Comparison:
  - $=, <, >, <=, >=$
- Spatial:
  - Intersect, Contain, Are within a distance of, Touch the boundary of
- Logical:
  - NOT, AND, OR

2.1. Queries

In QGIS attribute queries can be conducted with the Query Builder

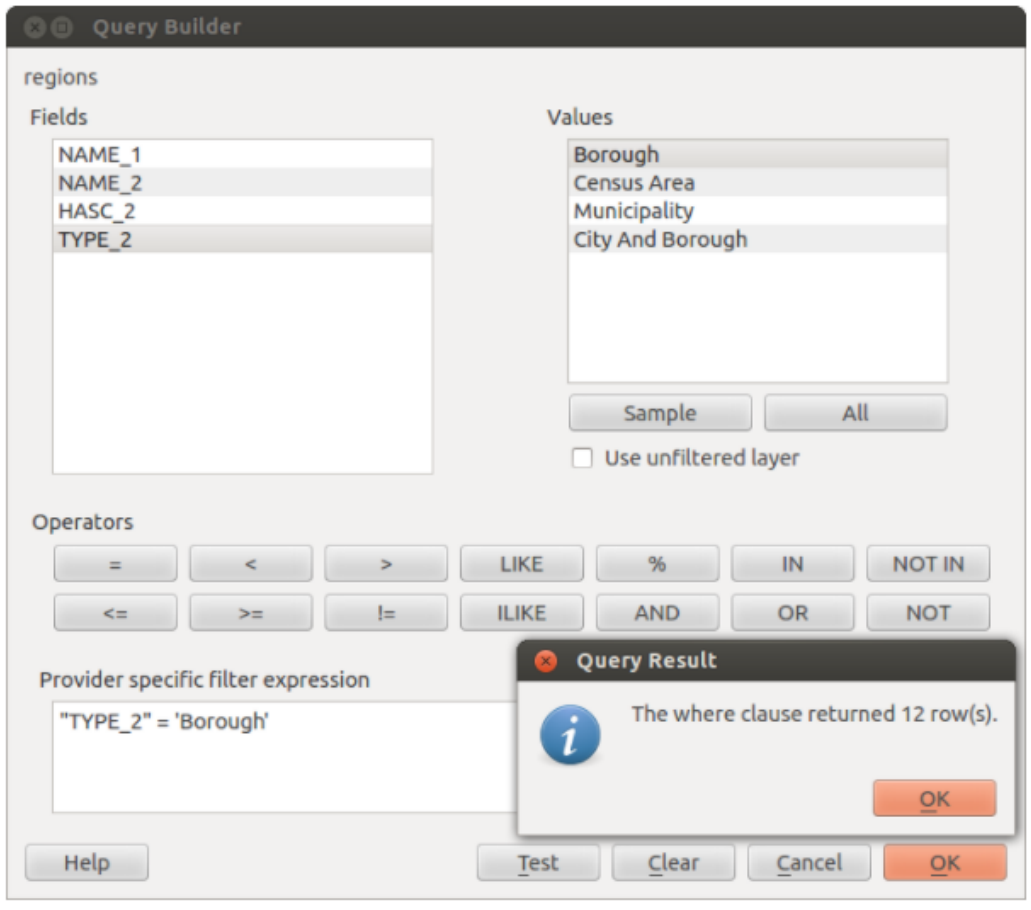


Image sources: http://docs.qgis.org/

2.1. Queries

In QGIS spatial queries can be conducted with the Spatial Query plugin

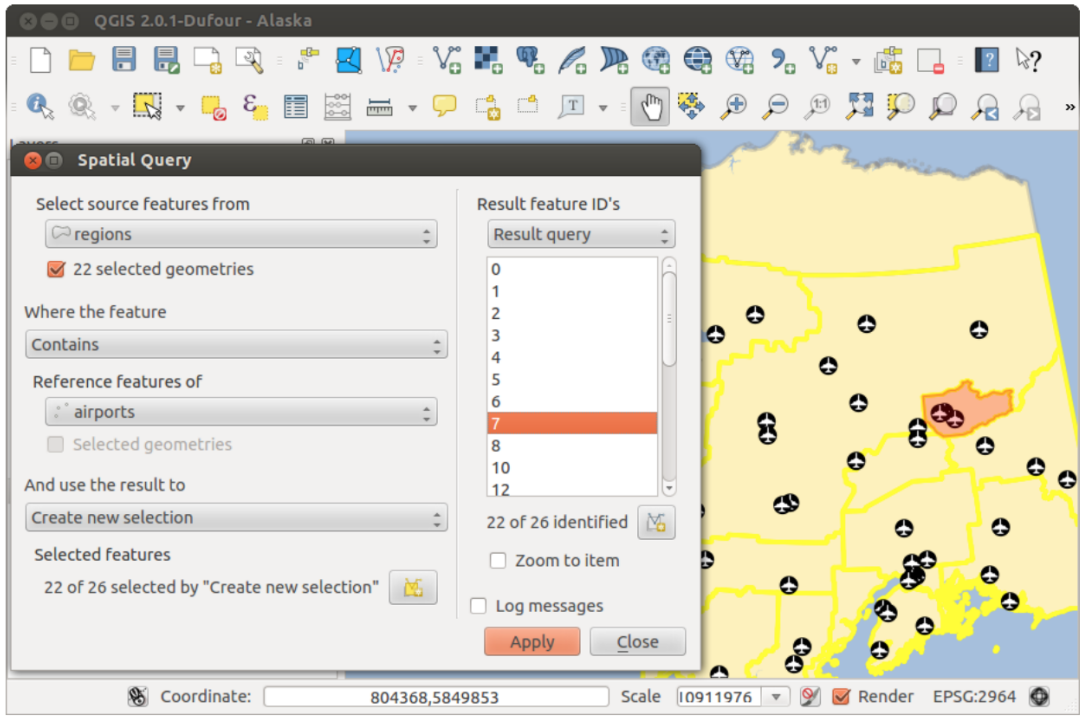


Image sources: http://docs.qgis.org/

2.1. Queries

Queries in QGIS

- A query basically performs a selection
- The selected features can be saved as a vector format.
- You can also transform the new vector into another Coordinate Reference System (CRS).

2.1. Queries

Exercise 2B - Attribute query with the Query Builder

2.2.1. Overlay - Erase

- Creates a feature class by overlaying the input features with the polygons of the erase features.
- Only those portions of the input features falling outside the erase features outside boundaries are copied to the output feature class.

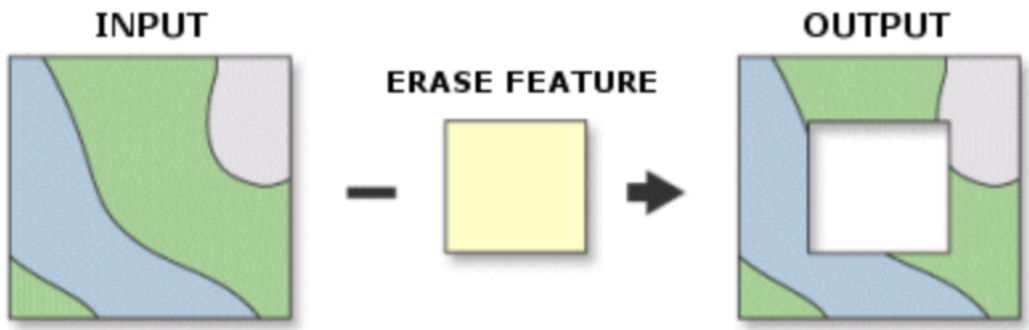
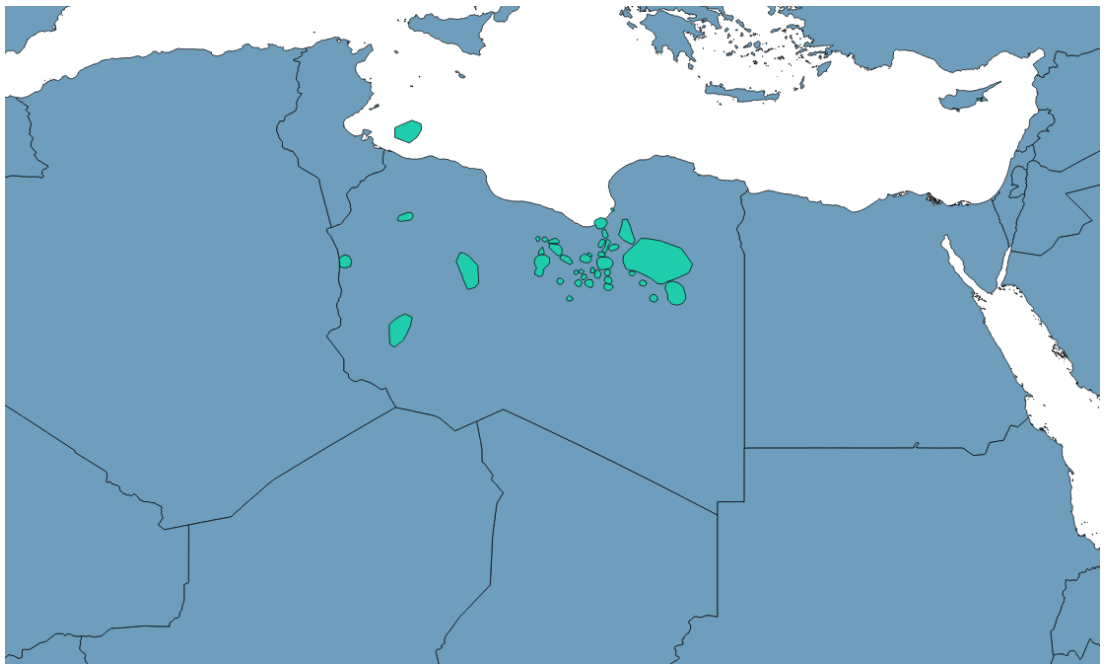


Image sources: http://pro.arcgis.com/

2.2.1. Overlay - Erase

Example: Gas Flares and Nighttime Light data

- An increasing number of economic studies use nighttime light intensity as a proxy for economic growth.
- NOAA already cleans the nighttime light data, but light from gas flares still shows up in the data.
- Problem: The glow from gas flares is rather big in some areas



Data sources: NOAA

2.2.1. Overlay - Erase

Exercise 2C - Erase Gas Flares

2.2.2. Overlay - Identity

- Computes a geometric intersection of the input features and identity features.
- The input features or portions thereof that overlap identity features will get the attributes of those identity features.

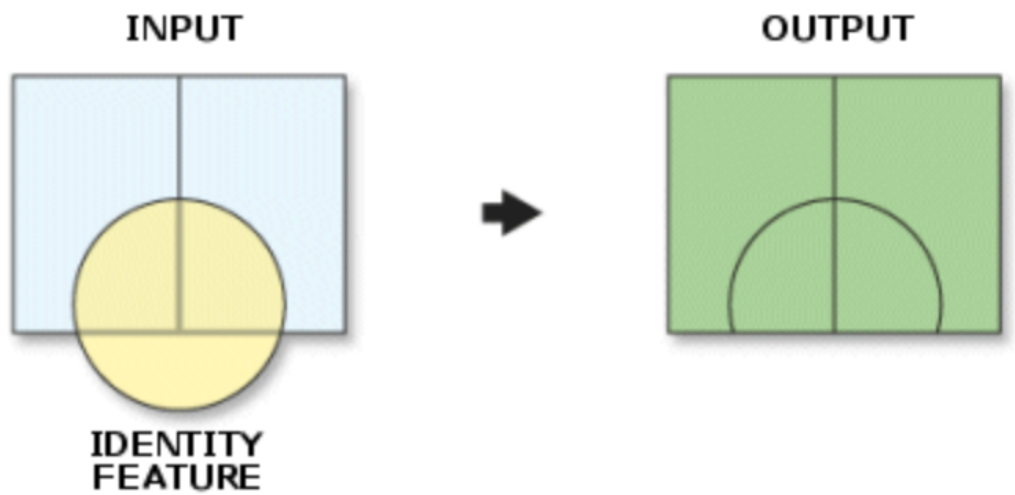


Image sources: http://pro.arcgis.com/

2.2.3. Overlay - Intersect

- Computes a geometric intersection of the input features.
- Features or portions of features which overlap in all layers and/or feature classes will be written to the output feature class.

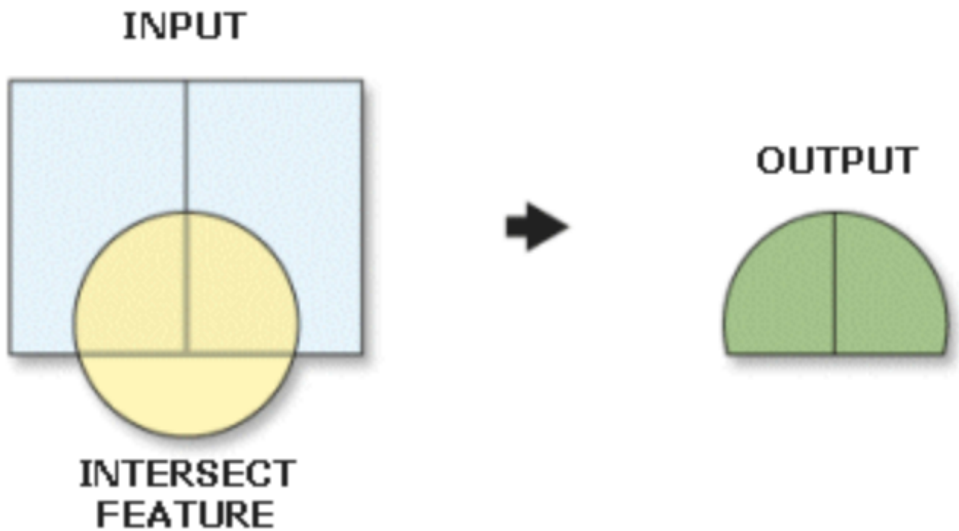


Image sources: http://pro.arcgis.com/

2.2.4. Overlay - Union

- Computes a geometric union of the input features.
- All features and their attributes will be written to the output feature class.

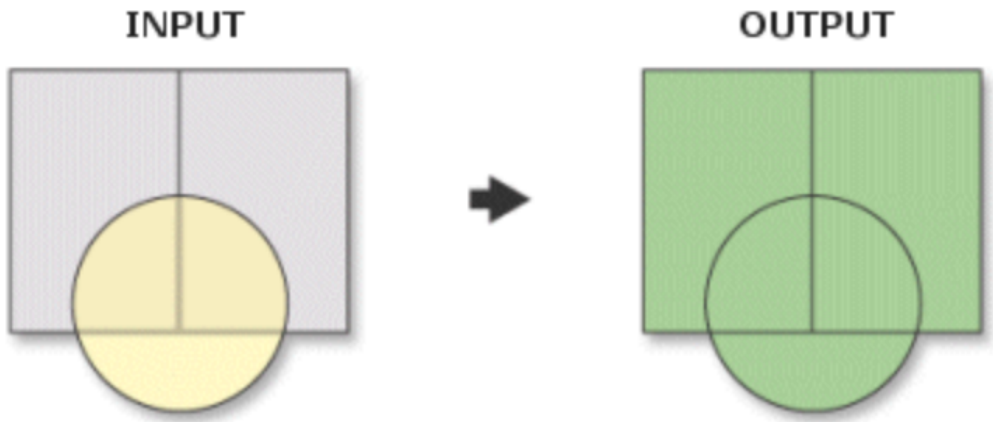


Image sources: http://pro.arcgis.com/

2.2.4. Overlay - Union

Example: Pre-colonial Ethnic Homelands in Africa (Murdock 1959, Nunn

- Drawn by Murdock (1959) and digitized by Nunn (2008)
- Other applications Michalopoulos & Papaioannou (2013, 2014, 2015), Alesina et al. (2016), Hodler & Raschky (2017)

Data sources: Nunn (2008)

2.2.4. Overlay - Union

Exercise 2D - Union: Murdock Ethnic Homelands and African Country Boundaries

2.2.5. Overlay - Spatial Join

- Joins attributes from one feature to another based on the spatial relationship.
- The target features and the joined attributes from the join features are written to the output feature class.

2.2.5. Overlay - Spatial Join

Example: Berman et al (2017) "This Mine Is Mine! How Minerals Fuel Conflicts in Africa"

- Do Natural Resources Cause Conflict in Africa?
- Georeferenced data on conflict and mines (14 minerals) in Africa between 1997-2010.
- Mining activity increases incidence of conflicts at the local level and creates spatial spill-overs.

2.2.5. Overlay - Spatial Join

Example: Berman et al (2017) "This Mine Is Mine! How Minerals Fuel Conflicts in Africa"

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2.2.5. Overlay - Spatial Join

Conflict in Africa - 1997-2010

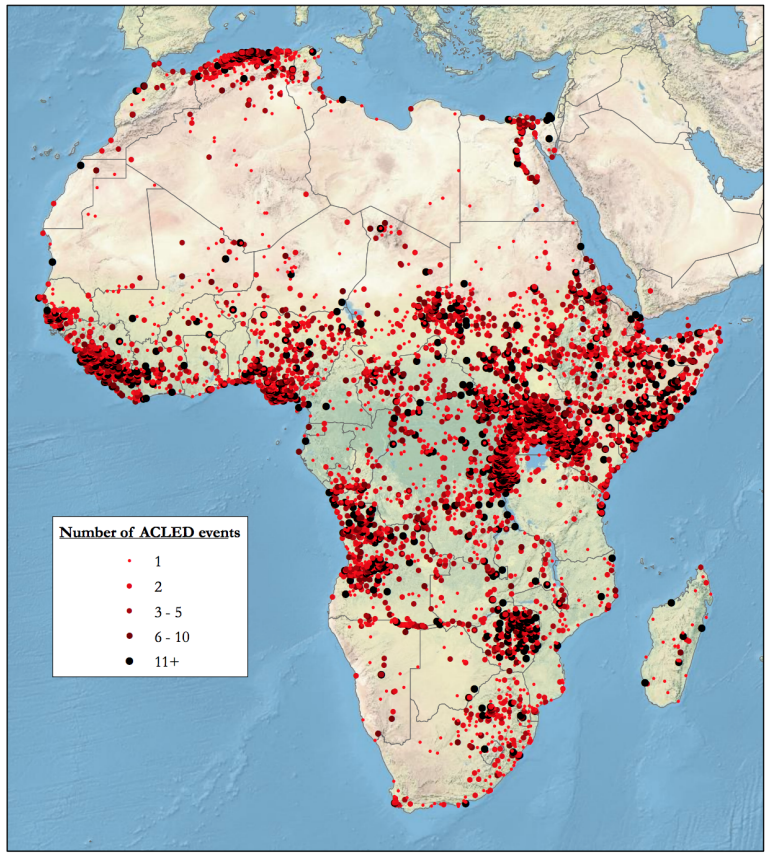

Image sources: Berman et al. (2014)

2.2.5. Overlay - Spatial Join

Active Mining Areas

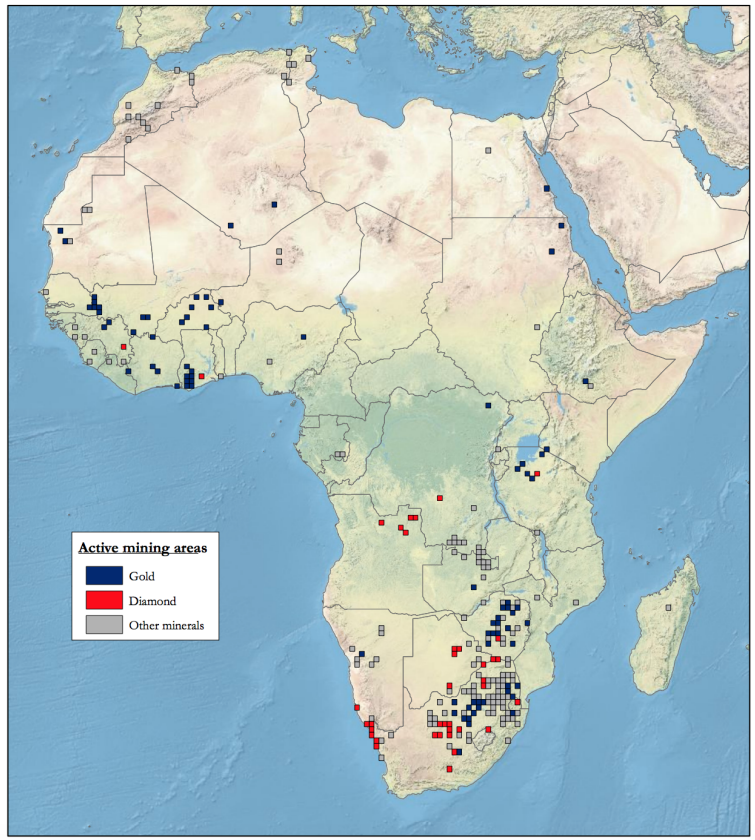

Image sources: Berman et al. (2014)

2.2.5. Overlay - Spatial Join

Example: Berman et al (2017) "This Mine Is Mine! How Minerals Fuel Conflicts in Africa"

- Main data sources:
- Conflict data: Armed Conflict Location Events Data (ACLED)
- Mines: Raw Material Data (RMD, IntierraRMG)
- World prices of the minerals: World Bank Commodities

2.2.5. Overlay - Spatial Join

TABLE 1—DESCRIPTIVE STATISTICS: CELL LEVEL

	Observations	Mean	Standard deviation	Median
Pr(Conflict > 0)				
all cells	144,690	0.06	0.23	0
if mines > 0	2,798	0.14	0.35	0
if mines = 0	141,892	0.05	0.22	0
battles	144,690	0.03	0.17	0
viol. against. civ.	144,690	0.03	0.17	0
riots and protests	144,690	0.02	0.12	0
Number of conflicts				
all cells	144,690	0.25	3.41	0
if > 0	7,980	4.61	13.79	2
Pr(Mine > 0)				
only cell	144,594	0.02	0.14	0
incl. 1st surrounding cells	144,690	0.09	0.29	0
incl. 1st and 2nd surrounding cells	144,687	0.17	0.38	0
Number of mines				
all cells	144,594	0.05	0.60	0
if > 0	2,702	2.57	3.55	1
Pr(number of mines > 2)				
all cells	144,690	0.01	0.09	0
if mine > 0	2,798	0.40	0.49	0

Image sources: Berman et al. (2017)

2.2.5. Overlay - Spatial Join

Example: Berman et al (2017) "This Mine Is Mine! How Minerals Fuel Conflicts in Africa"

- Identification strategy:
- Combines georeferenced data on location of mines of the main mineral extracted with exogenous variation in the world price.
- Analysis is conducted at the subnational (0.5×0.5 degree grid cell level)
- Specifications including country-year and grid cell fixed effects.
- $\rightarrow$ Exploit within-mining area panel variations in violence due to changes in the world price of the main mineral.

2.2.5. Overlay - Spatial Join

Example: Berman et al (2017) "This Mine Is Mine! How Minerals Fuel Conflicts in Africa"

- Specification:

$$CONFLICT_{kt} = \alpha_1 M_{kt} + \alpha_2 ln(p_{kt}^W) + \alpha_3 (M_{kt} \times ln(p_{kt}^W)) + \mathbf{FE_k} + \mathbf{FE_{it}} + \epsilon_{kt} \quad (1)$$

2.2.5. Overlay - Spatial Join

TABLE 2—CONFLICTS AND MINERAL PRICES

Estimator	LPM					
Dependent variable	Conflict incidence					
Sample	All	$V(M_{kt}) = 0$		All	$V(M_{kt}) = 0$	
	(1)	(2)	(3)	(4)	(5)	(6)
mine $>$ 0	0.112					0.048
	(0.065)					(0.065)
ln price main mineral	−0.029					0.028
	(0.032)					(0.019)
ln price × mines $>$ 0	0.086	0.072	0.060		0.085	0.108
	(0.034)	(0.020)	(0.021)		(0.024)	(0.041)
ln price × mines $>$ 0 (neighboring cells)			0.021			
			(0.006)			
ln price × mines $>$ 0 (ever)				0.045		
				(0.014)		
Country × year fixed effects	Yes	Yes	Yes	Yes	No	No
Year fixed effects	No	No	No	No	Yes	Yes
Cell fixed effects	Yes	Yes	Yes	Yes	Yes	No
Neighborhood fixed effects	No	No	No	No	No	Yes
Observations	143,768	142,296	127,974	143,864	142,296	17,360

Image sources: Berman et al. (2017)

2.2.5. Overlay - Spatial Join

Example: Berman et al (2017) "This Mine Is Mine! How Minerals Fuel Conflicts in Africa"

- In addition, they address the concern of endogenous Mining Activity.
- Restricting the analysis to the subsample of cells for which mining activity always takes place during 1997-2010.

$$CONFLICT_{kt} = \alpha_3(M_{kt} \times ln(p_{kt}^W)) + \mathbf{FE_k} + \mathbf{FE_{it}} + \epsilon_{kt} \quad (2)$$

2.2.5. Overlay - Spatial Join

Exercise 2E - Spatial Join: Conflict, Mines and ADM2 areas

2.3.1. Extract - Split

- Splitting the Input Features creates a subset of multiple output feature classes.
- The Split Field's unique values form the names of the output feature classes. These are saved in the target workspace.

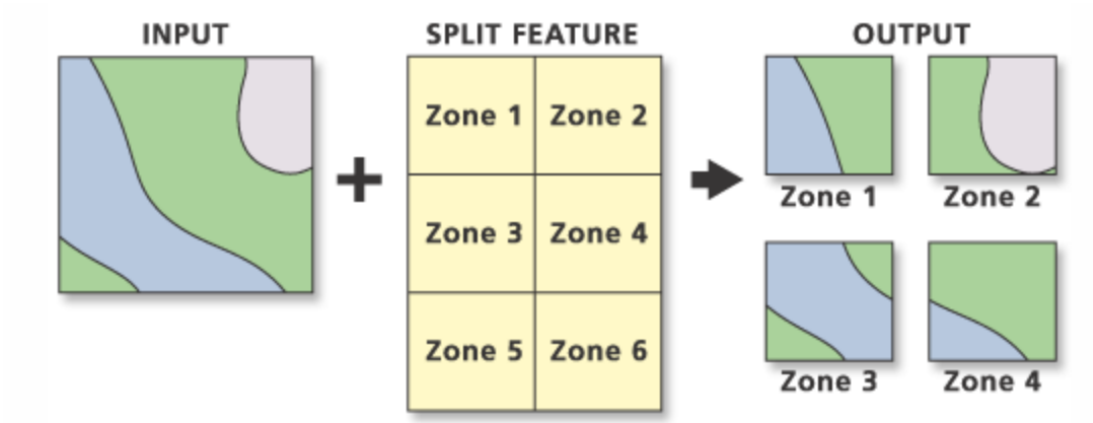

Image sources: http://pro.arcgis.com/

2.3.2. Extract - Clip

- Extracts input features that overlay the clip features.
- Use this tool to cut out a piece of one feature class using one or more of the features in another feature class as a cookie cutter.
- Useful to create new study area

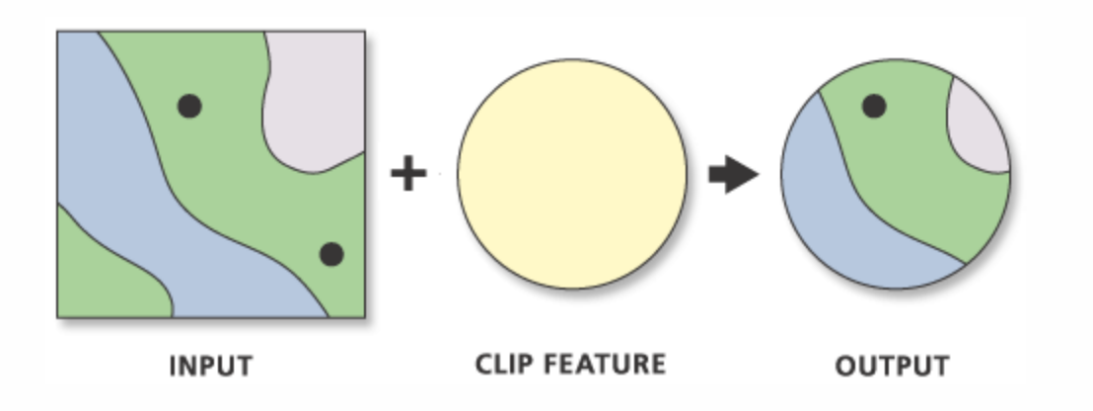

Image sources: http://pro.arcgis.com/