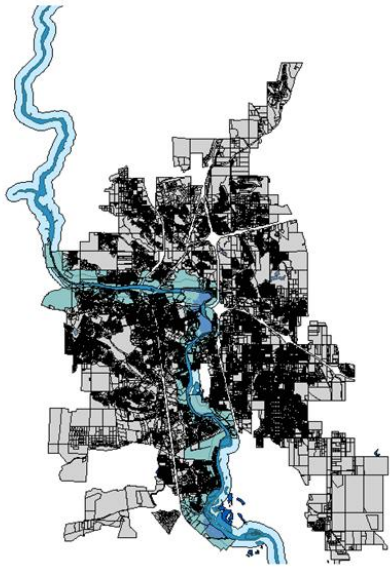
Spatial Analysis

Overview

Spatial analysis is the process of working with geospatial data layers to create new data layers in order to answer questions and make decisions during the engineering planning project phase. One of the most common operations is to create a buffer around a feature and then identify features on other layers based on their proximity to the buffer. Another useful method of spatial analysis is called an overlay. Overlays combine two geospatial layers to create a new layer.

In the following illustration, the blue buffer defines an area within 100 feet of the river. This buffer could be used to identify the land parcels that lie within the flood zone.



The following illustration overlays two layers, a flood zone and a parcel layer, in order to determine where the two intersect. The intersected parcels layer becomes a new layer, which can be styled and used for additional analysis.

Objectives

After completing this lesson, students will be able to:

- Describe buffer and overlay analysis methods.
- Analyze data using a feature buffer.
- Analyze data by creating a feature overlay.

Exercises

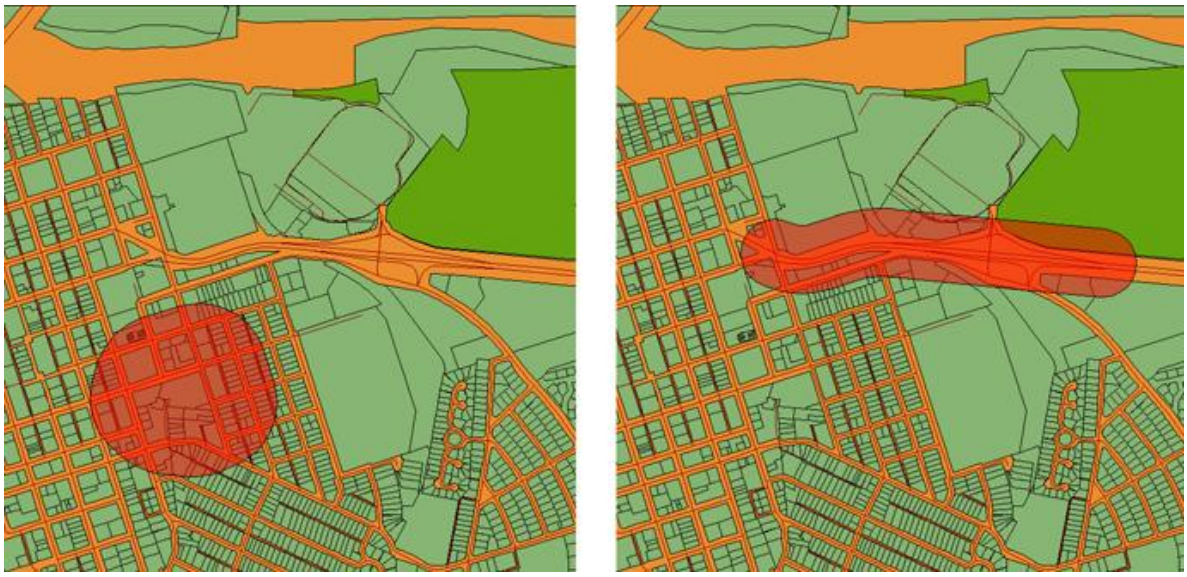
The following exercises are provided in a step-by-step format in this lesson:

1. Create a Buffer Analysis
2. Create an Intersection Overlay Analysis

About Buffers

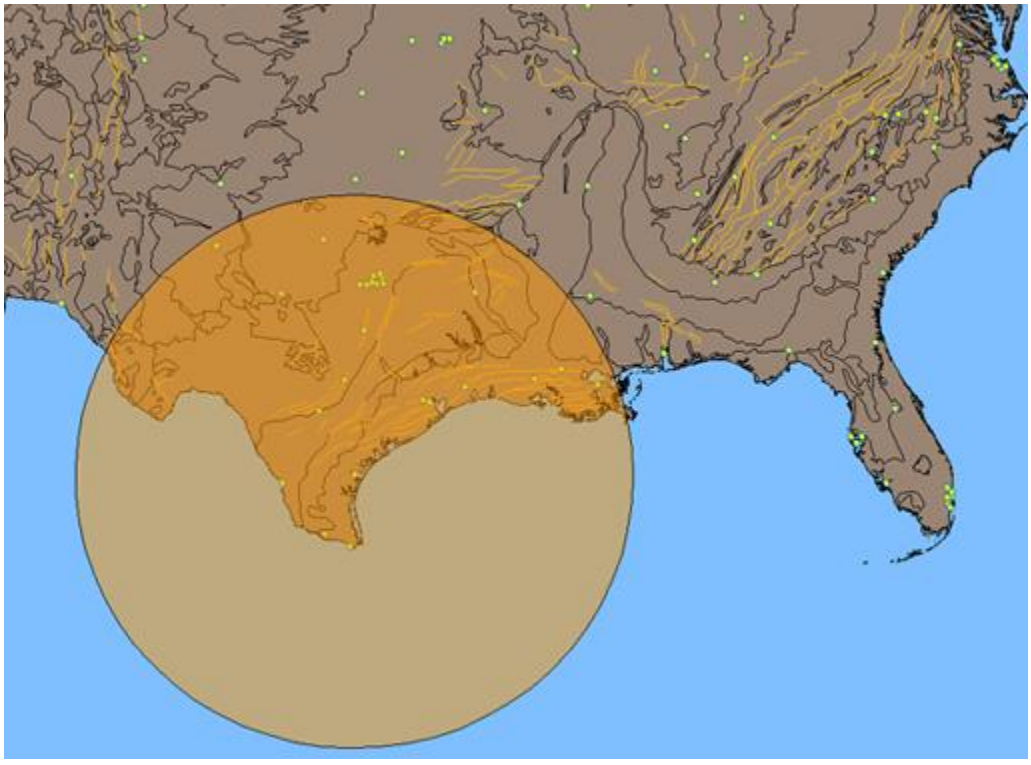
A buffer is a polygon that is drawn at a specific distance around a selected feature. It is typically used as a way to select features on the map for further analysis. Buffers can be created around points, lines, or polygons. In the Create Buffer dialog box, you specify a distance value for the buffer. If the selected feature is a point, then the distance is the radius of a circle around the point. Spatial analysis on a point buffer feature could be used to identify the number and location of wells within a specific distance from a chemical spill. If the selected feature is a line or polyline, then the buffer value represents an offset distance for the line or polyline. Spatial analysis on a line, polyline, or polygon buffer could be used to identify residential properties affected by specific noise decibel levels adjacent to a proposed runway expansion at an airport. Buffers for multiple features can overlap one another.

The following illustrations show a polygon buffer on the left, and a polyline buffer on the right.



The buffer is created as a polygon on its own layer. By default, it is styled to be semitransparent and is saved externally as an SDF file.

The following illustration displays the result of a buffer operation around a city point, using a distance of 500 miles.

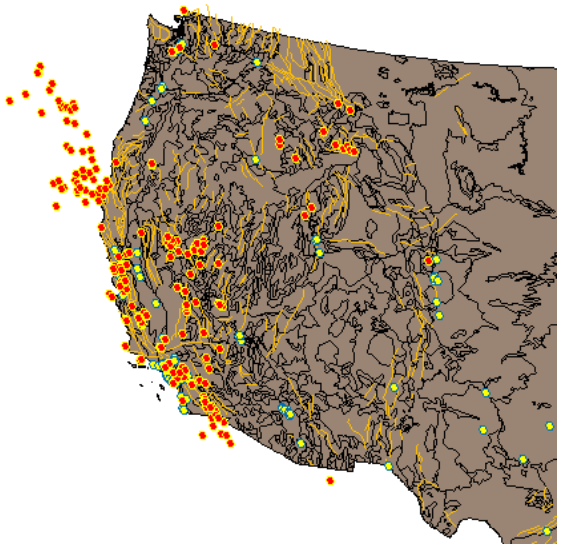


Overlapping Buffers

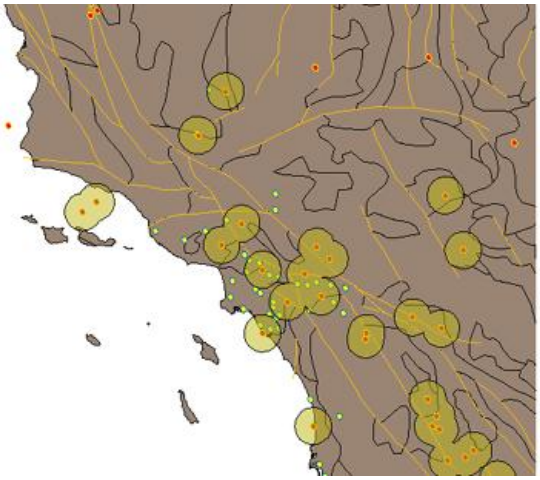
A more complex analysis involves using multiple buffers for multiple sources of data such as points and lines.

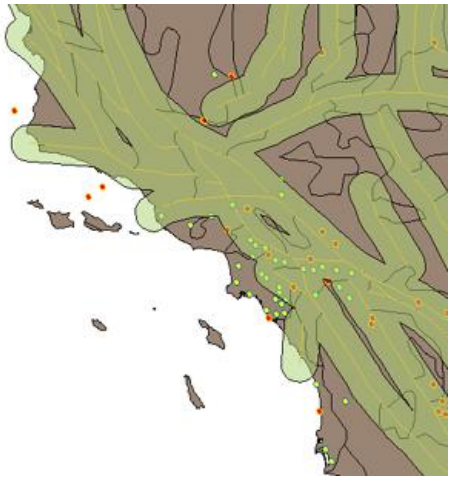
Suppose you are researching seismic activity in the western U.S. You have already created a map (shown in the next illustration) that shows all the earthquakes of a magnitude 6 or more (the red circles), the municipalities with a population of 100,000 or more (the yellow circles), and the major fault lines. To produce this map, you combined property and location queries and display the data from various sources.

You are required to identify and display the municipalities in the Los Angeles area that are at the greatest risk, based on past earthquake activity and the proximity of the municipalities to fault lines.



The first analysis step is to create a point buffer layer to show the areas within a specific distance of a past earthquake, say 10 miles. The buffers around the individual earthquake points can overlap to form continuous zones, as shown in the next image on the left. The same procedure performed with the fault lines creates a polyline buffer layer (shown on the right).





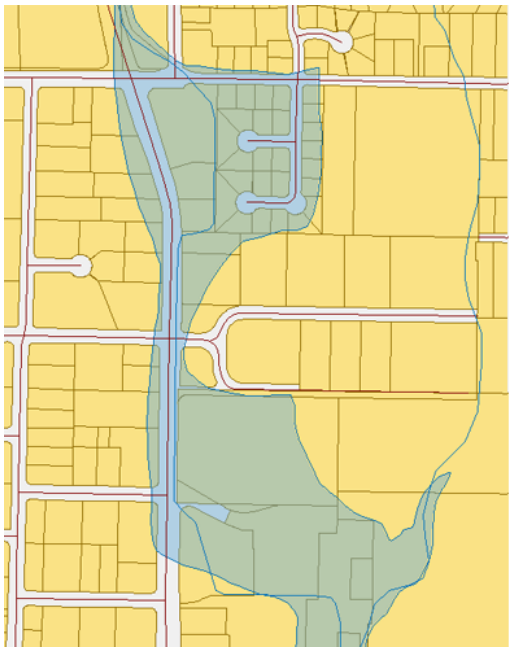
Once the buffer zones are created, a multiple-location query can be used on the municipalities layer to isolate those municipalities that are within one or more of the buffer zones. These municipalities are located within 10 miles of a past epicenter or within 10 miles of a major fault line.

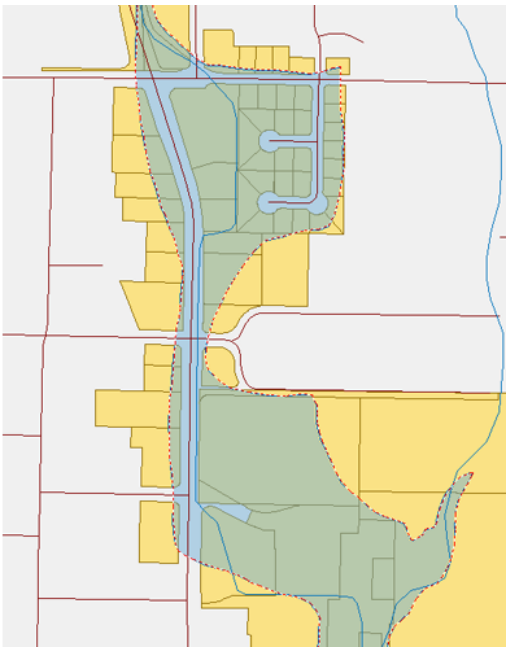
Overlay Analysis

An overlay analysis is very useful to create new feature layers from existing feature layers. Overlay analysis compares two layers that are spatially related. One layer is designated the source layer, and one is designated the overlay layer. The overlay operation produces an output layer that is saved as an external SDF file. The features and attributes of the new layer vary, depending on the type of overlay operation you perform.

A typical application of a type of overlay analysis method is shown in the following illustration. The top image displays a city map with contours. To create a new layer of contour polylines that are located inside the parks and areas of open space in the city, an overlay analysis is used. The source layer is the contour data, and the overlay layer is the parks data. This overlay analysis type is called an “intersect.” The result is a new layer (an external SDF file), containing only the contours within the boundaries of the parks, as shown in the second image.

The ability to restrict the display of features is very useful. However, the main advantage of using the overlay method is to create a new layer based on the analysis. For example, in the following illustration, the transparent blue polygon represents a flood plain. With an overlay analysis, you can easily isolate the features. In this case the isolated feature are the parcels that are inside, or touching any part of, the flood plain.





Source and Overlay Layers

The geometry in the layers that are selected as the source and overlay layers determines the result of the analysis. Only certain types of geometries can be combined. For example, union and symmetric difference support polygon/polygon comparisons only. Point layers cannot be specified for both source and overlay layers. If a point layer is selected as the source layer, only polygon layers can be selected as the overlay layer.

The order of the layers selected is important. To compare line and polygon geometries, the line geometry must be the source layer. If a polygon layer is selected as the source layer, line layers are not available as the overlay layer.

Overlay Operations

The type of overlay operation available is dependent upon the geometry chosen for the source and overlay layers. The list of possible operations includes Intersect, Union, Erase, Identity, Clip, Paste, and Symmetric Difference.

Intersect

Intersect determines the geometry that overlaps in the Source and Overlay feature sources. Features that do not overlap are discarded from the output, so the resulting layer represents the common layers between the source and overlay. Use Intersect to find points or lines that lie within a polygon, or to determine the places where two line features overlap. The Intersect operation is useful to locate and identify tree points that are within park polygons.

The resulting layer has the attributes of both the Source and Overlay features.

Intersect supports the following geometry types:

Intersect: line/line	
Intersect: line/polygon	
Intersect: point/polygon	
Intersect: polygon/polygon	

Union

Union determines the geometry that exists in either the Source or Overlay geometry. Where the geometry intersects, additional features are created. The resulting layer is the sum of the two comparison layers. Use Union to combine two related polygon features. For example, create a new feature source that combines the business district and the theater district when these two areas overlap.

The resulting layer has the attributes of both the Source and Overlay features.

Union supports polygon/polygon comparisons only.

Union: polygon/polygon	

Erase

Erase determines the geometry from the Source that does not intersect with the Overlay. The intersecting pieces are discarded. Use Erase to subtract a geometric section from a feature class. For example, find all roads that lie outside the enterprise district, or all hospitals that are outside the flood zone.

The resulting layer has the attributes of the Source feature only. Erase supports the following geometry types:

Erase: line/polygon	
Erase: point/polygon	
Erase: polygon/polygon	

Identity

Identity creates new features where the Source and Overlay features intersect. Use Identity to split features at the point where they intersect with another feature class, and to create new features at that point. For example, divide roads or parcels where they cross county borders.

Feature attributes from both the source and overlay are included in the resulting features, but only the intersecting features have the values from both. If AutoCAD Map 3D splits an original feature to produce an output feature, it uses the Split/Merge rules to determine how to assign the attributes. When that occurs, attributes of the Overlay feature are appended to the resulting features. Nonintersecting Source features retain their original properties.

Identity supports the following geometry types:

Identity: line/polygon	
Identity: point/polygon	
Identity: polygon/polygon	

Clip

Like Intersect, Clip creates features from the areas of the Source that overlap with the Overlay.

Use Clip to find features that lie within a geometric area. For example, find hydrants within a development, or road segments within a particular neighborhood.

If AutoCAD Map 3D splits an original feature to produce an output feature, it uses the Split/Merge rules to determine how to assign the attributes.

When you use Clip, only feature attributes from the Source are included in the resulting layer.

Clip supports the following geometry types:

Clip: line/polygon	
Clip: point/polygon	
Clip: polygon/polygon	

Paste

Paste creates new features by pasting the Overlay features onto the Source features. All Overlay features become new features in the resulting layer. In addition, areas of the Source that do not fall within the geometry of the Overlay become features in the resulting layer. Use Paste to combine two overlapping features. For example, add the attributes of city districts to the developments they overlap.

The output layer has attributes from both the Source and Overlay. Features resulting from the Source geometry have values for Source attributes, but their Overlay attribute values are NULL. Features resulting from the Overlay geometry have values for Overlay attributes, but their Source attribute values are NULL.

Paste supports polygon/polygon comparisons only.

Paste: polygon/polygon	

Symmetric Difference

Symmetric Difference determines geometry in the Source and Overlay that does not overlap. Overlapping areas of the features are discarded in the output. The nonoverlapping areas become new features. Use Symmetric Difference to find areas that are mutually exclusive in two feature classes. For example, find new housing developments that are outside existing school districts.

The output layer has attributes from both the Source and Overlay. Features resulting from the Source geometry have values for Source attributes, but their Overlay attribute values are NULL. Features resulting from the Overlay geometry have values for Overlay attributes, but their Source attribute values are NULL.

Symmetric Difference supports polygon/polygon comparisons only.

Symmetric Difference: polygon/polygon	

Key Terms

Spatial Analysis	Spatial Analysis is the process of using geospatial data layers to create new data layers in order to answer questions and make decisions.
Buffer	A buffer is a polygon that is drawn at a specific distance around a selected feature. After being created, the buffer is a new data layer that can be stylized.
Overlay Analysis	Overlay analysis compares two layers that are spatially related. One layer is designated the Source layer, and one is designated the Overlay layer. The Overlay operation produces an output layer that is saved as a separate SDF file. The features and attributes of the new layer vary, depending on the type of Overlay operation you perform.
Overlay Operations	The type of Overlay operation available is dependent upon the geometry chosen for the source and overlay layers. The list of possible operations includes Intersect, Union, Erase, Identity, Clip, Paste, and Symmetric Difference.

Exercise 1: Create a Buffer Analysis

In this exercise, students create a 100’ (30.48 m) buffer around a stream.

At the end of this exercise, the drawing displays as shown.

For this exercise, open …*I_Analyze-EX1.dwg* (*M_Analyze-EX1.dwg*).

Exercise 2: Create an Intersection Overlay Analysis

In this exercise, students create an overlay analysis using Parcel data and 100 year flood zone data. The purpose of this analysis is to determine which parcels are located within the flood zone.

At the end of this exercise, the drawing displays as shown.

For this exercise, open …*I_Analyze-EX2.dwg* (*M_Analyze-EX2.dwg*).

Assessment

Challenge Exercise

Instructors provide a master or challenge exercise for students to do based on this lesson.

Questions

1. What is a buffer?
2. What is the main purpose of overlay analysis?
3. When would you use a Union Overlay option?
4. This diagram is the result of what type of overlay analysis?

Answers

1. A buffer is a polygon that is drawn at a specific distance around a selected feature. After being created, the buffer is a new data layer that can be stylized.
2. The main purpose of overlay analysis is to create new data layers based on geometric operations of existing data layers.
3. Use Union to create a new data layer that consists of the combined features of two polygon layers.
4. This is an example of a point/polygon intersection.

Lesson Summary

In this lesson, students learned how to analyze data using buffers and overlay analysis. Students learned how these methods create new layers of information. Students use these methods to provide answers to questions and to make better decisions during the engineering planning process. Students performed a buffer analysis on a stream and also performed an intersection analysis to determine the parcels that lie inside a flood plain.